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Europe's biomethane landscape: Between ambition and reality

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Abstract

Europe's biomethane sector is gaining momentum amid rising energy security and climate ambitions, yet production remains far below the EU's 2030 target of 35 billion cubic meters. This article explores the sector's current landscape, highlighting biomethane's versatility across power, transport, and industry, and its potential to decarbonize hard-to-electrify sectors. Despite rapid growth, structural barriers – such as regulatory fragmentation, market harmonization, and feedstock challenges – continue to hinder deployment. Policy instruments like RED III and ETS2 offer support, but biomethane still lags behind other renewables in attention and funding. Achieving scale will depend on infrastructure readiness, streamlined permitting, feedstock availability, and coordinated action across EU and national levels.

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Biomethane: Finally in the spotlight?

Three years ago, the EU launched its REPowerEU Plan to structurally transform the EU's energy system – ensuring both energy security and progress toward climate neutrality by 2050. This strategic initiative aims to rapidly reduce dependence on Russian fossil fuels. It does so by accelerating the clean energy transition, diversifying energy supplies, and enhancing energy efficiency through coordinated investments, policy reforms, and the deployment of renewable technologies. While the plan prioritizes solar photovoltaics, offshore wind, and heat pumps, it also emphasizes the accelerated deployment of renewable hydrogen and sustainable biomethane. A non-binding target of 35bcm of biomethane by 2030 was introduced, serving as a key ambition for the development of the sector.

Biogas – produced locally from organic materials such as agricultural residues, manure, and sewage sludge – is uniquely positioned to support both decarbonization and energy security. Through anaerobic digestion (AD), these feedstocks release biogas, a mixture typically containing 50% to 65% methane and 25% to 50% carbon dioxide (CO2). When upgraded by removing CO2 and other impurities, biogas becomes biomethane – a drop-in substitute for natural gas with identical qualities. As such, the production of biogas and biomethane are strongly interlinked and need to be considered and understood together. Therefore, the term "biogases" is often used to refer collectively to biogas and biomethane.

The versatility of biogases offers great potential for Europe's energy system. AD and biogas upgrading rely on locally available feedstock and require no critical materials. Moreover, biomethane integrates seamlessly into existing gas infrastructure and offers dispatchable clean power, complementing variable renewables. It can also serve as a renewable feedstock in the chemical industry, directly replacing natural gas.

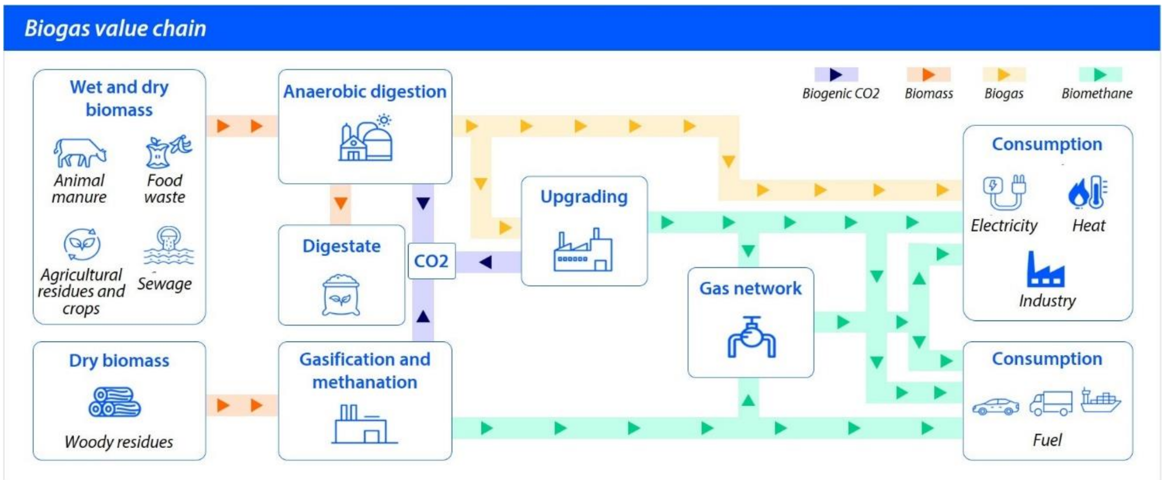
These benefits are increasingly acknowledged across industries, markets, and political spheres. Amid growing concerns over energy security, sustainability, and electricity grid flexibility, biogases appear to have gained momentum. Yet, realizing their full potential remains work in progress. In 2023, Europe (including the UK, Norway, Switzerland, and Ukraine) produced 22bcm of biogases.[1] However, only 4.9bcm of that total was biomethane.

With the clock ticking on climate goals and energy resilience high on the agenda, this article outlines the current realities of Europe's biomethane sector – measured against the ambitions set by the REPowerEU.

From organic waste to renewable gas: The value chain of biogases

The value chain of biogases is complex and involves several stages – from feedstock sourcing to utilization – across different sectors (see figure 1).

Figure 1. The value chain of biogases



Source: International Energy Agency 2019, RaboResearch 2025

[1] Including biogas and biomethane. Notably, 1m3 of biogas typically yields around 0.56m3 to 0.62m3 of biomethane when upgraded.

Production begins with the collection and treatment of organic materials, such as agricultural residues and crops, organic waste, and sewage sludge. The type and availability of feedstocks vary by region, influencing both the potential volume and composition of the biogas produced.

AD is the most common conversion method, in which microorganisms break down organic matter in oxygen-free environments to produce biogas, CO2 and digestate[2] (see table 1).

Gasification is a complementary pathway for hard-to-digest biomass, like woody residues, bio-based plastics, and semi-biogenic waste (see table 1). The resulting syngas can be used for power generation, synthetic natural gas (via methanation), or utilized as a chemical feedstock.

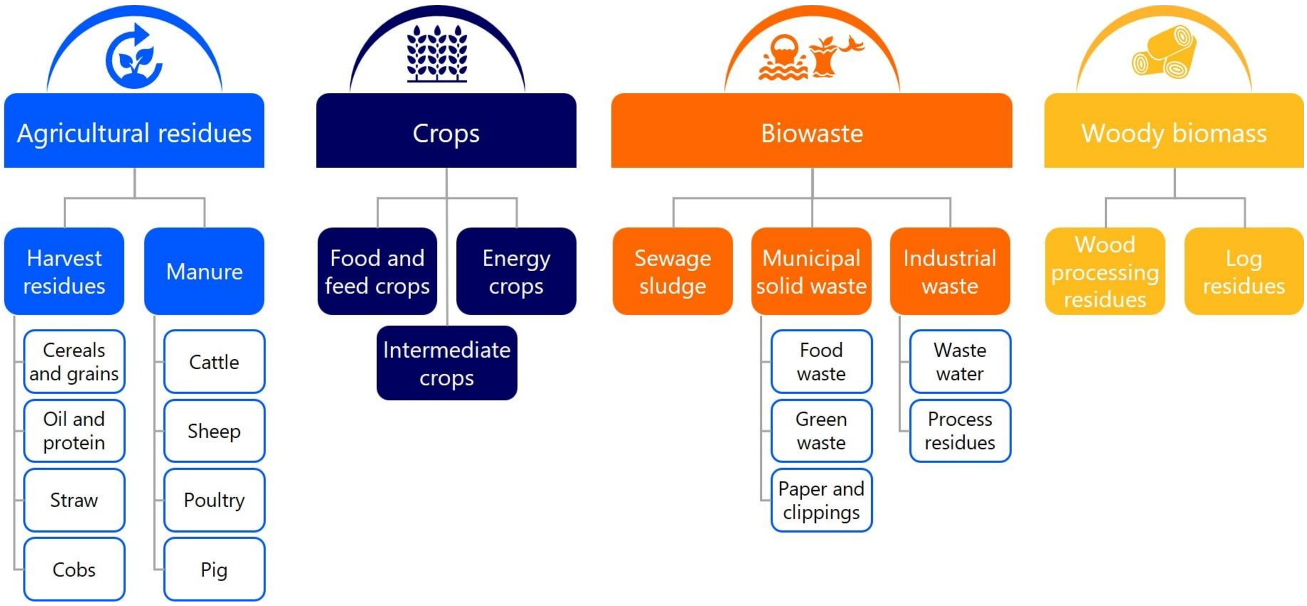
Depending on regional terminology and feedstock origin, biomethane may also be referred to as green gas or renewable gas. Biomethane can be injected into existing gas grids or used as transport fuel in the form of bio-CNG (short for compressed natural biogas) or bio-LNG (liquefied natural biogas).

In addition to energy production, AD also yields digestate and biogenic CO2. Depending on the feedstock, digestate can be used as fertilizer or may require processing before use. Biogenic CO2 can be used in greenhouses replacing fossil CO2 or in food processing.

Feedstocks powering Europe

Biogases are produced from a variety of organic feedstocks, which can be categorized as shown in figure 2. One of the main advantages of biogas production is that it allows for the processing of several residues and waste streams, therefore directly contributing to circularity.[3] Due to current European regulations – mainly under the Renewable Energy Directive (RED III) – residue and waste streams are prioritized over food and feed crops. The goal is to prevent biogas production from (directly) interfering with food and feed production.

Figure 2. Various feedstock categories for the production of biogases



Source: International Energy Agency, RaboResearch 2025

[2] A byproduct of biogas production, rich in nutrients and nitrogen, which serves as organic fertilizer in agriculture.
[3] EBA position paper, IEA Bioenergy report

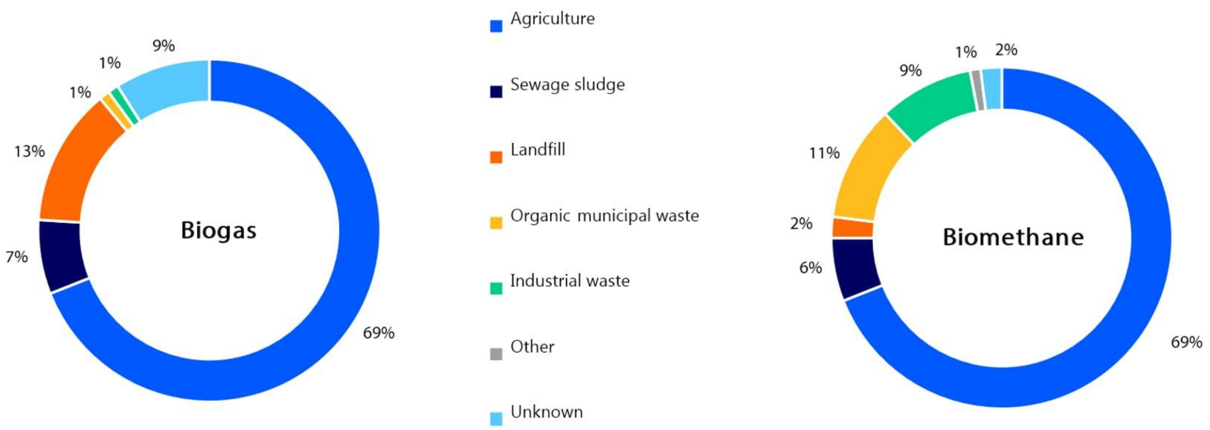
In some cases, policy and market developments are placing greater emphasis on CO2 reduction rather than simply maximizing biomethane output, which can encourage the use of feedstocks with better carbon intensity (CI) scores – although these often have lower energy yields CI scores of feedstocks vary significantly:

- Crops: around 30 grams of CO2 equivalent per megajoule (g CO2e/MJ).
- Waste and residues: average around 15g CO2e/MJ.
- Manure: performs best, with a score of –100g CO2e/MJ.

Certified feedstocks, like those approved by the International Sustainability and Carbon Certification (ISCC) and Better Biomass, are gaining traction – especially where biomethane pricing reflects CI scores.

Agriculture-based[4] feedstocks – mainly residues – are the dominating inputs for biogases in Europe (see figure 3). These are followed by landfill gas and organic municipal waste for biogas and biomethane, respectively. Feedstock use varies significantly by country. For instance, in Norway 85% of the plants are using sewage sludge, while in Germany 40% of the plants rely on agricultural residues and another 40% on energy crops.

Figure 3. Ratio of plants using different feedstocks for biogas and biomethane production in Europe



Source: European Biogas Association (EBA) Statistical report 2024

Biogas production pathways

Due to the variety of feedstocks, there are also different production pathways to convert biomass into energy (see table 1). Among those, AD is the most mature and widely used technology. AD is followed by gasification, which allows for a wide range of potential configurations but is still in a demonstration stage. Technologies for biogas upgrading, on the other hand, are mature and widely deployed, as they are comparable to those used in carbon capture. Other types of technologies are still in development, with varying levels of maturity and deployment. Nevertheless, they are promising pathways that are expected to improve over time and therefore contribute more to biogas and biomethane production.

[4] Agriculture-based feedstocks include agricultural residues, manure, intermediate crops, and monocrops. Often, national registries do not distinguish between agricultural residues and manure, which can make comparisons difficult. To address this, the European Biogas Association (EBA) aggregated the data to enable better comparisons across Europe.

Table 1. Overview of the different biogas production pathways and their characteristics

Production route	Description	Feedstocks	Maturity
Anaerobic digestion (AD)	A biological process where microorganisms break down organic materials in the absence of oxygen. The resulting biogas consists of mainly methane and CO2, and there is a nutrient-rich by-product (digestate), which can be used as fertilizer, depending on used feedstock and legislation. AD systems can either co-digest multiple feedstocks or use a single feedstock (mono-digestion).	Organic waste Manure Sewage sludge Agricultural crops and residues	Most mature (TRL 9) and widespread technology for biogas production.
Gasification	A thermochemical process that converts lignocellulosic materials into a synthetic gas (syngas) composed mainly of carbon monoxide, hydrogen, and CO2. This occurs at high temperatures (typically >700°C) in a controlled environment with limited oxygen or steam.	Woody residues Energy crops Agricultural residues Municipal solid waste	Versatile process. Less mature (TRL 6-8).
Supercritical water gasification (SWG)	Also known as hydrothermal gasification – SWG is a thermochemical conversion process that takes place at high pressures (210-350 bar) and high temperatures (360-700 degrees Celsius) in the presence of water. Supercritical water acts as both a solvent and a reactant, enabling the conversion of wet biomass into hydrogen-rich gas without the need for drying.	Sewage sludge Industrial wastewater Slurry Process waste	Versatile methods that can use many wet feedstocks. Currently at pilot-demonstration scale (TRL 5-7).
Methanation	Refers to a group of technologies that convert CO2 and hydrogen (H2) into e-methane (CH4) using electricity. When using biogenic CO2 from anaerobic digestion, biogas, or syngas as the carbon source, H2 can be used as a reducing agent to increase biomethane yields in AD.	Biogenic CO2 Green H2	Less widespread due to the need of green H2, but some of the technologies reached commercial (TRL 7-9) levels.
Biogas upgrading	Biogas can be upgraded to biomethane by removing CO2 and contaminants. The resulting biomethane has properties nearly identical to those of natural gas. Therefore, it can directly be injected into the gas grid or used as a transport fuel.	Biogas Syngas Landfill gas	Mature and widespread method (TRL 9).

Note: TRL = Technology Readiness Level, a scale from 1 (basic principle) to 9 (fully commercial technology).
Source: Guidehouse 2022, Joint Research Centre 2024, RaboResearch 2025

In 2023, there were more than 21,100 AD plants in Europe, of which 1,510 were producing biomethane (see figure 5a). In contrast, there were only 162 gasification plants (processing organic materials)[5] across Europe, mainly located in Germany (61), Finland (18), and Italy (18). The EBA recorded just 35 operational e-methane plants in 2023, with an

[5] Gasification plants processing non-organic materials such as plastic or tires are excluded.

additional 12 plants under construction. Geographically, Germany, France, and Finland were the leading countries for e-methane plants. Based on project announcements, the EBA expects the number of e-methane production plants to grow to 55 by 2027, although the feedstocks they will use remain unknown.

Sectoral use of biogases

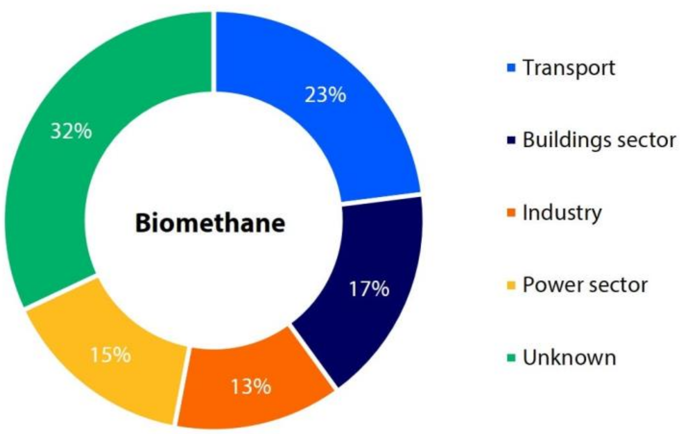
Biogases – especially biomethane – compete with other renewables across sectors. Their use depends on system value, national policies, market demand, and infrastructure. Thanks to their versatility, biogases are particularly valuable in areas where electrification is challenging, such as high-temperature industrial processes, long-distance transport, and district heating in the built environment. Sector-specific uses of biogases include:

- **Power sector**: Generating electricity and heat, including combined heat and power (CHP) – biogas is often advantageous here as it does not require upgrading; supporting flexible, peak-load demand rather than baseload generation, due to the increasing availability and lower cost of wind and solar.
- **Buildings sector**: Generating heat from biogases either on-site or off-site and distributed via district heating networks.
- **Industry**: Replacing natural gas in high-temperature processes (e.g., cement, steel, glass) and serving as a renewable feedstock in sectors such as the chemical industry.
- **Transport**: Fueling long-distance heavy-duty vehicles and maritime transport, in the form of bio-CNG and bio-LNG, respectively.

These sectoral applications are not uniform across Europe. Instead, the role of biogases varies significantly between countries, reflecting differences in strategic priorities, resource availability, and infrastructure readiness. This diversity underscores the importance of tailored national approaches to maximize their system value.

Tracking the exact utilization of biogas is challenging, as it is often consumed locally and off-grid, particularly in small-scale CHP plants. Biomethane consumption, on the other hand, is easier to track once injected into the gas grid and is often linked to national renewable energy targets and statistics. According to the EBA, end-use patterns vary significantly across countries (see figure 4). In the Nordic countries, where gas grids are limited (except in Denmark), biomethane is primarily used in transport. Italy also favors biomethane for transport, while Belgium sees a dominant use in industry. In Switzerland and the UK, household and building applications are most common.

Figure 4. The share of biomethane utilization per sector - European average



Note: Data is based on a survey of national data providers within the EBA network, covering the EU-27 as well as the UK, Norway, Switzerland, and Ukraine.
Source: EBA 2024

Pathways to 35bcm: Can the EU meet its biomethane target?

Mixed landscape across the EU

Combined biogas and biomethane production in Europe grew by 5% in 2023, reaching 22bcm, or 234 terawatt hours (TWh) – about 7% of the EU's natural gas consumption. The EU-27 (excluding Bulgaria) contributed 18.9bcm, produced in 19,160 plants (see figure 5b).

Biomethane is driving much of this growth with 1,510 plants in 2023 – an increase of 201 compared to 2022. Production has nearly doubled over the past three years, supported by higher market value, policy incentives, and broader applications.

Figure 5a. Number of plants in Europe and EU-27

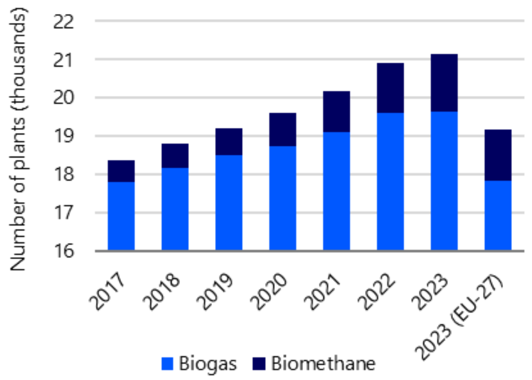
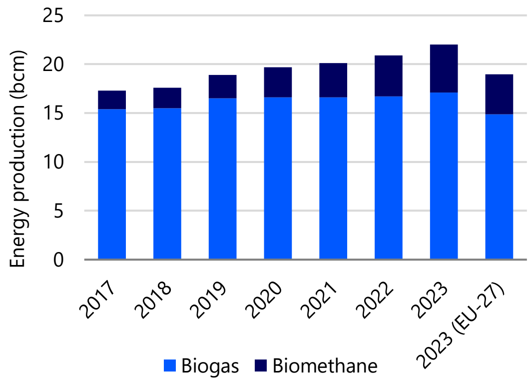


Figure 5b. Production volume in Europe and EU-27



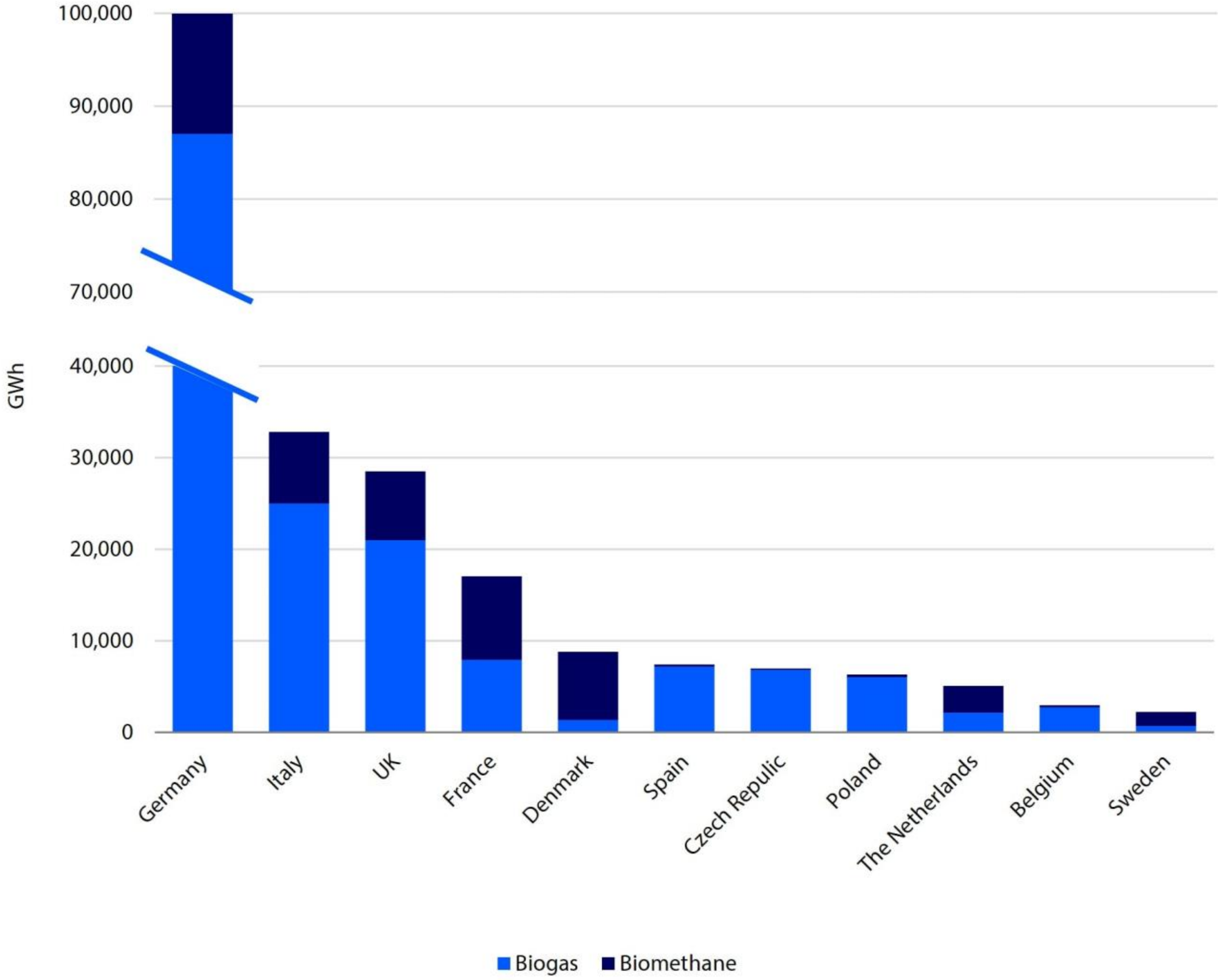
Note: These figures include data of the EU-27 (except for Bulgaria) and UK, Norway, Switzerland and Ukraine.
Source: EBA 2024

Additional data, in EBA's Statistical report, suggests that biomethane plants tend to be larger, with an average annual output of 35 gigawatt hours (GWh), compared to 9GWh for biogas. While biogas production remains relatively stable, biomethane is experiencing near-exponential growth. This may encourage existing biogas facilities to invest in upgrading technologies to produce biomethane and benefit from higher market prices or tradeable certifications such as Guarantees of Origin (in Dutch). In several countries, existing AD plants with CHP have already shifted to biomethane or are making plans for shifting if possible.

Production volumes of biogases vary significantly across countries (see figure 6). Germany leads with 100TWh, followed by Italy (33TWh), the UK (29TWh), and France (17TWh). Notably, France has shown the highest year-on-year growth. In countries like France, Denmark, the Netherlands, and Sweden, biomethane production now exceeds biogas, driven by grid access and supportive policy schemes.

Plant volumes also vary by country. Denmark's 22 biogas plants produce a total of 1,359GWh, averaging 11GWh per plant. In contrast, Sweden's 225 biogas plants produce just 712GWh, averaging 3.1GWh per plant – nearly twice as many plants producing less than half the energy. A similar pattern is observed in biomethane production. These differences are linked to local market conditions, such as availability of certain feedstocks, regulatory environment, infrastructure, and off-taker arrangements.

Figure 6. Combined biogas and biomethane production of the main producing countries



Note: The vertical axis includes a break between 40,000GWh and 70,000GWh to improve readability and visualize both large and small production values.
Source: EBA 2024

Closing the gap: Scenarios toward the 2030 ambition

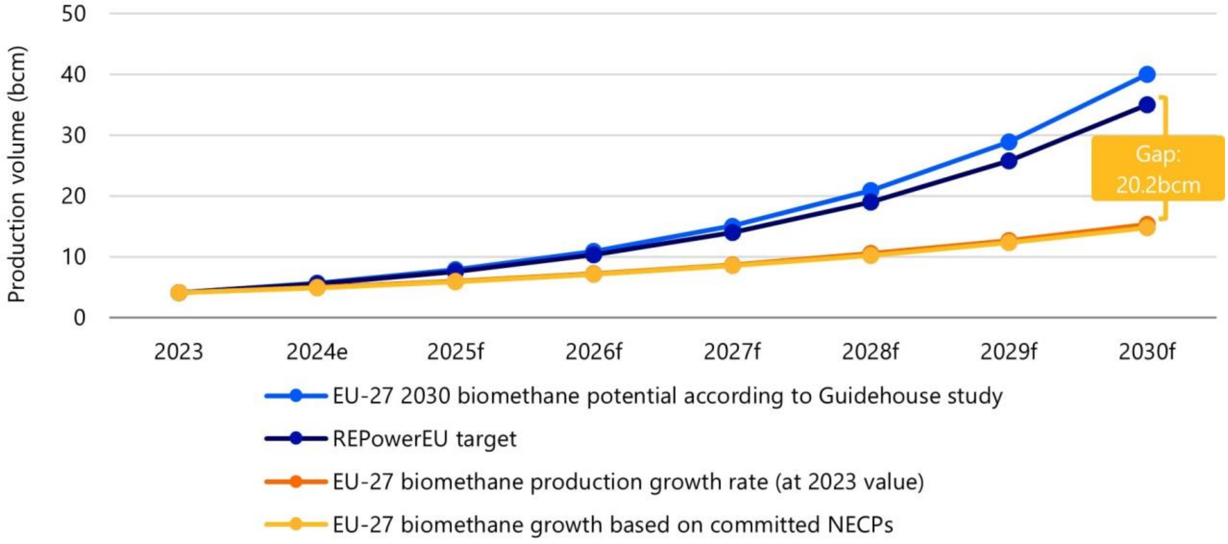
While biomethane production is growing rapidly, the scale of expansion needed to meet the EU's 2030 target of 35bcm remains substantial. The REPowerEU Plan sets a clear ambition, but reaching this goal will require more than continued incremental growth – especially since it excludes biogas, which remains the dominant end-product in Europe. To better understand what it would take to close the gap, the EBA developed multiple scenarios to illustrate potential pathways.

Figure 7 compares projected biomethane growth trajectories based on:

- Biomethane potential in the EU-27, according to Guidehouse's "A Gas for Climate" report commissioned by the European Commission.
- The REPowerEU Plan's biomethane target for the EU-27.
- Biomethane growth projected from the 2023 growth rate.
- Biomethane growth according to committed national volumes from the 2024 National Energy and Climate Plans (NECPs).

While current growth aligns closely with the NECP commitments of the EU member states, a significant gap of 20.2bcm remains between these volumes and the REPowerEU target. Without a substantial and rapid acceleration in production, achieving the 2030 goal appears unlikely.

Figure 7. EU-27 biomethane growth scenarios by 2030



Source: EBA 2024

In light of the projected shortfall illustrated in figure 7, it is worth exploring how existing biogas infrastructure could contribute to narrow the gap. Figure 8 models two scenarios: converting 50% and 90% of current biogas output to biomethane.[6]

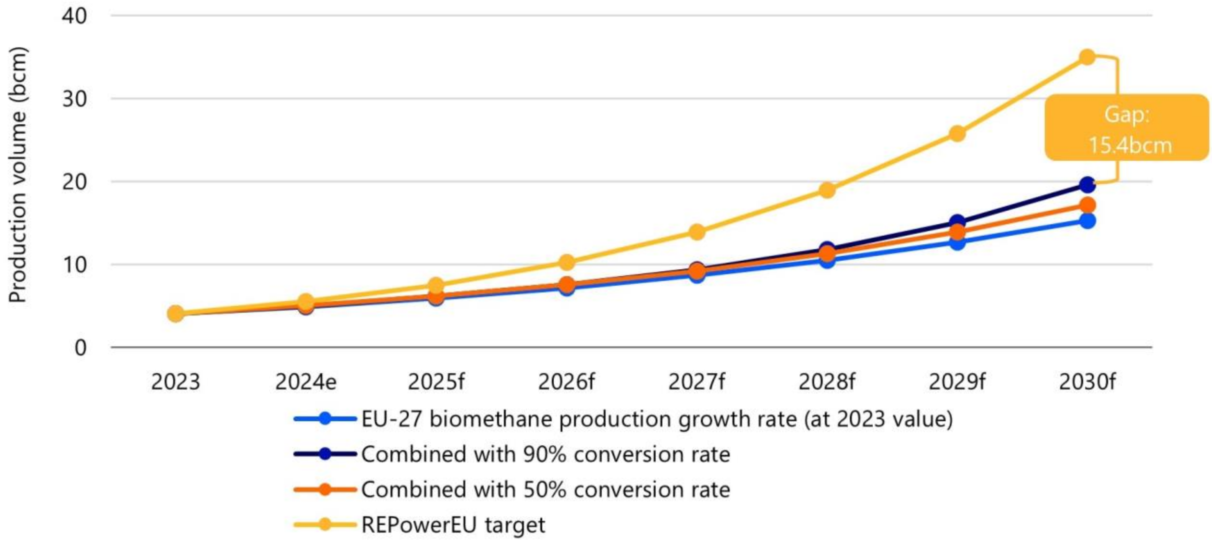
If we assume that 50% of existing biogas facilities are upgraded by 2030, total biomethane production – combined with projected greenfield installations – would reach 17.2bcm. Increasing the conversion rate to 90% would raise output to 20bcm, only 2.8bcm more. This relatively small difference between the two scenarios suggests that even converting half of the existing biogas infrastructure could deliver most of the potential gains in biomethane output, especially when paired with new capacity.

However, even under the 90% scenario, the EU would still need an additional 15bcm of new capacity to meet the 35bcm target – highlighting the continued importance of greenfield development. These results underscore the strategic value of upgrading existing plants, while reinforcing the need for parallel investment in new projects.

To unlock sufficient growth potential, several barriers must be addressed related to permitting delays, grid connections, cross-border certification challenges, feedstock supply chain limitations, and financing constraints. Tackling these issues is often cited as a key requirement for scaling biomethane production to meet EU targets.

[6] We assumed that by 2030, either 50% or 90% of the biogas facilities operating in 2023 would be retrofitted with upgrading technologies. The number of converted facilities was distributed annually between 2024 and 2030, following the same growth curve as greenfield biomethane projects under the 2023 growth rate scenario. These retrofitted facilities were then added to the projected number of new biomethane plants to estimate total production growth.

Figure 8. Biogas to biomethane upgrading scenarios compared to the REPowerEU target



Note: An average 60% of methane content was assumed for biogas, therefore a 0.6 conversion rate was applied to calculate biomethane outputs.
Source: RaboResearch 2025

Unpacking the constraints: What is hindering growth?

To understand what is holding back biomethane deployment, it is essential to examine the structural barriers that persist across regulatory, market, financial, and operational dimensions.

Regulatory fragmentation

Europe's biomethane ambitions face challenges due to fragmented regulations across member states and the lack of a unified EU strategy. The 35bcm target is non-binding, leaving implementation to member states and creating uncertainty for investors. Delays in implementing RED III and rolling out the Union Database for Biofuels (UDB)[7] further hinder cross-border trade and compliance.

Permitting process constraints

Despite growing political momentum, permitting remains a persistent bottleneck for biomethane deployment across Europe. Environmental permits are subject to lengthy review periods, often compounded by appeals and inconsistent procedures at the regional level.

Grid connection and congestion

The European gas grid is generally structured in layers: high-pressure, medium-pressure, and low-pressure networks. Biomethane is typically injected locally into the low-pressure grid, which is designed for one-way flow – unlike the electricity grid – and depends on local gas consumption to create space for new input. In summer, when demand for biomethane is lower – pressure drops, potentially causing congestion if supply exceeds local consumption. This limits the ability of producers' ability to inject biomethane consistently, especially in rural areas with low summer demand.

Feedstock sourcing challenges

Feedstock availability remains one of the most unpredictable variables in scaling biomethane production. But beyond availability, the logistics of sourcing, handling, and managing feedstocks pose significant challenges. Consistent production efficiency requires a reliable flow of inputs with stable characteristics – something that is difficult to achieve when dealing with diverse, weather-sensitive, and regionally dispersed materials. Seasonal fluctuations and extreme weather events can disrupt supply chains, while variability in feedstock quality affects output and operational

[7] EU-wide registry for the Guarantees of Origen and Proof of Sustainability certificates of biofuels for cross-border trade.

stability. At the same time, demand for high-CI feedstocks like manure is increasing, particularly in countries like the Netherlands and in industries such as the maritime sector, where GHG reduction is considered a key priority.

Lack of market harmonized market

The absence of a harmonized European biomethane market continues to constrain trade and system integration. Incompatible registry systems for certificates prevent mutual recognition between countries, limiting the mobility of biomethane across national borders. Even where trade is technically feasible, national restrictions often prohibit the use of imported biomethane in domestic support schemes or its contribution to national targets. Mass balancing[8] limitations – particularly for liquefied biomethane – further complicate tracking and allocation, undermining transparency and market efficiency.

Financial challenges

Biomethane projects remain capital-intensive, with high upfront costs for infrastructure, logistics, and grid integration. Financing is challenging in some markets due to limited and fragmented public support. In various countries, financial investors are backing biomethane projects and businesses with the aim of scaling them up, however they continue to face operational and scale-up challenges. Emerging private-sector solutions, like blended finance models are promising but have yet to reach scale. Price volatility – driven by feedstock supply and gas market fluctuations – adds risk and complicates long-term planning, slowing deployment across Europe.

Policy support and gaps: What's driving biomethane?

Reaching the REPowerEU target of 35bcm biomethane by 2030 requires more than technical potential – it demands enabling policies, market incentives, and regulatory clarity. The current policy landscape presents both opportunities and barriers that shape the speed and scale of deployment.

Supportive policies

- RED III introduces stricter sustainability criteria and mandates grid injection logging via the UDB, improving transparency and cross-border trade once implemented.
- The FuelEU Maritime Regulation promotes low-emission marine fuels like bio-LNG, boosting demand in maritime transport.
- The upcoming EU ETS 2 and the phase-out of free allowances under the original ETS will raise carbon costs, incentivizing low-carbon alternatives like biomethane, especially in the industries with high natural gas consumption (e.g., heavy industry).

Policies with gaps that limit the impact of biogases

- The REPowerEU roadmap (May 2025) reaffirmed the role of biomethane but lacks a binding EU-wide biomethane target, leaving member states without clear accountability.
- The Clean Industrial Deal (May 2025) outlines decarbonization measures but overlooks biomethane, favoring electrification and emerging technologies.
- Funding disparities persist, with biomethane receiving less attention and financial support than other renewables such as solar, wind, or green hydrogen – slowing deployment and investment.

Looking ahead: Taking advantage of the momentum

Biogases – particularly biomethane – are gaining recognition as a strategic pillar in the EU's energy transition. Their versatility, local production potential, and compatibility with existing infrastructure make them well-suited to help decarbonize hard-to-electrify sectors. Yet despite growing momentum, the sector remains at a crossroads.

[8] Mass balance is a chain-of-custody method that tracks the amount of certified recycled or bio-based input materials through a production process and attributes them to outputs via verified bookkeeping, even when mixed with fossil-based materials.

Production is rising, and the value chain is maturing, but the gap to the REPowerEU target of 35bcm by 2030 remains wide. Scaling up will require more than just technological scaling and supportive policies – it also hinges on market design, infrastructure readiness, feedstock availability, and investment certainty. Robust demand signals (like the Dutch blending obligation), streamlined permitting, and coordinated efforts across supply chains – from farmers to grid operators – will determine whether biomethane can reach its full potential.

As outlined in this article, the sector is evolving, and use cases are diverse. Existing EU instruments such as RED III, ETS 2, and the FuelEU Maritime Regulation offer entry points to embed biomethane more firmly into the EU's energy and industrial strategies. But deployment speed is still constrained by fragmented regulation, limited financial incentives, and infrastructure bottlenecks. The extent to which these barriers are addressed – at both national and EU levels – will shape the pace and scale of biomethane deployment in the years ahead.

About the author

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