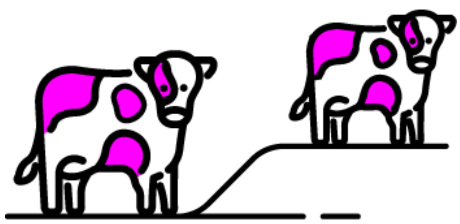
July 2026

Biomethane

Exploring the Role of Biomethane in the Energy System to 2050

NESO
National Energy System Operator

Contents



Executive summary

Biomethane is a low carbon gas that can be produced domestically and used in place of natural gas, supporting the decarbonisation of the energy system. Biomethane currently plays a relatively small role in GB's energy system but there is potential for this role to grow in scale and importance.

As the organisation responsible for planning GB's future energy system, NESO needs to understand the contribution biomethane could make alongside other low carbon technologies and fuels, and the implications for future energy infrastructure.

We have undertaken a project to explore the possible role of biomethane in the energy system out to 2050. This considers three questions: what value could biomethane deliver across different end uses, what would it take to scale up biomethane production, and what decisions and actions are needed to maximise the value from biomethane.

As part of our work, we carried out extensive analysis and engaged with stakeholders across the energy, networks, agriculture, waste and environmental sectors.

The findings will help inform NESO's strategic planning activities, including the Strategic Spatial Energy Plan (SSEP) and Regional Energy Strategic Plans (RESPs), as well as other activities such as the Future Energy Scenarios (FES). The analysis also contributes to the commitment made by government and NESO in the Clean Flexibility Roadmap (2025) to further refine biomethane's role in the future energy system.

Our analysis finds that:

1. **Biomethane could deliver significant value across the energy system.**

Biomethane could play a role in decarbonising a range of end uses, with the potential to deliver benefits across multiple sectors in the energy system and help lower the cost of the future power system. Biomethane could provide a long-term, low carbon solution for industry and transport where electrification or other alternatives are not viable. It can also provide a transitional solution in other areas while alternative decarbonisation options mature. Carbon capture from biomethane production also has the potential to offer a relatively low-cost route to achieving permanent greenhouse gas removals.

2. **Sustainable biomethane production can increase substantially beyond current levels, but challenges and trade-offs increase with scale.**

The role biomethane can play in the future energy system depends on the extent to which production scales up. Based on our analysis, as biomethane production increases, we would expect a growing number of dependencies, trade-offs and risks to emerge and increase. These challenges span across sectors, including agriculture and environment.

We conclude that cross-sector collaboration is needed to assess a biomethane production ambition that strikes the right balance between the significant benefits biomethane can deliver to the energy system alongside the wider challenges associated with increasing feedstock availability.

Our analysis indicates that these wider challenges may only start to materially emerge beyond an ambition of around 30 TWh per year by 2050. This volume is considerably higher than the current annual production of 6 TWh, meaning there is substantial scope for continued growth without significant dependencies, trade-offs and risks around feedstock availability.

Sustainable biomethane production has the potential to rise well above 30 TWh. FES 2025 explores pathways reaching up to 64 TWh by 2050. This volume is feasible but is within a range where we believe a cross-sector assessment of the appropriate level of ambition should be conducted.

Any growth in biomethane production is reliant on policy support, at least in the short- to medium-term, and on overcoming barriers to gas grid injection.

3. **A strategic approach and cross-sector collaboration could maximise biomethane's value in the future energy system.**

A government-led, strategic approach, involving cross-sector collaboration, could help maximise the value that biomethane delivers to the energy system and the wider energy transition. This involves:

- Assessing a biomethane production ambition that strikes the right balance between the benefits biomethane can deliver against the dependencies, trade-offs and risks associated with scaling production.
- Identifying hard-to-decarbonise applications where biomethane could deliver the greatest value and implementing the policy needed to support the use of biomethane in those markets.

Together, these decisions and actions could provide greater confidence in future availability of biomethane for particular sectors. This would help inform infrastructure and investment decisions, which could, in turn, deliver additional benefits such as cost savings against alternative decarbonisation routes.

1. Understanding biomethane

Biomethane is a low carbon gas produced from various biological feedstocks. It can be used as a drop-in alternative to natural gas.

Biomethane is produced primarily via anaerobic digestion (AD), where biological materials such as animal waste or plant material are broken down and release 'biogas', a mixture of methane and carbon dioxide (CO_2).[1] The biogas is captured and upgraded by separating its CO_2 content, yielding biomethane, which is almost identical to natural gas and can be injected into the gas grid.[2]

The CO_2 that has been separated can be captured and used in sectors such as food and drink production or potentially stored as a greenhouse gas removal option. The AD process also results in a substance called digestate that can be used as a fertiliser.

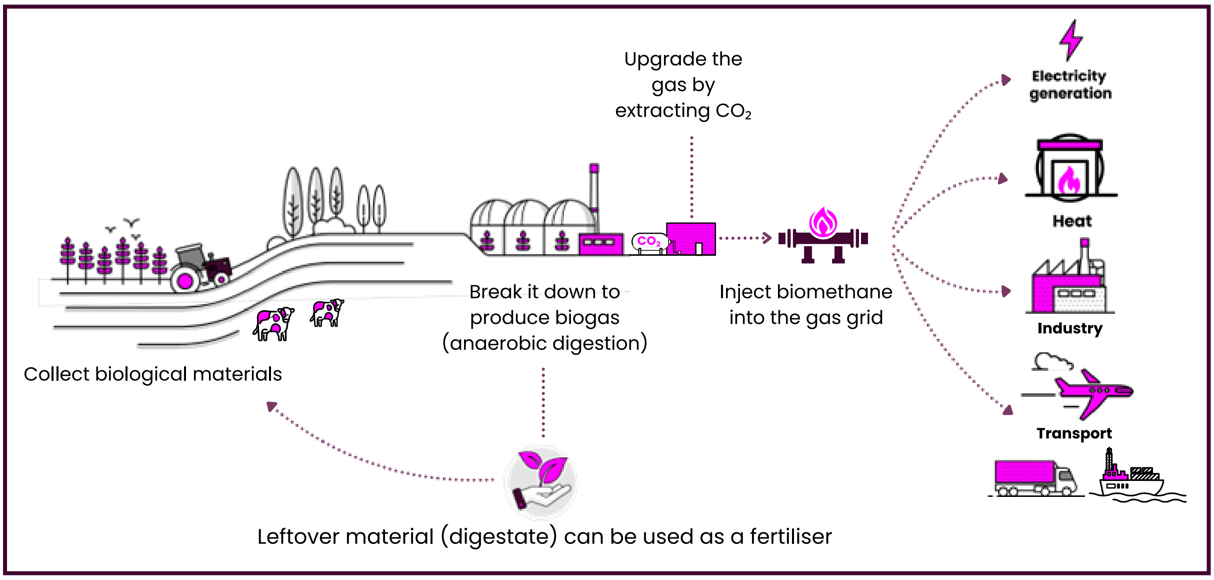


Figure 1: Simplified biomethane production process

[1] Biomethane can also be produced via other processes that are less common.
[2] There are also many plants that do not upgrade the biogas and instead burn this directly on-site in combined heat and power systems.

Biomethane must be produced sustainably to support decarbonisation.

Within this work, we have explored the potential for sustainable biomethane. We consider this as biomethane that meets the greenhouse gas and land criteria required for biomethane to receive policy support in GB. Meeting these criteria is fundamental to biomethane's role in supporting decarbonisation.

The conversion of sustainably produced biomethane into useful energy is generally treated as carbon neutral as the CO_2 emitted is biogenic. The term biogenic refers to CO_2 released from recently living biological material rather than from fossil fuels, as illustrated in Figure 2. This is why the overall greenhouse gas impact of biomethane is assessed in a different way than that of natural gas, even though they have almost identical emissions at the point of use.

However, there are other greenhouse gas emissions throughout the biomethane supply chain that must be minimised for biomethane to meaningfully contribute to decarbonisation. The greenhouse gas criteria require the emissions across the life cycle of biomethane to be below a certain threshold. These criteria cover emissions resulting from the extraction or cultivation of raw materials, land use change, processing of the biomethane or its interim products, transport and distribution activities, as well as methane leakage (including from the AD and upgrading units and digestate storage).

The land criteria, on the other hand, focus on ensuring the production of biomethane is aligned with wider environmental goals. This includes protecting biodiversity, preserving areas of high carbon stock and preventing negative impacts on soil health.

The type of feedstock used has a major impact on biomethane's lifecycle emissions: biomethane produced from waste is typically associated with lower emissions than biomethane produced from dedicated energy crops. Around two thirds of biomethane produced in GB today is based on waste feedstocks while the other one third is crop-based.

- Waste feedstocks are treated as having no emissions associated with their production,[3] reflecting the principle that they are a result of another activity and not produced for the purpose of generating energy. Using waste feedstocks also has the additional benefit of avoiding methane that would be released into the atmosphere if those wastes were left untreated. Wastes such as food waste, sewage sludge and manures naturally decompose and release methane. AD captures this methane which is then used to produce energy.
- Unlike wastes, the carbon intensity of crop-based biomethane needs to account for emissions from the agricultural production process as it uses plants grown specifically for energy production. This includes emissions associated with cultivation, fertiliser use and harvesting.

Biomethane production can also enable negative emissions if the CO_2 released during the upgrading of biogas to biomethane is captured and permanently stored. The net greenhouse gas impact of the resulting biomethane would depend on how these

[3] DESNZ (2025): *GGSS Greenhouse Gas Calculator.*

negative emissions balance against the positive emissions along the supply chain. The biomethane would be considered carbon negative if the negative emissions exceed the positive emissions.

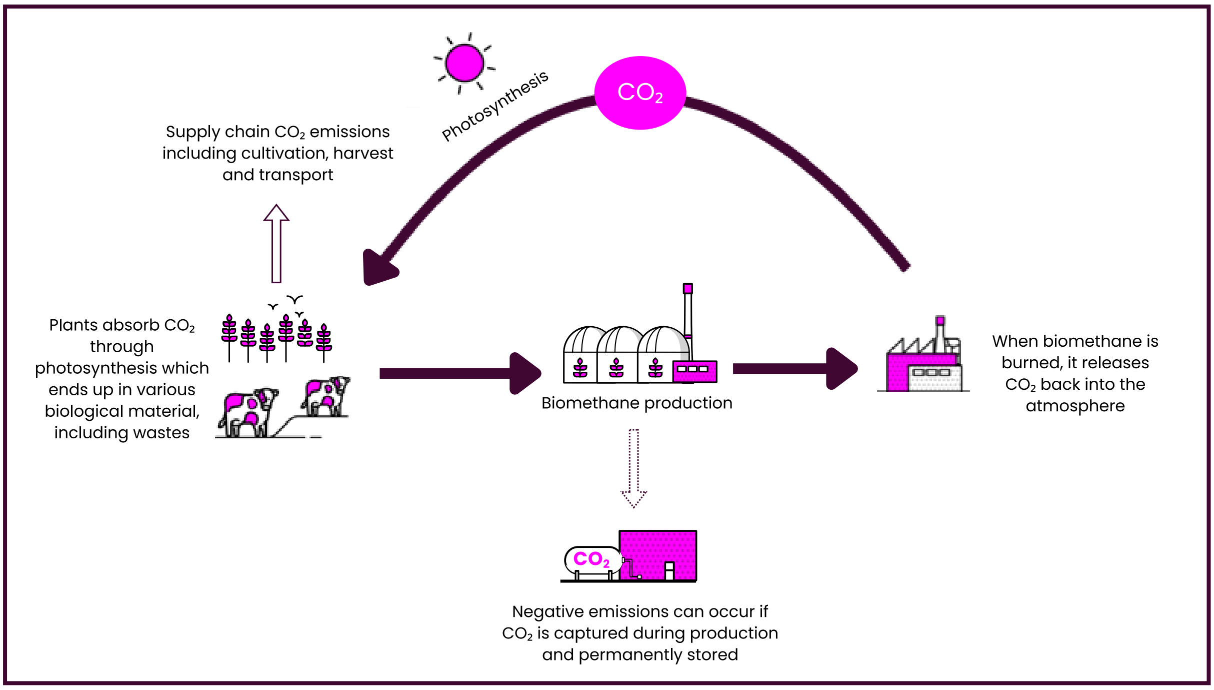


Figure 2: Simplified biomethane carbon cycle

Biomethane is currently produced in GB and injected into the gas grid.

Biomethane is already produced and used in GB. Around 6 TWh of biomethane was injected into the gas grid in 2025, equivalent to around 1% of total gas demand.[4] There are currently over 500 AD sites producing biogas, of which over 120 supply biomethane to the grid, with the remainder using the biogas locally in combined heat and power (CHP) systems. We have not explored biogas CHP systems as part of this work but they play an important role in on-site waste treatment and low carbon energy generation and there is potential for some of these to convert to biomethane injection in the future if appropriate incentives are in place.

Current policy design means most of the emissions savings driven by biomethane injected into the grid are assigned to the heat and buildings sector. However, there are also certification schemes that allow biomethane use to be allocated to other sectors. For example, some transport users, such as heavy goods vehicle (HGV) fleet owners, can choose to purchase methane certified as biomethane, akin to green electricity tariffs offered by some energy suppliers. These certificates allow users to claim lower operational emissions for sustainability targets and reporting.

[4] NESO (2026): *Ten Year Outlook 2026* (to be made available).

Current policies lead to biomethane use being allocated to heat and transport.

Biomethane production is currently supported through policy mechanisms, primarily the Green Gas Support Scheme (GGSS), which incentivises injection into the gas grid. Estimated emissions savings that are achieved through the injection of GGSS-supported biomethane into the grid are assigned to the heat and buildings sector. The GGSS closes to new applications in March 2028, with a commissioning deadline by March 2030. However, the government is expected to consult on a future framework for biomethane support to follow this scheme.[5]

Additionally, the Renewable Transport Fuel Obligation (RTFO) is the UK's main policy for increasing the use of renewable fuels in transport. The RTFO requires transport fuel providers to ensure a certain portion of the fuel they supply is renewable, which can include biomethane. In setting this requirement, the RTFO encourages fuel providers to purchase renewable fuels and to create a market for those fuels. Under the RTFO, certification mechanisms enable biomethane to be allocated to transport users, supporting its uptake in sectors such as HGVs by organisations that are seeking to reduce their emissions.

The UK Emissions Trading Scheme (ETS), which covers power, heavy industry, aviation and maritime, recognises biomethane as a low carbon gas if used via a direct supply as opposed to from the gas grid. However, most gas-using facilities access gas supply through the grid. The UK ETS does not currently differentiate the emissions implication of grid-injected biomethane from natural gas, meaning there is not an incentive for gas grid-connected sites to use biomethane to reduce emissions. However, the government is considering how grid-injected biomethane can be recognised under the UK ETS.

Looking beyond today, there is potential for biomethane to scale up and for its role in the energy system to evolve, which we explore in the following chapters.

[5] Future policy framework for biomethane production: call for evidence - GOV.UK

2. The value of biomethane in the energy system

Biomethane could play a role in decarbonising a range of different end uses with the potential to deliver benefits across multiple sectors in the energy system. It can lower the cost of decarbonisation and offer a transitional or long-term low carbon solution where alternatives are not viable. Biomethane could also enable permanent greenhouse gas removals at lower cost than various alternative methods.

This chapter sets out the benefits that biomethane can offer in hard-to-decarbonise areas of the energy system as well as through greenhouse gas removals. Cross-sector collaboration is needed to develop a biomethane production ambition that balances the potential benefits of biomethane laid out in this chapter against the trade-offs, risks and dependencies involved in scaling up. The latter are discussed in the next chapter.

The future energy system needs low carbon gas.

Electrification is the main route by which the energy system will decarbonise. This is supported by analyses including our Future Energy Scenarios 2025 (FES), which explores different ways GB can reach a net zero energy system.[6] It also reflects the Climate Change Committee's (CCC) advice for reducing emissions in the UK and, in the global context, the net zero roadmap developed by the International Energy Agency. All three net zero pathways in FES 2025 see electricity providing upwards of 70% of final consumer energy demand by 2050 in GB. However, the need for gas and liquid fuels persists in meeting most of the remaining share.

Gas will remain important for security of power supply during periods of low renewable energy output or high electricity demand and in meeting hard-to-electrify energy needs across other sectors. As a low carbon gas, biomethane can play an important role alongside hydrogen and natural gas with carbon capture and storage (CCS). While rapid progress on these solutions is crucial for reaching net zero, having more biomethane available could offer optionality for achieving some of the necessary emissions reductions and offer particular benefits for some end uses, as discussed in detail later in this chapter.

In FES 2025, biomethane's contribution to the gas mix varies between different net zero pathways but is smaller than both that of natural gas with CCS and hydrogen in all three pathways (see Figure 3). Holistic Transition includes the greatest amount of biomethane of the three net zero pathways, scaling to around 64 TWh by 2050, representing a ten-fold increase on current biomethane supply volumes.

[6] The differences emerge from the choices and uncertainty in areas such as speed of technology uptake, prominence of different solutions and levels of consumer engagement. A Falling Behind scenario, which fails to meet net zero, is included for comparison against the net zero pathways.

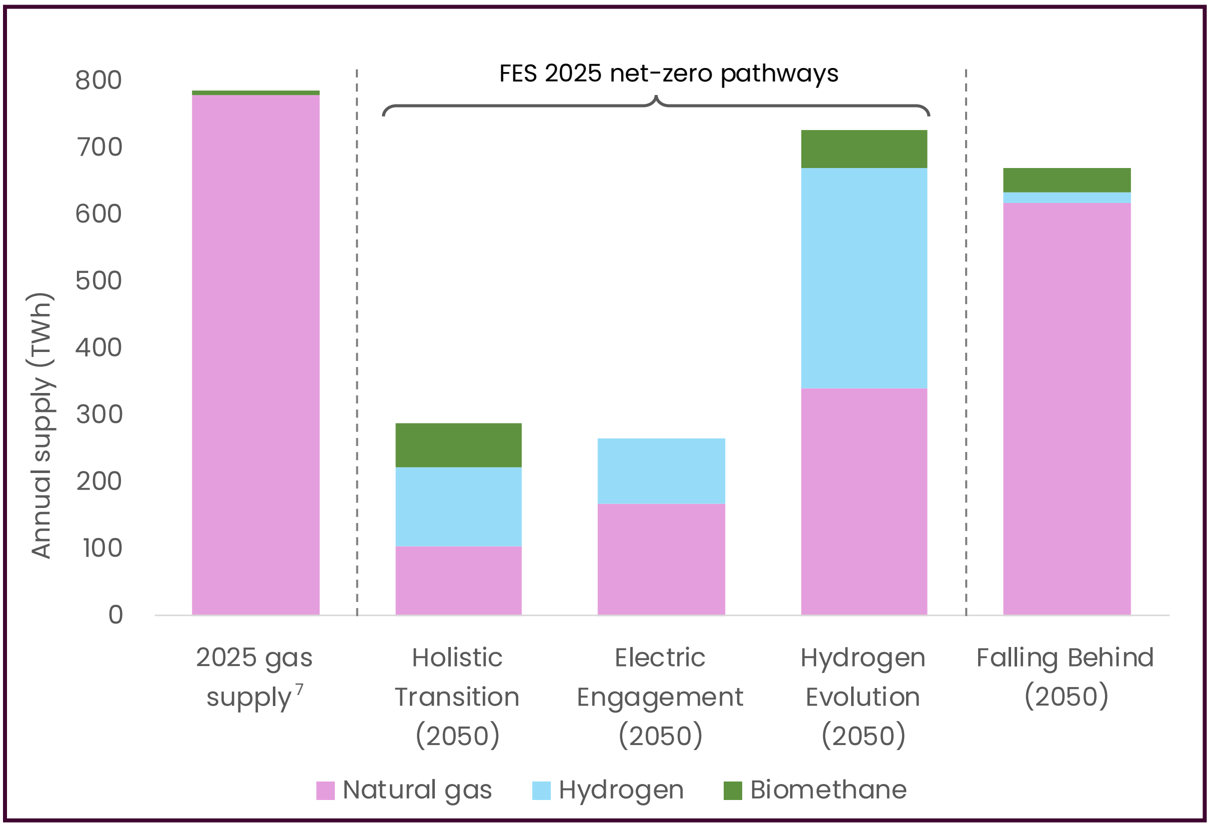


Figure 3: Supply of different gases in 2050 in each FES 2025 pathway. Gas supply for 2025, taken from NESO's Ten Year Outlook 2026, is shown for reference.[7] Natural gas supply in 2050 in the net zero pathways tends to be associated with CCS, such as in power generation with CCS or blue hydrogen production, the latter of which is 38-157 TWh across these pathways.

Biomethane costs are comparable to projected hydrogen costs, while bridging the cost gap with natural gas requires policy support.

The cost of biomethane will affect the role it plays in a future energy system, particularly the cost relative to other low carbon gas and liquid fuels such as hydrogen, CCS and e-fuels (low carbon fuels made by combining clean electricity, hydrogen and captured CO_2).[8]

There are several factors, such as asset size and feedstock type, that influence the levelised cost of biomethane production. Levelised cost refers to the total lifetime cost of a project, including both upfront and operational costs, spread across all the energy it produces. Current levelised production costs lie within a range of £73-£135/MWh.[9] The development of larger anaerobic digestion (AD) assets can push costs to the lower end of this cost range, while needing to access more expensive feedstocks can contribute to

[7] NESO (2026): *Ten Year Outlook 2026* (to be made available).
[8] For consistency, all presented costs are adjusted to 2024 prices.
[9] Source of underlying data: Baringa/Cadent (2025). Assumed AD asset size: 7-36MW. Excludes carbon capture or secondary revenues. A conversion to a levelised cost of electricity would need to reflect efficiency losses at the point of generation.

costs reaching the higher range. Further cost reductions over time are also feasible (see our 'Stakeholders tell us' box) which could lower the cost range.

For cost comparison purposes, our previously published 2050 hydrogen costs are within a range of £73-130/MWh,[10] although green hydrogen costs in particular are subject to many uncertainties such as electricity price and electrolyser capacity factors. While current biomethane costs are already similar to longer-term projected hydrogen costs, hydrogen deployment is also more likely to require purpose-built infrastructure, depending on the end use. These characteristics should be considered alongside the limited and uncertain scale of biomethane production out to 2050. There may also be costs associated with enabling higher volumes of biomethane injection into gas networks, although these are expected to be relatively modest when compared to the development of entirely new infrastructure.

Comparison between levelised production costs of biomethane and combined 2025 natural gas and carbon prices (£41/MWh) highlights the need to bridge an existing cost gap.[11] This gap could widen or close in the future depending on longer-term natural gas and carbon prices. The cost of gas, including carbon prices, is projected to lie within a range of £26-70/MWh by 2050.[12] DESNZ forecasts indicate that this may require pricing at the upper end of this range to support the achievement of net zero (£65/MWh by 2050).[13]

The Green Gas Support Scheme (GGSS) is currently playing an important role in closing the cost gap by subsidising the production of biomethane via tariff payments to biomethane producers.

Over time, reliance on subsidy support for biomethane can reduce through achieving cost reductions and through the development of secondary revenue streams. In some instances, these revenue streams already exist and operators are already able to leverage additional revenues, such as through green gas certificates, gate fees for waste treatment and CO_2 utilisation markets. Additional revenues are already considered by DESNZ when setting tariffs for the GGSS, helping to reduce the required subsidy level.[14] There are other potential revenue opportunities through making greater use of the CO_2 and digestate that result from the biomethane production process (see our 'Stakeholders tell us' box). In particular, carbon capture from biomethane production has potential to

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[10] Costs based on projections from our prior work. Range represents a combination of blue and green hydrogen (electrolyser capacity factor: 60%, electricity price: £65/MWh).
[11] NESO (2026): *Ten Year Outlook 2026* (to be made available). Employed an average 2025 natural gas price of £30/MWh and a traded carbon price of £63/tonneCO_2e (equivalent to £11/MWh assuming methane combustion).
[12] NESO (2025): *Future Energy Scenarios*: *Pathways to Net Zero 2025*. For 2050, natural gas projection: £11-36/MWh. Carbon price projection: £78-178/tonneCO2e (equivalent to £15-34/MWh for the combustion of methane). NB: Not all consumers pay carbon prices. Geopolitical impacts and potential new policies beyond those currently in place are not included.
[13] Cost includes natural gas price (DESNZ, 2025) and market traded carbon value (DESNZ, 2026).
[14] DESNZ (2021): *Final Stage IA*: *Green Gas Support Scheme/Green Gas Levy*, page 55 – assumptions on GGCs are reflected in tariff setting.

offer a lower cost means of greenhouse gas removal relative to various alternative technologies, which is discussed further in a following section.

Stakeholders tell us: Insights from industry suggest that biomethane production costs may be reduced by addressing several key barriers. Firstly, stakeholders have highlighted the economic benefits of developing larger AD assets although it has been emphasised that current support mechanisms create a challenge in delivering larger assets. Additionally, the importance of overcoming challenges associated with gas grid connections, gas grid constraints and 'propanation' have been emphasised by the sector.[15]

Stakeholders have also highlighted the potential to lower biomethane production costs by leveraging secondary revenue streams from biomethane by-products, including biogenic CO_2 for utilisation or greenhouse gas removals, and selling digestate as a fertiliser.[16] However, several stakeholders have noted there are barriers to overcome for these secondary revenues to become more viable.

We have explored the potential role of biomethane across three hard-to-decarbonise sectors.

As the energy transition progresses there will be a particular need for low carbon gases in hard-to-decarbonise end uses. We have considered the use of biomethane for three end uses that are established as needing a low carbon gas option or being hard-to-electrify in the transition to net zero. These are low carbon dispatchable power (LCDP), hard-to-electrify industry and hard-to-electrify transport. Exploring these example end uses helps to build an understanding of the benefits biomethane could deliver. However, we have not prioritised these in relation to each other. We also have not assessed potential uses of biomethane for other end uses as part of this work, such as for home heating or data centres.

Future use of biomethane will be, in most cases, dependent on access to the gas grid. While this piece does not explicitly consider the future of the gas grid, the Gas Market Roadmap (GMR) sets out NESO's considerations in this area.[17]

Our discussion of the use of biomethane in the following sectors assumes that use is assigned through end users purchasing certificates to represent biomethane use, rather than relating to where biomethane is physically flowing to in the grid.

A role for biomethane in low carbon dispatchable power could reduce the cost of the future power system.

The transition to a fully decarbonised energy system by 2050 will require a large amount of power generation capacity being built, both to replace decommissioned assets and to increase overall generation capacity to meet the growing electrification of demand. We

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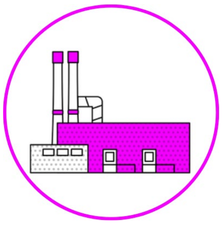
[15] Biomethane, due to its lower calorific content relative to natural gas, is currently supplemented with small quantities of propane for its injection into the gas grid. This is to ensure consumers are billed fairly for the gas they receive, but other routes are being explored to achieve fair billing.
[16] Secondary revenues opportunities are explored in further detail in work by Baringa/Cadent.
[17] NESO (2026): *Gas Market Roadmap*

have conducted analysis to consider what the power system might look like between 2031-2050 with and without biomethane available for low carbon dispatch.[18]

LCDP



LCDP refers to low carbon power generation that can turn up and down relatively quickly to match demand needs, regardless of the weather. There will remain a long-term need for this kind of flexible low carbon supply during periods of low renewable generation or higher electricity demand when storage options (such as batteries and pumped hydro) are unable to meet the need for longer duration supply. Utilising biomethane in conventional gas power plants provides an option, alongside others including hydrogen to power, power from gas with CCS and biomass, as a source of low carbon dispatchable power.

Our analysis suggests that using biomethane in power generation can reduce the costs of the future power system compared with not having biomethane available. Where biomethane is made available, our model identifies a small reduction in the need for new generation assets and related infrastructure, lowering the capital investment required for building the future power system. This could ultimately mean reduced costs on consumer bills, but achieving these savings has important dependencies that we discuss in Chapter 4.

Using biomethane in the unabated gas fleet would likely be a more geographically distributed low carbon dispatch option relative to some other options, such as hydrogen to power and gas power with CCS (gas CCS) whose locations will be constrained by their ability to access hydrogen or CO_2 networks. This aspect of biomethane could offer advantages for meeting system needs in different parts of the country.

Biomethane can play a role in decarbonising hard-to-electrify industry where CCS and hydrogen are not available.

As set out in FES 2025, the main route for industry to decarbonise is via electrification but this will not be possible for all industrial processes. Biomethane could be one of the low carbon options available, alongside hydrogen and CCS, for industrial processes that are difficult or not possible to electrify such as generating high-temperature heat or for use as chemical feedstock.

There is a potentially valuable role for biomethane to play in decarbonising hard-to-electrify industry that sits outside industrial clusters. Work is underway to deploy dedicated pipeline and storage infrastructure in industrial clusters to enable hard-to-electrify sites in these locations to access CCS and hydrogen as a path to a low carbon future. However, uncertainty remains over the availability of such infrastructure for sites

[18] We have used our capacity expansion model (CEM) for this analysis covering electricity and hydrogen generation and storage. This model is designed to optimise what capacity is built by type and location at the lowest system cost. Our CEM is implemented in the PLEXOS software and was used for the first time in our FES 2024 publication.

that sit outside these industrial clusters. Our analysis indicates that these dispersed industrial sites make up around half of the gas demand attributed to hard-to-electrify processes in GB.[19] If sufficient biomethane becomes available to meet corresponding demand, it may represent the most practical or economic long-term route to reducing emissions for some of these sites such as glass and ceramics producers, if other solutions do not emerge.

While these dispersed, hard-to-electrify sites may rely on biomethane as a long-term decarbonisation solution, there may be an additional role for biomethane as a transitional fuel for hard-to-electrify sites within industrial clusters before hydrogen and CCS become available or as part of completing their asset investment cycle.

Demand may also emerge from sites needing to install CCS for decarbonising process emissions (for example, cement production sites). Once CCS infrastructure is installed, coupling biomethane use with CCS at such sites could generate greenhouse gas removals, subject to economic viability at the project level.

Biomethane use in transport is growing, with the long-term role heavily dependent on the scale-up of other decarbonisation options.

Currently, the main role of biomethane in transport in GB is in heavy goods vehicles (HGVs), using around 1 TWh of biomethane in 2025 (around 1% of total HGV fuel demand). While much of surface transport is expected to transition to electric vehicles in the future, low carbon fuels could play a growing role targeting sectors where electrification is more challenging. These sectors include shipping and aviation, potentially long-haul, heavy-duty HGVs and certain industrial and agricultural vehicles. The total demand for low carbon fuels across transport will be high, with demand in the CCC's Seventh Carbon Budget reaching towards 100 TWh by 2050.[20]

The role that biomethane could play in meeting low carbon fuel demand in transport depends on the pace and scale at which alternative decarbonisation options develop and their relative cost. As many of these alternatives are at a nascent stage, this future role for biomethane and the scale of demand is highly uncertain. Currently, the key benefit of biomethane in transport is in reducing emissions from sectors where alternative decarbonisation options are not available, or not available yet at the required scale.

The risk of methane leakage is an important factor to be considered regarding the potential role for biomethane in transport. Despite emission reductions from using biomethane compared to conventional fuels, there are significant concerns that methane leakage could offset much or all of these savings. While methane can leak during

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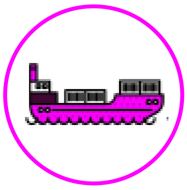
[19] Site level gas demand and locational data was sourced from the CCC's Net Zero Industry Pathway (N-ZIP) model, published in 2020, and relevant updates were made to reflect site closures.
[20] The CCC's Seventh Carbon Budget Balanced Pathway has synthetic fuel demand for shipping of around 40 TWh and SAF demand of over 50 TWh by 2050 (the CCC does not assign any low carbon fuel to HGVs). It is not expected that biomethane or competing feedstock would cover all of this demand. Inefficiencies in the conversion process could lead to several TWh of biomethane or feedstock being required for each TWh of SAF produced such that any demand for biomethane from SAF could be significantly higher.

production and supply for any use, using it in transport creates additional sources of methane leakage. Methane leakage occurs where unburnt methane is released from the engines of vehicles during use especially at low loads such as ships with low cargo, plus leakage from storage has been particularly highlighted in LNG storage for shipping.

HGVs

Ongoing challenges for electric HGVs in long-distance, heavy-duty applications include concerns around range, charging infrastructure and upfront cost. These challenges have led to organisations with internal decarbonisation targets (such as major supermarket chains) driving uptake in gas-powered HGVs that run on biomethane, aided by supportive policies such as the RTFO and reduced fuel duty for methane.

Shipping



LNG uptake has been driven by the need for international fleets using EU ports to meet FuelEU emissions targets while longer-term options such as methanol and ammonia are not yet deployed at scale. Although LNG is a fossil fuel, LNG still offers emissions savings relative to conventional shipping fuels helping fleets to meet interim emissions targets. Biomethane in the form of bioLNG is expected to contribute to the decarbonisation of these LNG vessels over time, particularly as emissions targets tighten. Industry-specific reports still show a variety of decarbonisation pathways, including some with a larger role for biomethane and biofuels more generally, highlighting the degree of uncertainty around the future fuel mix in shipping.

Pathways such as the CCC's Seventh Carbon Budget set out a limited role for biomethane in transport, in part due to concerns around methane leakage. However, current trends show the uptake of gas-powered HGVs outpacing electric HGVs, and LNG ships outnumbering other low carbon alternatives in shipping order books. These uptake rates have been driven by organisational emission reduction ambitions and policy drivers, particularly where alternatives for reducing emissions are not yet viable.

These trends suggest that demand for methane and biomethane in these sectors is likely to increase in the near-to-medium term, in contrast with long-term decarbonisation pathways.

Aviation is the area where there is expected to be a large and long-term role for biofuels, given the large scale of aviation fuel demand as a whole and the difficulty of decarbonising the sector. However, there are not clear frontrunners in the expected production methods or feedstock types for sustainable aviation fuel (SAF), so the extent to which SAF may present a demand for biomethane or competition for feedstocks is not yet clear.

Aviation

The UK SAF Mandate requires an increasing share of aviation fuel to come from SAFs. Demand is initially expected to be met by hydroprocessed esters and fatty acids (HEFA) fuels (i.e. waste oils), with demand relevant to biomethane expected to ramp up in the 2030s. Some methods for producing SAF use biomethane, some compete with biomethane for feedstocks, and others rely on non-competing feedstocks. There is the potential for complementarity as well, such as where CO_2 captured from biomethane production can be used with hydrogen to produce power-to-liquid (PtL) SAFs.

The UK SAF mandate recognises the potential competition for feedstocks between SAF and other uses, especially in the 2030s. The documentation around the mandate highlights that, as aviation is a particularly hard-to-decarbonise sector, there is a strong strategic case for prioritising feedstocks for SAF. However, there is recognition that diverting feedstocks to SAF may not deliver additional emissions savings across the economy and that SAF should be considered in the context of economy-wide emission reductions.[21]

Biomethane could play a role in delivering relatively low-cost greenhouse gas removals.

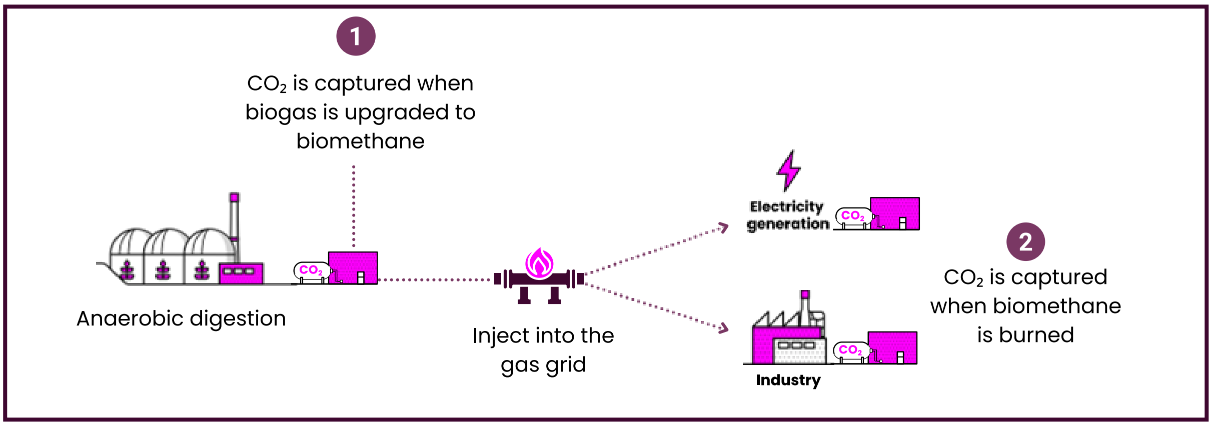


Figure 4: Opportunities for carbon capture from biomethane production and use

Greenhouse gas removals from biomethane production

CO_2 capture from biomethane production provides a route to achieving permanent greenhouse gas removals. The raw biogas produced during AD is upgraded to biomethane by extracting its CO_2 content to make it suitable for injection to the gas grid. Capturing the CO_2 released at this stage (point 1 in Figure 4) is a well-established practice, with around a quarter of biomethane plants in GB already capturing their CO_2 for use in markets such as food and beverages.[22]

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[21] The information in the UK SAF Mandate is supported by the more detailed cost benefit analysis with additional considerations set out in the consultation on crop-derived SAF.
[22] Ceres Energy (2025): *Biogas to biomethane: The carbon trail.*

As CO_2 transport and storage networks come online in the coming years, the captured CO_2 from biomethane production could be permanently stored to enable greenhouse gas removals. For illustration, a scale-up of annual biomethane production to 30 TWh could enable up to around 4 $MtCO_2$ of greenhouse gas removals (around one-tenth of the engineered removals assumed in 2050 under the CCC's Seventh Carbon Budget Balanced Pathway), if all plants captured and stored their CO_2. As most biomethane plants would be expected to require CO_2 trucking solutions to reach piped CO_2 networks,[23] the development of the infrastructure and policy and regulatory frameworks for non-pipeline transport will be crucial for unlocking this potential.

CO_2 capture from the production of biomethane has the potential to enable lower-cost greenhouse gas removals than some other methods. Biogas upgrading yields a high-purity and concentrated CO_2 stream that is more easily captured than CO_2 from combustion or directly from the air. However, biomethane plants are relatively small and dispersed sources of CO_2. In the short-to-medium term, plants far away from injection points into a piped CO_2 network may see the cost of trucking as a limitation on the economic viability of associated greenhouse gas removals. We would expect trucking distance to become a less important factor over time, with rising carbon prices enabling more plants to absorb transport costs to provide greenhouse gas removals.

Stakeholders tell us: A study commissioned by the Green Gas Taskforce estimates the cost of greenhouse gas removals from biomethane production to lie between £84-213 per tonne of CO_2.[24] Another study estimates £154 per tonne of CO_2 for the cost of the practice, under specific assumptions for a plant located in Scotland.[25] These figures sit below the estimated costs for 2030 of some other permanent greenhouse gas removal methods set out in a separate study by ERM and CO_2RE including direct air carbon capture and storage (£325-842/t CO_2), retrofit of energy from waste with CCS (£221-347/t CO_2) and enhanced rock weathering (£350-864/t CO_2).[26,27]

The scale of greenhouse gas removals from biomethane production that materialises will depend on the revenues available to operators from carbon markets (and from any policy incentives) relative to costs, as well as on how those revenues compare to the alternative of selling CO_2 into utilisation markets. Demand in these markets may grow with the development of e-fuels including SAFs. Operators would be expected to choose utilisation over permanent storage if they can access higher revenues from utilisation.

Greenhouse gas removals from biomethane use

[23] This assumes the distribution of future plants would be similar to the distribution of existing plants.
[24] Green Gas Taskforce (2025): *Biomethane GGRs.* The study breaks this down as £54-123/t CO_2 for the estimated cost of sourcing and conditioning the CO_2 from biogas upgrading and trucking it to a transport and storage network, and £30-90/t CO_2 for estimated costs attributed to Transport & Storage Companies (T&SCo).
[25] Cavanagh et al. (2024): *Onshore and inshore storage of carbon dioxide.*
[26] Range provided is for the estimated costs of liquid solvent and solid sorbent methods combined.
[27] ERM and CO2RE (2025): *2025 Update on greenhouse gas removal costs and scaling challenges*

Biomethane can also enable greenhouse gas removals if burned in a gas CCS plant or used in an industrial facility fitted with CCS (point 2 in Figure 4). The scale of greenhouse gas removals that materialises will heavily depend on which sectors see market and policy signals emerge for using biomethane, and the relative incentives for greenhouse gas removals.

Using biomethane in gas CCS plants as opposed to unabated gas plants could represent a trade-off between flexibility and greenhouse gas removals. Unabated gas plants are likely to continue providing greater levels of operational flexibility to respond to system needs than gas CCS plants will likely be able to. Gas CCS plants face increased complexities associated with interactions with CO_2 transport and storage systems and energy penalties associated with the CO_2 capture process. If using biomethane, operational choices of a gas CCS plant would likely also be influenced by the incentives in place for greenhouse gas removals.

In industry, CCS is expected to play an especially important role in decarbonising sites with a large portion of emissions coming from process emissions, such as cement and lime production. If sites that are adopting CCS anyway for process emissions also switched their use of natural gas to biomethane, capturing the emissions from the combustion of that biomethane could make a small contribution to the levels of greenhouse gas removals assumed under the CCC's Seventh Carbon Budget Balanced Pathway for the UK to net zero by 2050. The viability of greenhouse gas removals that can be achieved in this way is likely to depend heavily on policy incentives for CCS adoption more widely.

Across greenhouse gas removals, hard-to-electrify sectors and low carbon dispatchable power, biomethane has the potential to deliver significant value to the energy system. Realising these benefits depends on whether biomethane production can scale sustainably and on decisions and actions needed to maximise value to the energy system. We explore these questions in the following chapters.

3. Scaling up biomethane

The use of sustainable biomethane feedstocks could scale up significantly from today's levels, supporting a greater role for biomethane in the energy system. However, a scale-up involves increasing dependencies, trade-offs and risks impacting other sectors. The ambition for biomethane production needs to strike the right balance across all sectors. Scaling up also relies on near-term developments with the gas grid and on policy support.

This chapter sets out what a scale-up of biomethane may involve from the feedstock perspective. This can help support informed and transparent debate about what the right ambition level is for GB. We also set out some of the near-term dependencies for scaling up aside from feedstock availability.

The discussion in this chapter is based on the principle of only using sustainable routes to producing biomethane, as set out in Chapter 1. As with all bioenergy, there are also unsustainable routes to producing biomethane, and risks of adverse outcomes for example through direct and indirect land use change and methane leakage. These could reverse potential carbon savings. The risks grow at higher volumes and with stronger policy incentives and are core to the consideration of scaling up biomethane.

There is a wide range of views on the potential scale of sustainable biomethane production.

GB does not have a specific annual target for biomethane production, although the Biomass Strategy has previously set out analysis suggesting biomethane production reaching around 30-40 TWh by 2050 could help a cost-effective transition to net zero.[28] This represents a substantial increase from the 6 TWh injected into the gas grid in 2025. The Carbon Budget Delivery Plan assumes a yearly biomethane injection into the grid assigned to the heat and buildings sector of 14.7 TWh by 2035.[29]

There have been studies that have attempted to assess feedstock potential. Each of these studies has considered different time horizons, feedstock types and conversion technologies. A recent International Energy Agency study identified an existing potential of around 50 TWh of biomethane production from consideration of manures, crop residues and biowaste.[30] Another study, commissioned by the European Biogas Association and conducted by Guidehouse, has indicated potential production levels of around 150 TWh by 2050.[31]

[28] DESNZ (2023): *Biomass strategy.*
[29] DESNZ (2025): *Carbon budget and growth delivery plan.*
[30] IEA (2025): *Outlook for biogas and biomethane*. Numbers are UK-wide.
[31] Guidehouse (2026): *Biogases – Europe's overlooked path to independence?* Includes consideration of both anaerobic digestion and gasification technology. Numbers are UK-wide and consider both waste and crop-based production.

Our Future Energy Scenarios (FES) 2025 included a supply of up to 64 TWh of biomethane by 2050 across the three net zero pathways. The external analysis of sustainable biomethane feedstock potential in GB (referred to as "the external analysis" hereafter) that contributed to this, identified a range of waste and crop feedstocks that could drive a significant increase in production up to 108 TWh by 2050 in the medium scenario. A study by the Green Gas Taskforce[32] undertook a similar analysis, although this covered the UK rather than GB, resulting in a slightly higher assessment of biomethane feedstock potential of 120 TWh by 2050.

Beyond GB, several nations are already moving at pace. France, Italy and the Netherlands have all set ambitious biomethane production targets ranging from 21-60 TWh by 2030, while the EU has set a 2030 target of approximately 370 TWh to support clean energy objectives and reduced reliance on Russian gas.[33] Progress is being made in delivering on European ambitions. In 2025, France and Germany each injected more than 10 TWh of biomethane into their gas grids.[34] The potential and practicalities of biomethane production differ between nations given differences such as land area and approaches to farming, but we anticipate there to be learning opportunities across Europe to consider.

Sustainable biomethane production can substantially increase but cross-sector collaboration is needed to assess the right level.

We have considered the external analysis, wider research and information drawn from a wide range of external stakeholders to understand the potential for biomethane to scale up from the perspective of feedstock availability.

We have concluded that sustainable biomethane production can increase substantially beyond current levels. However, our analysis shows that as biomethane production scales up, we would expect a growing number of dependencies, trade-offs and risks to emerge and increase across sectors including agriculture and environment. Examples of these challenges are set out later in this chapter.

As a result, we consider that cross-sector collaboration is needed to assess a biomethane production ambition that strikes the right balance between the significant benefits biomethane can deliver to the energy system alongside these wider challenges associated with increasing feedstock availability. Ultimately, this decision on ambition would be for government to make.

Our analysis indicates that these wider challenges may only start to materially emerge beyond an ambition of around 30 TWh by 2050. This value is considerably higher than the current 6 TWh production per year, meaning there is substantial scope for continued growth without significant dependencies, trade-offs and risks around feedstock availability.

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[32] Green Gas Taskforce (2025): *A green gas future – outlining the feedstock potential for biomethane generation.*
[33] European Commission (2025).
[34] Natran (2025) - 13.5 TWh in France, German Biogas Association (2026) – 12.8 TWh in Germany.

Biomethane production has the potential to rise well above 30 TWh. For example, FES 2025 explores pathways reaching up to 64 TWh by 2050. This volume is feasible but in the range where we see a cross-sector assessment of the right level of ambition being needed.

While feedstock availability has been the focus in considering the potential scale of biomethane in the future, any growth in biomethane production is reliant on policy support at least in the short-to medium term, given the higher cost of biomethane compared to natural gas. Currently this policy support is largely via the Green Gas Support Scheme (GGSS), and a future framework is expected to follow this. Growth in biomethane production is also dependent on barriers to gas grid injection being overcome, discussed later in this chapter.

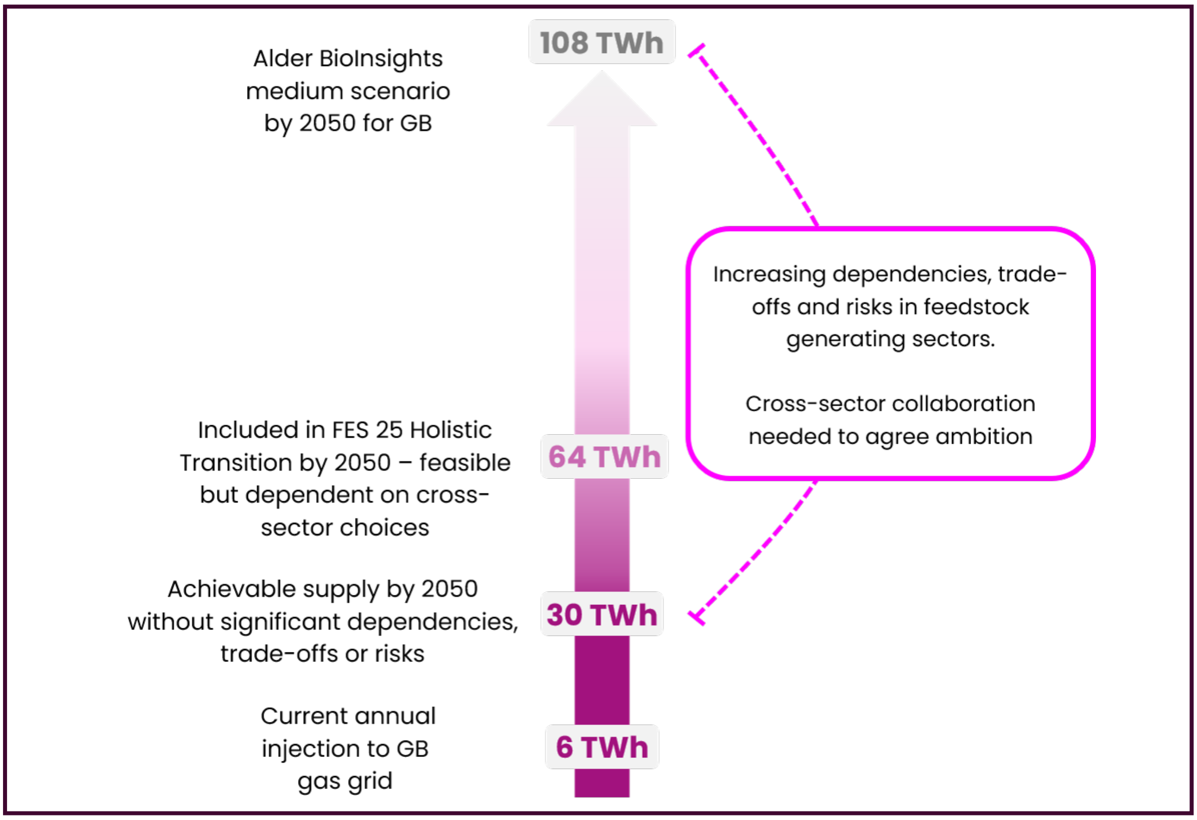

Figure 5: Biomethane scale-up potential by 2050 – a summary of key figures and sources

There are five feedstocks that could offer the most growth potential.

Scaling up biomethane production will rely upon ramping up different feedstocks. While prior studies use various assumptions on how different feedstocks can contribute, we focus on the five feedstocks that the external analysis sets out as having the most potential to drive a significant scale-up (see Figure 6). These five feedstocks are grassland, rotational crops, sequential crops, agricultural residues and livestock waste.

Below we articulate clear examples of the kind of assumptions, opportunities, dependencies and trade-offs involved in scaling up each feedstock. These examples demonstrate the need for cross-sector collaboration to assess the right biomethane production ambition and make the necessary choices to deliver it.

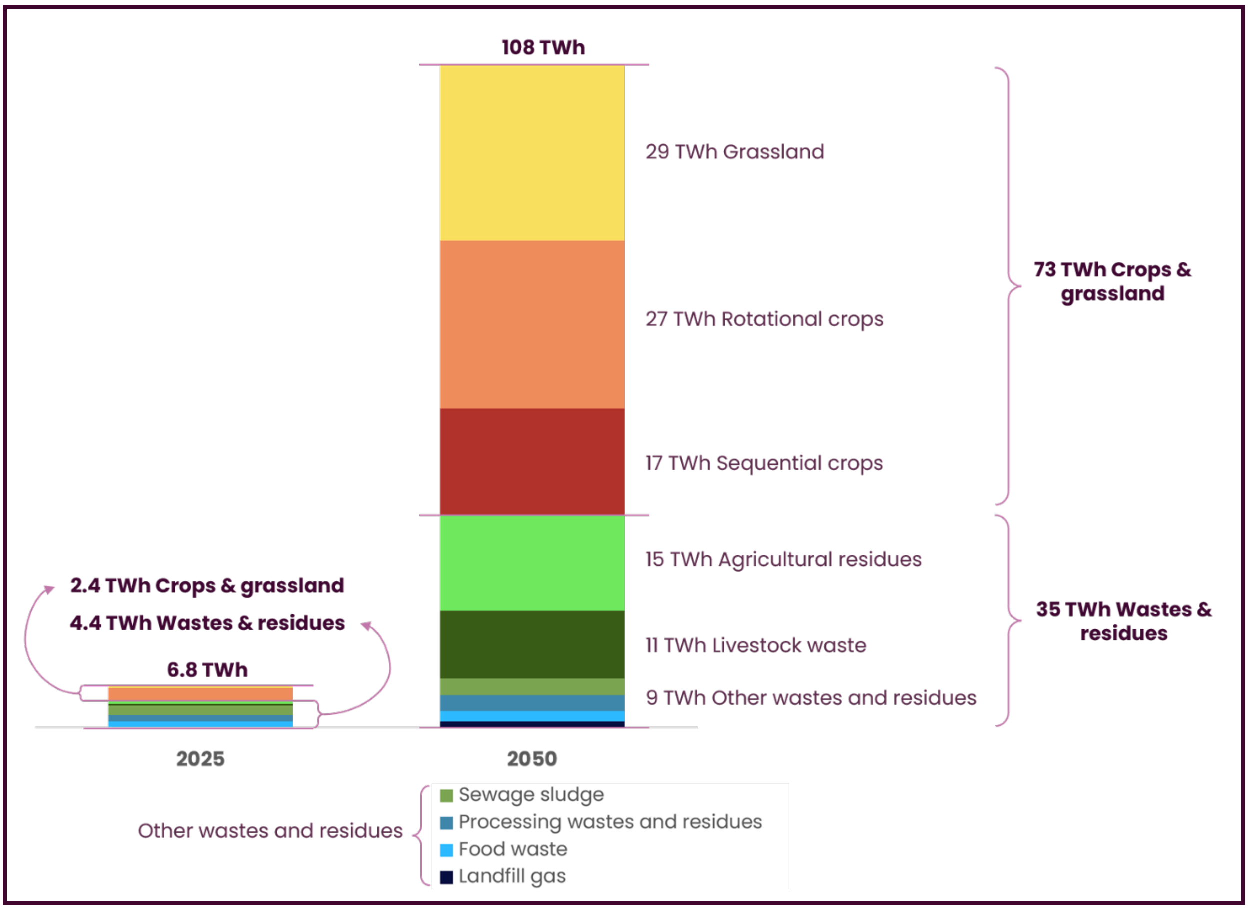

Figure 6: Biomethane feedstock mix in 2025 and feedstock potential for 2050 in the medium scenario in the external analysis conducted by Alder BioInsights.[35]

There are some key principles assumed within the external analysis relating to these feedstocks:

Dedicated land is not required for crops, and crops would not compete with food

The external analysis assumes that crops grown for biomethane production would be grown on arable land and form part of existing crop rotations in a manner that complements food production rather than competes with it.

Rotational cropping with food and animal feed crops is already a well-established practice, with different crops grown across planned cycles of four to seven years, to support soil health and manage pests and diseases. The external analysis assumes crops for biomethane production could be included as part of these rotations.

Sequential cropping is where a crop is planted to cover the soil in between the main 'cash crops'. This can support soil health, while providing an additional feedstock for biomethane production.

[35] The 2025 total represents Alder BioInsights' view on current installed capacity.

Land release from livestock reduction

The Climate Change Committee (CCC) Seventh Carbon Budget Balanced Pathway assumes that livestock numbers reduce by 38% in 2050. The external analysis adopts the same assumption, with some of the feedstock potential depending on it. Land release from livestock reduction has a particularly significant impact on the assumptions regarding grassland availability. As livestock reduces, the external analysis assumes that the grassland used for grazing can become managed grassland, where multiple cuts per year are used for biomethane production. Livestock reduction is also a dependency for some of the assumed potential from rotational crops and agricultural residues: crops for biomethane production could replace animal feed crops and straw previously required for animal bedding could be used for biomethane production. The CCC employs different assumptions on how released land is used, such as for biodiversity or climate adaptation, which is an example of where there could be trade-offs.

Opportunities, dependencies, trade-offs and risks come with scaling up biomethane.

Scaling up biomethane significantly beyond current levels brings opportunity but it also brings increasing dependencies, risks and trade-offs as ambition level increases.

A biomethane production ambition for GB needs to be based on an understanding of what it takes to achieve a scale-up and what the right balance is across all sectors. We set out key examples below of the kind of factors that need to be considered as part of cross-sector decision-making, which incorporates insights from the external analysis and a wide range of stakeholders. This is not an exhaustive list but is intended to support understanding and progress towards a clear biomethane production ambition in GB.

Livestock waste

Context: Livestock waste refers to manures and slurries from farm animals.
Opportunities: Treating more livestock waste through anaerobic digestion (AD) would avoid the release of methane which is a highly potent greenhouse gas. The resulting digestate can be spread to land, in place of the livestock waste being spread directly.
Dependencies: Growth could depend on additional policy incentives to treat livestock waste in AD to avoid the methane emissions, with examples of this in other countries. In the Netherlands, treatment of manure in AD is heavily subsidised by the state. Denmark also plans to enforce a methane tax on livestock in 2030 which could drive the use of manure as an AD feedstock.

Rotational crops

Context: The use of rotational crops in agriculture is already a well-established practice, including integration and use of rotational crops for biomethane production.
Opportunities: The integration of crops for AD can be beneficial through positive impacts on soil health and pest management due to additional crop diversity.

Risk: There is a risk of competition with food production with this feedstock type, for example if relative prices favour rotational crops for biomethane over crops for food. The scale of this risk is unclear but should be considered within an assessment of the ambition for biomethane scale-up. There is also a risk to soil health if these crops are not incorporated appropriately, with maize being highlighted as needing particularly careful management.

Sequential crops

Context: The benefits of sequential crops for soil health are being increasingly recognised, and the growth of sequential crops (also known as 'cover crops') was incentivised as part of recent government-funding initiatives such as the Sustainable Farming Incentive in England. The use of sequential crops for AD has been demonstrated in Italy.[36]
Opportunities: Sequential crops can generally help to improve soil health, reducing nutrient loss and soil erosion whilst improving soil structure.[37] The use of these crops in AD could provide a revenue opportunity for farmers.
Risk: Generally, sequential crops are left in-field to avoid disturbance of soils and to retain nutrients. The practice of harvesting sequential crops for AD could lead to soil compaction due to greater levels of field traffic that can have adverse impacts on soil properties. This risk can be reduced through adopting best practice. There are also potential impacts on soil carbon levels as a result of removing crops from the field, although there is evidence to indicate there may be benefits in this regard.[38]
Dependencies: The use of sequential crops for AD is not established in GB, so there is a dependency on this being adopted in agricultural practice and on this being a viable model for farmers and biomethane plant operators.
Evidence gaps: GB-focused research and evidence are needed on the impact of harvesting sequential crops compared to leaving them in-field to inform the case for a scale-up of this practice.

Land use and livestock reduction

Context: There are choices to be made about the best alternative use of land, if livestock reductions occur.
Trade-offs: There is a possible trade-off regarding the use of grassland that is released following any livestock reductions. This land could become managed grassland with cuts being used to produce biomethane but there are other possible uses for purposes such as biodiversity and climate adaptation. There are also choices to be made about whether

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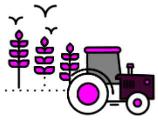
36 Magnolo et al. (2021): *The role of sequential cropping and biogasdoneright™ in enhancing the sustainability of agricultural systems in Europe.*
37 AHDB (no date): *Why grow cover crops?*
38 Launay et al. (2022): *Incorporating energy cover crops for biogas production into agricultural systems: benefits and environmental impacts*, Ecofys (2016): *Assessing the case for sequential cropping to produce low ILUC risk biomethane.*

rotational crops currently grown to feed livestock are replaced with crops for biomethane production or are, instead, replaced by more crops for food production or for other uses.

Agricultural residues

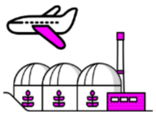


Context: These are by-products of crop production, such as straw and stalks. Agricultural residues are already used in biomethane production, as well as for other uses such as straw for animal bedding.
Opportunities: Biomethane production provides an alternative use of existing residues if livestock numbers decrease.
Evidence gaps: Evidence is needed of any impacts of collecting a higher proportion of residues for AD instead of leaving them in the field and whether there are trade-offs regarding soil health.

Digestate management

Context: Biomethane production results in a by-product called digestate, a nutrient-rich material that can be used as a fertiliser, although in its raw form is not a like-for-like replacement for chemical fertiliser in terms of its composition or method of spreading.
Opportunities: Using digestate as a fertiliser could reduce the need for fertiliser produced using fossil fuels, which is all currently imported, and support nutrient circularity.
Risk: There could be increasing environmental risk associated with the production of larger volumes of digestate in terms of its storage and the ability to spread on land appropriately.
Dependency: There is likely to be a dependency on post-processing methods to enable the effective use, transport and storage of digestate as volumes increase. Employing nutrient recovery technologies that can produce more consistent and familiar products can widen the application options and locations.

Feedstock competition



Context: While biomethane production is currently the most established use of the feedstocks discussed, many of these feedstocks may become useful for other sectors such as SAF or chemical production as technologies and processes develop.
Dependency/Evidence gap: The scale of future biomethane production has a dependency on whether competition for feedstock emerges, but the likelihood and scale of competition is currently highly uncertain. If competing demands emerge, there will be a need for assessment of where feedstocks can offer the most overall value.

Waste and crop proportions

Context: The GGSS requires a minimum of 50% of subsidised biomethane to be produced from waste. The current feedstock mix in GB is around two-thirds waste to one-third crops.

Dependency: The full feedstock potential in the external analysis is achieved through one-third waste and two-thirds crops. Depending on cross-sector assessment of biomethane production ambition, there could be a dependency on a route to market that enables this higher proportion of crops.
Risk: As the proportion of biomethane sourced from crops increases, there are inherently more sustainability risks. For example, according to the external analysis, grassland has the highest average associated greenhouse gas emissions so would need particularly careful management to minimise emissions, although the same principle applies to rotational and sequential crops.

Methane leakage

Context: Methane leakage occurs at biomethane production sites, with previous studies identifying some unacceptable leakage rates.[39] Methane is a highly potent greenhouse gas and even very small proportions of leakage along the supply chain can significantly undermine the climate benefits to be achieved from biomethane. Minimising methane leakage is, therefore, critical to the status of biomethane as a low carbon fuel.
Dependency: It is important that the best available techniques, leak detection and repair, stringent standards and monitoring are in place to ensure leakage is minimised. According to stakeholder feedback, very low levels of leakage are achievable with modern technologies and approaches, possibly delivering less than 1% leakage at biomethane production sites.[40]

Biomethane scale-up is dependent on near-term gas grid developments and policy support.

Scaling biomethane will depend on the gas grid acting as an enabler for increased injection. Today, grid challenges, including constraints and connection delays, are slowing deployment, with the extent of challenges differing across the transmission and distribution networks.

Stakeholders tell us: The gas grid connection process facing AD developers for new projects has historically often been slow and complex, with each network operator setting different requirements. Work is ongoing by gas distribution network operators to overcome such barriers including through greater standardisation of processes and equipment. National Gas is also working on reducing connection times and costs for the growing number of biomethane developers wanting to connect to the National Transmission System.

Constraints across the gas distribution networks are already limiting injection in some areas, particularly during periods of low demand (for example, in the summer). This leads to curtailment of biomethane injection and weakens project economics. Connections of

[39] NPL (2023): *Methane from anaerobic digestion (MEAD) study*; Methane Matters Coalition (2025): *Quantifying methane emissions in European biogas systems.*
[40] Leakage can occur not only from digesters and upgrade units but also from digestate storage tanks and during land-spreading. Best practice is required across all sections of the biomethane production process to minimise leakage.

new plants in these areas are also becoming more restricted. As biomethane production increases and/or overall gas demand falls, these constraints are likely to intensify. Investment in gas grid reinforcement in necessary areas, utilising available solutions such as smart pressure control and reverse compression, can help address these constraints. The Regional Energy Strategic Planner (RESPs) will set the direction for gas distribution network (GDN) planning which is expected to support the GDN operators in identifying future constraints.

Biomethane, due to its typically lower calorific content relative to natural gas, must currently be supplemented with small quantities of propane for its injection into the gas grid. This is to ensure consumers are billed fairly for the gas they receive. However, the addition of propane increases the costs of production and could represent a barrier to growth. Alternative routes to achieving fair billing that reduce or eliminate the need for propanation could support further growth in biomethane production.

Biomethane producers have called for greater certainty and clarity on future government support to unlock biomethane investment. The government is planning to consult on support for the biomethane sector to follow the GGSS and is looking at how to address a range of investment barriers. Without this future framework, growth in the sector is likely to stall, limiting the contribution biomethane can make to a clean energy system.

4. A strategic approach to biomethane

A strategic approach involving cross-sector collaboration could help maximise the value that biomethane delivers to the energy system. Assessing the right biomethane production ambition as well as the end uses where biomethane can deliver the greatest value could lead to greater confidence in the future availability of biomethane. This can unlock further benefits from biomethane, strengthening the role it can play in the energy system.

The current uses of biomethane are driven by sector-specific policies.

As set out in Chapter 2, biomethane is currently supported by policy to reduce the gap between the cost of natural gas and biomethane. The current policy set up means that biomethane use primarily supports decarbonisation of heat in buildings and of transport, driven by the Green Gas Support Scheme (GGSS) and Renewable Transport Fuel Obligation (RTFO):

- Through the GGSS, decarbonisation of heat is achieved via a subsidised tariff payment to biomethane operators injecting biomethane into the grid, so this approach does not require a demand from specific end users. The carbon savings are allocated to heat (as opposed to all end users) because the GGSS scheme was set up as a mechanism for decarbonising the heat sector, highlighting how sector-by-sector policy has shaped biomethane production to date.
- In transport, the RTFO and reduced fuel duty help to make biomethane cost competitive with conventional fuels. Certification of biomethane through the RTFO is used to assign emission savings to the transport sector and can be used to assign emission savings to specific users. Uptake of biomethane in transport has largely been in heavy goods vehicles (HGVs) and influenced by organisational ambitions to reduce emissions. However, these policy drivers have contributed to making biomethane increasingly economically attractive in this market.

In contrast, there are not currently any policies that encourage biomethane use in industry or power and these sectors do not currently represent a major end use of biomethane. This contrast highlights that the markets biomethane operates in and where the benefits are allocated is being driven by the policy mechanisms currently in place. The UK Emissions Trading Scheme (ETS), which covers power and heavy industry, does not currently recognise the emissions savings from grid-injected biomethane, although the government is exploring how this could be integrated.

There is a question of where biomethane can deliver the most value.

As carbon targets tighten, the hard-to-decarbonise end uses will need solutions. Biomethane could have a strategically important role to play here alongside other options including hydrogen, carbon capture and storage (CCS) and e-fuels. An understanding of which decarbonisation option is most suitable for each sector and end use could support a more efficient and cost-effective transition.

Even in the Holistic Transition pathway in our Future Energy Scenarios (FES) 2025, which represents a highly electrified system, total demand for gaseous fuels remains at 287 TWh in 2050. This points to a substantial and enduring need for gaseous fuels. Against this residual need, biomethane's available supply will be limited by feedstock availability so demand for low carbon gases would far exceed what biomethane alone can provide.

This leads to the question of where biomethane, as a finite resource, delivers the most value and how this changes over time. Given the need for this to be a cross-sector approach, we have not developed a proposed hierarchy of end use. However, the following examples show the range of factors that would influence the value biomethane can bring to each sector:

- The cost and carbon implications of biomethane relative to alternative decarbonisation options for each sector.
- The relative likelihood of those alternatives being deployed at the required volume and timescale.
- The timing of demand, including, for instance, whether biomethane is a transitional solution or part of a permanent net zero solution for each sector.
- Additional sector-specific considerations around methane leakage, particularly in growing demands such as HGVs and shipping.

A strategic approach could be key to maximising biomethane’s value.

Our analysis indicates that assessing the highest value end uses would need to be accompanied by an ability for these sectors to plan ahead for availability of biomethane, to support the delivery of benefits beyond carbon savings. This strategic approach would require greater overall confidence in the total production volume over time and greater confidence in which sectors it would be available for:

Biomethane production ambition

As previously discussed, there is currently no specific ambition for biomethane production in GB and it is unclear what level is achievable that strikes the right balance across sectors. Our analysis suggests that producing 30 TWh by 2050 could be achievable before material dependencies, trade-offs and risks arise in sectors responsible for or impacted by feedstock production. There is potential to produce much more than this, but cross-sectoral collaboration is needed to assess the appropriate ambition.

A vision for the end use of biomethane

An assessment of the most valuable end uses could help to maximise benefits from biomethane. This vision for end use would need enabling through policy and market levers, to provide the confidence in future biomethane availability in these sectors. This, in turn, could support effective energy system planning and incorporation into the decarbonisation strategies for different sectors and is likely to have an impact on the demand that materialises.

Our work has provided insight into how a strategic approach could deliver further benefits. For example, our modelling highlights the potential for lowering the cost of the future power system if biomethane is available for power generation, compared to having no biomethane available. This is because when biomethane is made available in the model, an outcome is a small reduction in new infrastructure and generation assets that are required to meet demand while reaching carbon targets. In the real world, achieving these cost savings would depend on making infrastructure decisions years ahead of needing that biomethane to materialise.

These decisions would need to balance potential savings against the risk of the expected volume of biomethane not being delivered in the future and the potential implications of such an outcome on system resilience and decarbonisation. These factors would need to be considered as part of a strategically planned system.

This principle also applies to hard-to-electrify industry and transport, where confidence in future availability of biomethane could influence investment cycles and infrastructure planning. For example, biomethane being part of the decarbonisation strategy for dispersed hard-to-electrify industry could have implications for decisions regarding the gas network transition, as parts of the gas network will remain important for this sector. This topic is discussed further in NESO's Gas Market Roadmap.

These examples do not answer the question of where biomethane should be used but highlight how further benefits could be unlocked through a strategic approach.

The future role of biomethane will be impacted by strategic decisions.

Biomethane already plays a valuable role in the energy system. It supports the delivery of carbon targets by displacing natural gas and will continue doing so, if it is produced sustainably and is not displacing more effective uses of the feedstocks or land.

The introduction of a strategic approach could lead to the delivery of additional benefits during the energy transition. However, this requires cross-sector collaboration to develop a production ambition and a vision for the end use of biomethane. This could see biomethane also having a role in informing infrastructure and investment decisions through greater certainty of availability across sectors.

NESO will now be using these findings on the role of biomethane in the energy system in its own activities such as strategic planning and feeding them into the collaborative work with government to refine the vision for biomethane. We will also continue to build on this evidence base and engage with wider stakeholders. This ongoing effort to develop the evidence base around biomethane will be important in making effective strategic decisions towards a net zero energy system by 2050.

National Energy System Operator
Faraday House
Warwick Technology Park
Gallows Hill
Warwick
CV34 6DA

www.neso.energy

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National Energy
System Operator