BIOMETHANE VISION DOCUMENT

A 5 point plan to scale up biomethane globally

INTRODUCTION

There has never been greater interest in biomethane than at the current time. Increased climate ambition, with net zero emissions commitments covering around 85% of global GHG emissions (IEA, 2022c), requires that all viable emissions reduction technologies are harnessed.

A significant scale up in biomethane production represents a “low hanging fruit” solution in this context. Its based on mature technology, provides a renewable fuel that is compatible with existing uses of natural gas in sectors where emissions are hard to abate, and is suitable to replace petroleum products in long haul transport. Wider benefits in aiding waste management, supporting rural development, offering an additional revenue stream for the agricultural sector and the production of co-products, further support expansion of the sector.

For these reasons long term outlooks for a decarbonised energy system project a strong increase in biomethane. For example, by 2050 global consumption grows 40-fold in the IEA´s ´Net Zero by 2050´scenario (IEA, 2021).

In Europe, given the wide-ranging impacts arising from Russia´s invasion of Ukraine, the importance of scaling up biomethane is further underlined by the energy security benefits it can offer as a domestically produced alternative to partially substitute natural gas imports from Russia. The EU´s target of producing 35 billion cubic meters (bcm) of biomethane by 2030, represents 9% of its natural gas demand in 2021, a share which will be higher in 2030 given EU efforts to diversify energy supplies in line with the REPowerEU plan.

This publication focuses on biomethane . The WBA recognises that there are various beneficial end use applications for biogas electricity, heat and cogeneration; as well as small-scale biogas digesters to enhance energy access in developing countries. However, these are not covered within this document.

In addition, the outlook of the document and its recommendations are intended to be applicable globally. Although the basis for the recommendations often draws from the most mature markets, currently found in Europe and North America.

Figure: Biogas production technolovgy (Source: Pixabay)

Current status: Promising biomethane markets are emerging in various European countries, with over 1000 plants operational in the Europe . Globally, several other bright spots for market development are evident, such as consumption in heavy duty transport in the United States and an emerging market in Brazil underpinned by vast feedstock potential and new policy incentives.

Nevertheless, biomethane output was around 5 billion cubic metres (bcm) globally in 2020 (Cedigaz, 2022) utilising only a small fraction of the feedstock available for production. Given current global natural gas consumption of over 4000 bcm, where favourable policies and market conditions are established there will be numerous ready-made opportunities to substitute biomethane into existing natural gas uses and grow demand.

Scaling up biomethane: Harnessing the full potential of biomethane requires the creation of holistic policy frameworks. No one policy will be sufficient to fully realise available feedstock potential and scale up biomethane markets to the extent needed in a low carbon energy system.

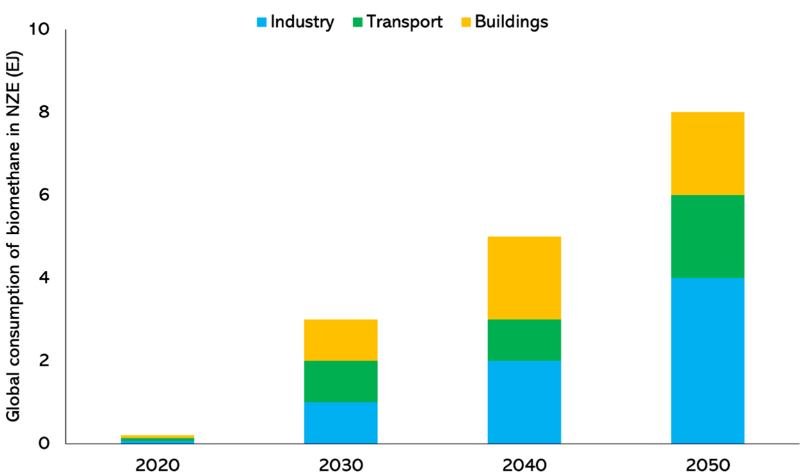

Figure: Global consumption of biomethane in a Net Zero outlook. Source: IEA (2021)
Notes: EJ = exajoules.

This ´vision document´ outlines five key recommendations adaptable to most markets globally (below), that should form part of national or regional biomethane strategies. The rationale for these, and a more comprehensive set of recommendations, is outlined in more detail in the following five sections, covering feedstocks, technology, gas infrastructures, policy and regulation.

1. Establish best practice waste management frameworks which ensure the segregation and valorisation of sustainable waste and residue feedstocks for biomethane.

2. Comprehensive action to reduce methane leakage to the greatest extent possible, comprising a. measurement, reporting and verification practices, and b. best available technology.

3. The introduction of Guarantees of Origin (GoO) certificate systems as a prerequisite for tracking and balancing biomethane injected into gas networks and subsequently consumed, as well as enabling trade.

4. Inclusion of a biomethane supply support mechanism balanced with demand-pull policy levers within a wider policy framework aimed at stimulating biomethane market development.

5. Coordinated actions to reduce the time needed to obtain the necessary permitting approvals for biomethane plants to within pre-defined timescales.

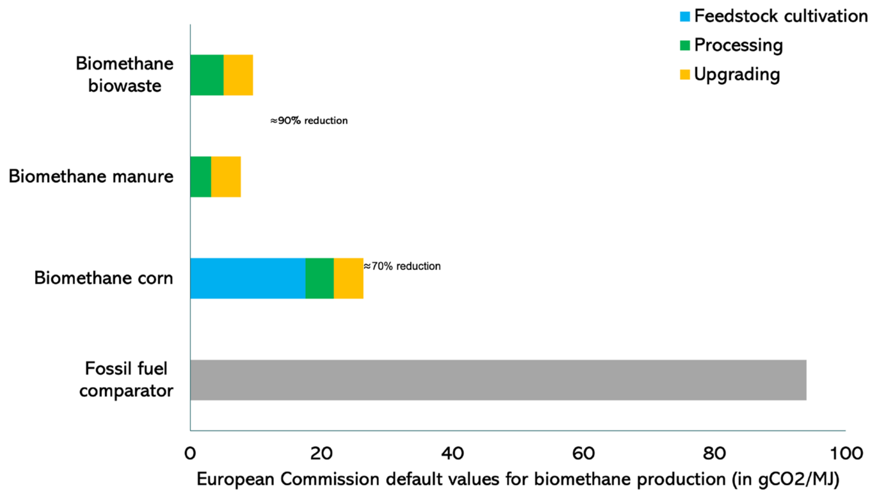

Figure: EU biomethane emissions European Commission default values.
Source: European Commission (2018); Note: biomethane emissions also need to factor in transport to the point of consumption and, for use in vehicles, compression. Emissions values shown are for best practice closed digestate systems with off-gas combustion so as to minimise methane slip. For manure feedstocks applying the avoided methane credit would result in negative emissions of -85,5 g CO_2/MJ.

Increasing access to sustainable feedstocks

A key initial consideration in scaling up biomethane output is facilitating access to the sustainable feedstocks needed for its production. Less than 1% of global feedstock potential is currently harnessed for biomethane . In the EU, where current output is around 3.5 bcm, feedstock assessments indicate that there is sufficient sustainable feedstock to scale up more than tenfold and meet the 35 bcm production goal by 2030 (Gas for Climate, 2022).

Use of organic waste and residue feedstocks is the key starting point. Biomethane production represents a waste management solution for such materials, offers low and sometimes negative lifecycle GHG emissions, and mitigates the methane emissions which could occur for some feedstocks if left unmanaged.

Effective policies and regulations to enhance the collection, logistics, processing and economics of waste management and biomethane production will help utilise this considerable untapped resource potential and enable further output growth.

Key means to mobilise waste and residue resources are:

- Conducting robust national and regional assessments of sustainable feedstock potential for biomethane production , and mapping these to provide context for policymaking, e.g. to inform realistic target/quota setting, and support project development.
- Waste management frameworks that channel these resources towards biomethane production rather than disposal . Options include prohibiting or putting a cost on landfilling / incineration of organic wastes and ensuring segregation and collection of the organic fraction of municipal wastes.
- Awareness raising with key stakeholders (e.g. farming , the agro-industrial sector, food and drink industry etc) of the potential to valorise the feedstocks they produce for biomethane (produced either on or off-site).
- Assigning GHG values to feedstocks and linking these to support policies, to mobilise those that offer the greatest emissions reduction first. This could include crediting avoided methane emissions from feedstock decomposition such as is the case in California´s Low Carbon Fuel Standard (LCFS).

Policy development in these areas spans across national, regional and municipal jurisdictions, making coordination between relevant bodies essential.

Biomethane production could also be significantly increased by harnessing the potential of alternative feedstocks such as woody biomass and substrates produced from sustainable agricultural processes such as sequential cropping . For example, an assessment of biomethane production potential in Europe indicated these feedstocks could provide around 70% of a total biomethane production of 151 bcm in 2050 (Gas for Climate, 2022).

Realising this potential requires sustained efforts to demonstrate the widespread application of the associated technology and agricultural practices. Maximising biomethane production from woody biomass needs further commercial scale demonstration of the thermal gasification of biomass. Advances in pre-treatment to permit higher shares of lignocellulosic feedstocks in anaerobic digestion plants is another avenue for technology development. While the benefits of sequential cropping practices need to be verified across a wider range of climates, soil conditions and crops. Such practices will need to become far more commonplace to significantly boost biomethane feedstock availability.

Figures: Biogas farms. Source: Pixabay

Furthermore, although they are not the core focus of this publication, non-sequential energy crop feedstocks account for a notable share of current biogas production in certain markets. These could represent a complimentary source of feedstock to scale up biomethane production further, with the potential for their use dependent on national circumstances and the fulfilment of applicable sustainably criteria.

Key recommendation: establish best practice waste management frameworks which ensure the segregation and valorisation of sustainable waste and residue feedstocks for biomethane.

Driving ongoing technology optimisation

Continuous technology development will have an important role in improving the performance of and scaling up the biomethane industry. This can yield benefits in terms of opening up a wider base of suitable feedstocks, delivering higher methane production efficiencies and lowering costs.

Anaerobic digestion (AD) processes and the upgrading technology to convert raw biogas to biomethane are already in commercial use. However, there is still scope for incremental technology improvements in areas such as feedstock pre-treatment, co-digestion and integrating biomethane liquefaction into certain plants among others.

Aside from these opportunities for incremental improvements, four important areas of further technology development for the industry are:

- Minimising methane leakage: minimising methane leakage from biomethane plants is critical to ensure optimal GHG emissions performance. The potential for methane slip can occur throughout the whole operational process to different extents, with particular vigilance required with the storage and handling of digestate. Analysis of a selection of anaerobic digestion biomethane plants using remote sensing indicated % methane losses of 0.1 – 3%, with the biggest differential being if gastight digestate storage was in place or not (IEA bioenergy, 2017). However, uncertainty still exists in this area with variable results from other studies which highlight the need for action in this area.

- Integrating monitoring programmes, technological solutions to detect fugitive emissions and rigorous maintenance regimes will ensure methane slip is minimised, therefore reducing the carbon intensity of biomethane and enhancing plant revenues.

- Optimising plant performance at all scales: lower production costs can be achieved through economies of scale. In Denmark, standardised large scale plants connected to the gas grid have delivered some of the most competitive production costs in Europe. However, the maximum capacity of a plant in any given location depends on feedstock availability in its vicinity e.g. a radius of <50 km, and the scaling potential of Danish production may not be feasible in the agriculture sectors of all countries. The development of modular technologies covering a range of plant and upgrading capacities will facilitate the utilisation of feedstock at different levels of availability, quicken project development and aid financing and cost competitiveness.

- Increasing biomethane yields with renewable hydrogen: as the energy transition advances opportunities may arise to harness synergies between the growth of biomethane and renewable ("green") hydrogen as the production of both increases. Methanation of hydrogen utilising the CO / CO2 present in biogas can produce additional synthetic renewable methane . Demonstration projects of integrated plants which harness hydrogen to boost biomethane yields will be needed to validate this concept.

- Commercialising new production processes: as outlined in the previous section, commercialisation of biomass gasification has an important role to play in harnessing solid biomass feedstocks. Financial support to mitigate the investment risk as technologies reach demonstration stage will be important.

In addition, efforts to advance innovative biomethane production pathways warrant consideration where they offer an avenue to sustainably increase production volumes or lower cost.

There is currently a difference in biomethane plant technology utilised across global regions. International development agency funding and technical assistance programmes can help to ensure that as the industry expands in new emerging economy and developing country markets, these can "leapfrog" to the most advanced technologies.

Europe already boasts around 19,000 biogas plants. The conversion of a suitable sub-set of electricity only biogas plants to produce biomethane represents one means to support the rapid scale up of biomethane production envisaged by the REPowerEU plan e.g. by avoiding multi-year development timescales. However, this will not be possible in all cases. The most suitable plants for conversion will have expiring subsidy support (e.g. FIT regime), a suitably large capacity to justify investment in biomethane conversion, a sustainable feedstock supply and market access e.g. gas pipeline in the vicinity or transport fuel offtaker.

Key recommendation: comprehensive action to reduce methane leakage to the greatest extent possible, comprising a. measurement, reporting and verification practices, and b. best available technology.

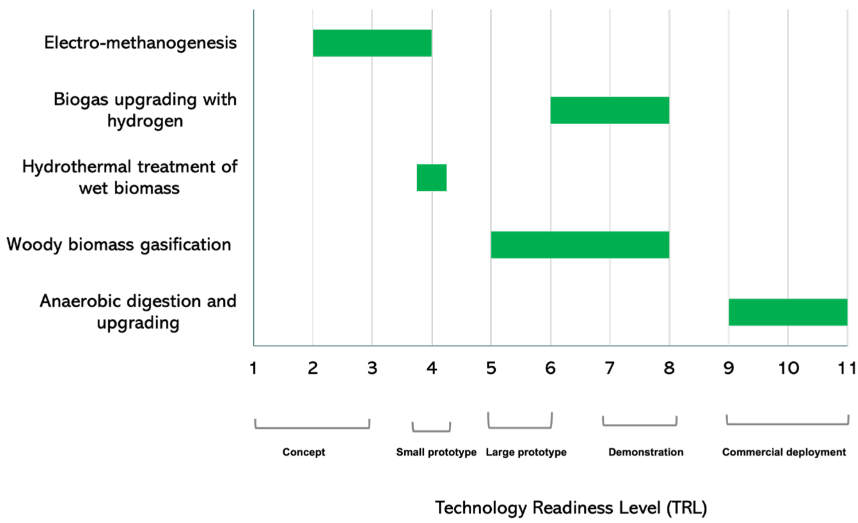

Figure: Technology readiness level of selected biomethane production routes Source: IEA Bioenergy (2021); note: TRL is a widely used common framework for measuring or communicating technology maturity. TRL scale used according to IEA (2022a) from 1-11, although alternative scales are to 9. Electro-methanogenesis is the production of methane directly from CO2 and electricity.

Injection of biomethane in gas network infrastructures

The injection of biomethane into gas networks is a key enabler to scale up the biomethane market. This is possible as, after upgrading, the composition of biomethane is near identical to natural gas and therefore fully compatible with the existing gas pipelines, storage facilities and end user equipment.

Injection into gas networks facilitates market access and a range of wider benefits. These include:

- The connection of areas of feedstock availability, which can often be rural and dispersed, with demand e.g. in urban areas or industrial zones.
- Offering producers access to a wider market of diversified consumers, via GoO certificates, rather than being "locked in" to local offtakers, which can represent a potential investment risk.
- Facilitating economies of scale, therefore lowering production costs, by removing the scale of local demand as a limiting factor on plant capacity.
- Offering a means to use biomethane to decarbonise hard to abate sectors in line with the needs of the energy transition.
- Access to available gas storage connected to the wider transportation network.

These benefits will only be harnessed where supportive policy, regulatory and technical conditions are in place. Examples of these are provided below.

Policy: demand can be created through setting ambitious targets for biomethane (or renewable gas) consumption, or injection in the network. For example, France has set a target of 10% of gas consumption from renewable origin by 2030. Denmark demonstrates impressive progress, biomethane surpassed a 25% share of gas network supply in summer 2022, and could be on track for 100% before 2030. An alternative to targets is setting mandatory quotas, which have the benefit of facilitating cost competition between producers to fill these.

GoO schemes, to track and balance the biomethane volumes that enter the gas network and subsequent consumption via a biomethane registry, are a prerequisite for injection. These enable "virtual" balancing and facilitate trade by connecting demand where it is not physically close to production , negate the risk of double counting and allow the sustainability credentials of renewable gas consumption to be claimed by the purchaser of the gas via GoO certificates.

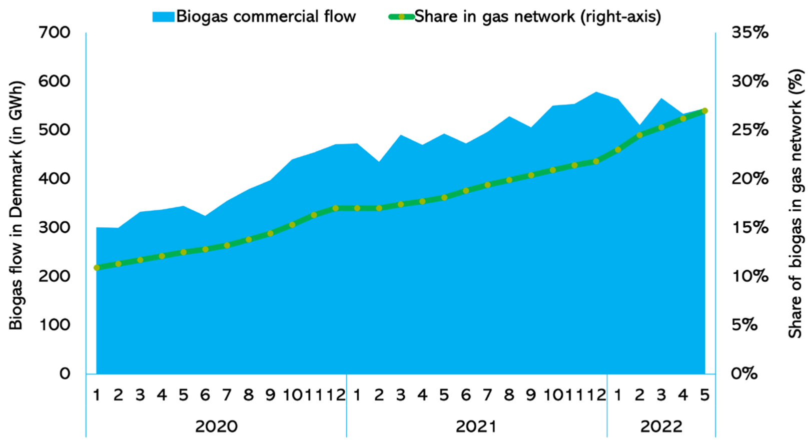

Figure: Biomethane in the Danish gas network
Source: Energinet.dk (2022)

In the EU GoO schemes have already been established by some Member States. However, to facilitate biomethane trade there is still the need to establish an EU-wide "Union Database" for renewable gases to ensure traceability across borders. The European Renewable Gas Registry (ERGaR) has already provided a platform for biomethane certificates of origin trade between countries such as Austria, Germany, the Netherlands as well as the United Kingdom.

Regulatory: a regulatory framework which enables biomethane blending needs to be established. This includes setting appropriate gas quality requirements for injection. Where cross-border trade could occur, such as in Europe, these should be harmonised so as to not impede the possibility of international trade.

Clarification regarding who pays for connection to the gas grid can also facilitate market growth. In many markets this remains unspecified and the capital costs of connection fall entirely to the producer . In France, Europe´s most dynamic biomethane market, these costs are shared between the biomethane plant owner and gas network operator , with the latter subsequently recouping them through regulated network tariffs. Cost sharing is also evident in Denmark where network operators cover compression and quality conditioning expenses.

In the European context fast track finalisation of the ´Hydrogen and Decarbonised Gas Package´, as outlined in the European Commission's REPowerEU document, can set the foundation to scaling up the market e.g. through measures to support biomethane injection such as discounted/eliminated tariffs for renewable gases.

Technical: Under normal conditions gas flows from the high-pressure transmission to lower pressure distribution network. In certain cases where biomethane production is connected to the gas distribution network, adaptations are required to permit bidirectional (also termed "reverse") flows to the transmission network. This could occur where ample feedstock means output in a given location is higher than demand, or during periods of lower demand e.g. during summer or if an industrial facility is offline. The need for technical modifications to permit bidirectional flows is assessed on a case by case basis, and fall within the capabilities of gas network operators.

There is also an important role for network planning to compare resource maps of biomethane feedstock availability with current gas networks to identify future network needs, such a "zoning" approach has been undertaken in France. Such exercises identify the optimal areas for developing plants and highlight regional grid development needs. Another relevant consideration is the possibility of various producers in a vicinity sharing a shared gas network injection facility, as a means to benefit from economies of scale and limit connection costs.

Gas network operators can have a key role in accelerating biomethane growth, given the synergies and overlapping expertise arising from established natural gas network operations and the needs of the emerging biomethane industry.

Key recommendation: the introduction of GoO certificate systems as a prerequisite for tracking and balancing biomethane injected into gas networks and subsequently consumed as well as enabling trade.

Establishing a supportive policy landscape for supply and demand:

Policies to bring biomethane production projects to market and stimulate consumption are fundamental to scale up the market.

The most dynamic global markets for biomethane all benefit from support policies on the supply- or demand-side, or both. Ultimately these should aid market and technology development to the point where biomethane is better equipped to compete against other fuels. A relevant example in this context is the sustained policy support that was required to achieve the current competitiveness of solar PV and onshore wind in the electricity sector.

In Europe, the elevated natural gas prices evident since summer 2021, and further pressured upwards by the conflict in Ukraine, mean that for periods during 2022 biomethane has been competitive with natural gas. Nevertheless, investment decisions are based on long-term timescales that look beyond the current context. The current competitiveness of biomethane does not negate the need for policy frameworks to support market growth and enable biomethane´s potential to support security of supply and offer a stable cost, low carbon energy source.

Production support: growth in the most prominent European biomethane markets has been supported by feed in tariff (or premium) policies. With such policies an important consideration is building in budgetary control measures and the capacity to adapt tariffs to any downward trend in production costs. Both of these considerations are evident in the UK´s "Green Gas Support Scheme", launched in 2021. Tariffs can also vary to reflect different feedstocks and scales of plant as per France´s FIT scheme, which as part of a holistic set of biomethane support measures has driven impressive market growth.

Nevertheless, in the electricity sector there has been a general move away from FITs in many markets, towards auction frameworks that facilitate competition and lower costs. Auction frameworks are also an option for biomethane, with France initiating these for larger capacity projects.

Financial de-risking measures such as public-private partnerships, soft loans with favourable terms or public sector loan guarantees can all lower investment risks and support reaching final investment decisions for biomethane development.

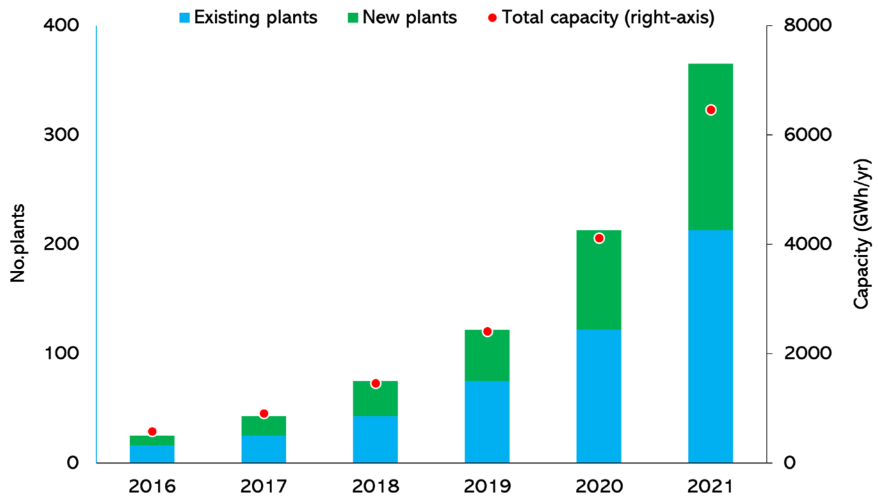

Figure: Biomethane production development in France
Source: ODRE (2022)

Relevant training and skills development to develop a workforce equipped to underpin the scale up the biomethane sector is also a key policy consideration.

Demand creation: there are a diverse number of levers that policymakers can utilise to generate a demand pull for biomethane. A first step is to signal direction through a high-level target. This can be an overall technology neutral renewable energy target e.g. as included in the EU Renewable Energy Directive (RED).

Alternatively, targets can be set for a sector e.g. biomethane can qualify for the EU´s sub target (3.5% in 2030) for the share of advanced biofuels in transport energy consumption; or for renewable gases specifically e.g. France´s target of 14-22 TWh of renewable gases in the gas network by 2028. Mandatory quotas for gas suppliers to supply a specified percentage of biomethane go one step further, creating "captive demand" that can lower investment risk and therefore financing costs, and stimulate competition between producers.

Carbon pricing regimes, which cover 23% of global GHG emissions (World Bank, 2022), can drive biomethane procurement or on-site project development . As stated previously, with 2022´s elevated natural gas prices biomethane is generally price competitive in many markets. However, should European natural gas prices reduce to levels more indicative of recent years a high carbon price would be needed to deliver cost parity. This may not be feasible in most markets in the medium-term, highlighting that carbon pricing regimes will likely need to be complemented by other policy measures.

Biomethane uptake can also be stimulated by carbon intensity-based policies. Examples include California's LCFS or Germany´s Climate Protection Quota, where low carbon fuels compete on the basis of the contribution they make to annual road transport emissions reduction targets relative to cost.

The Netherlands´ Stimulation of Sustainable Energy Production and Climate Transition´ (SDE ++) policy operates across a wider remit of sectors, with support awarded via tenders. Biomethane is well placed to compete in such policies due to the high lifecycle GHG emissions reduction it can offer, especially where avoided methane emissions from feedstock decomposition are credited.

Various policies can support biomethane utilisation in the transport sector, where in particular uptake for long-haul transport (e.g. heavy-duty road freight or bio-LNG in marine transport) and "captive fleets" (e.g. city buses or delivery vehicles which refuel in a set location) offers considerable promise. Policies include fiscal policy (Sweden), certificate schemes (UK, Italy) and initiatives to roll out LNG fuelling infrastructure which can accept bio-LNG (EU Alternative Fuels Infrastructure Directive) .

Key recommendation: inclusion of a biomethane supply support mechanism balanced with demand-pull policy levers within a wider policy framework aimed at stimulating biomethane market development.

Regulatory considerations

Biomethane production cuts across diverse areas – energy, agriculture, waste etc. – and consequently is affected by an array of varied regulations. While supportive regulatory frameworks hold potential to boost biomethane uptake, there are also areas where they may require modification in order to avoid the unintended effect of impeding market growth.

The following three areas require careful consideration:

Streamlined permitting: biomethane plants need to satisfy a wide range of regulatory requirements and obtain permits and approvals related to: emissions to air & water, waste handling, digestate management, health & safety, gas handling & storage, construction, feedstocks , connection to the gas grid etc.

Regulation in these areas to ensure best practice is necessary. However, currently obtaining approvals can take considerable time. In a best-case scenario obtaining the necessary approvals and constructing a plant may be achieved in around two years. However, in other cases obtaining the necessary permits has extended to five years or more. This is particularly problematic in Europe where extended permitting periods will hinder the rapid scale up needed to reach REPowerEU goal of 35 bcm by 2030, which could require around 5000 new plants (EBA, 2022).

Therefore, faster permitting processes (e.g. within standard approval timeframes), are key to rapid biomethane industry growth. This can be achieved through increasing staff resources to process applications, additional training dedicated to biogas/biomethane, harnessing digitalisation as well as streamlining and simplifying requirements where possible e.g. via one-stop shops. The designation of priority "go to" areas or pre-authorised sites for biomethane project development could also facilitate faster approval times. It should be recognised however, that although there may be scope to move faster the underlying need to demonstrate regulatory compliance and best practice is still necessary.

Digestate use: Biomethane production is accompanied by an associated volume of digestate . Depending on the feedstocks used for biogas production this can be utilised as a fertiliser, acting as a substitute for inorganic fertilisers, or as a soil improver (aiding restoration and carbon retention).

While digestate could represent a valuable co-product , in reality it is hard to monetise . A focus on developing and streamlining the regulations, standards and approval processes (e.g. permits for land spreading) for its use would aid the creation of a secondary market for its sale and use, potentially offering an additional revenue stream for biomethane producers and a sustainable alternative to energy intensive chemical fertilisers. However, this is highly dependent on the presence of local offtakers.

Sustainability criteria: to underline biomethane´s green credentials biomass sustainability regulations have a key role to play. This is especially relevant given the wide range of lifecycle emissions for biomethane, depending on its production pathway e.g. feedstock utilised, technology employed and end use application.

These are already established in some markets. For example, the EU sustainability criteria for biomass apply to biomethane when used for electricity generation, heat and transport, requiring third party verification at a producer and feedstock supplier level.

Demonstrating sustainability, and real lifecycle emissions reduction is a prerequisite for biomass in order to maintain consumer and policymaker confidence. In this respect California´s LCFS is an example of good practice, through using the GREET model to provide project specific carbon emissions intensity (CI) scores for biomethane and other renewable fuels´ production pathways. These assessments include a credit for avoided methane emissions, showing the high potential of biomethane as a means to tackle agricultural methane emissions.

Furthermore, emissions information could ultimately be incorporated in GoO certificates, therefore facilitating compliance with emissions reduction obligations or carbon markets such as the EU ETS. It is essential to ensure such obligations require an appropriate level of detail and are accompanied by support to demonstrate compliance, otherwise project development could be slowed.

These are only three areas where regulation could be assessed to consider how best to drive biomethane development. Others have already been covered in other sections of this document e.g. waste management, sectoral emissions reduction, gas infrastructure etc. Putting biomethane on a path to rapid growth will require a strategic evaluation of how best to focus regulation in these areas and others as well. For example, agriculture and waste represent between 47-60% of anthropogenic methane emissions (McKinsey, 2022). Biomethane offers one means to tackle a proportion of these emissions, and as such regulations which cap or put a cost on methane emissions can also boost market development.

Key recommendation: Coordinated actions to reduce the time needed to obtain the necessary permitting approvals for biomethane plants to within predefined timescales.

TABLE: CI SCORES FOR BIO-CNG CERTIFIED PATHWAYS IN CALIFORNIA´S LCFS

Feedstock	Range of CI	Feedstock average CI
Landfill gas	30 to 81	48
Manure	-544 to -151	-314
Organic wastes	-23 to 0	-11
Wastewater	8 to 43	30

Source: California Air Resources Board (2022); Notes: manure includes swine and dairy manure, organic wastes includes food and green waste, wastewater also includes sludges. The number of data points on which the range and average are based on are landfill gas (112), manure (70), organic wastes (5) and wastewater (10).

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