# D4.1 SCENARIOS AND VISION FOR MARKET PENETRATION



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# Executive Summary

BIOMETHAVERSE Deliverable 4.1 is the Scenario and Vision for Market Penetration, and it is intended as document within Task 4.3 to assesses the penetration of biomethane in the energy and transport system and examine how this can be achieved. The aim is to provide main figures and estimations on the substitution of natural gas with biomethane in the different gas-consuming sectors, including synergies between hydrogen and biomethane in the future energy mix and future infrastructure investments. This document provides strategies and visions for the contribution of biomethane in decarbonising different end-use sectors in Europe, thus contributing to the priorities of the SET Plan Action 8. In November 2023, European Biogas Association (EBA), in collaboration with the Biomethane Industrial Partnership (BIP), has launched an online survey titled *Substitution of Natural Gas with Biomethane* aimed at understanding the potential challenges and drivers related to the transition from natural gas to biomethane. The questionnaire has been sent to the main stakeholders of the gas sector and to other key experts identified within the extensive network of EBA members and among different organizations and companies in the transport, power, industry, and building sector.

The document contains comprehensive insight and feedback from different stakeholders with the objective to shape strategies for the broader adoption of biomethane, positioning it as a key player in the Europe's push towards a carbon-neutral future. Furthermore, visions and strategies at the 5 BIOMETHAVERSE demo–countries level are summarized. Doing so, the local consortium project partners (ENGIE, UABIO, CERTH, CIC, RISE, SGA) identified barriers and favourable conditions related to the usage of biomethane in each of the specific 5 countries (FR, EL, IT, SE, UA) considering technological legislative administrative economic social aspects.



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# 1. BIOMETHAVERSE in a nutshell

**BIOMETHAVERSE** (Demonstrating and Connecting Production Innovations in the **BIOMETHA**ne uni**VERSE**) aims to diversify the technology basis for biomethane production in Europe, increase its cost-effectiveness, contribute to the uptake of biomethane technologies, and support the priorities of the SET Plan Action 8.

To this purpose five innovative biomethane production pathways, which include one or a combination of thermochemical, biochemical, electrochemical and biological conversion processes, will be demonstrated and implemented at plant scale in five European countries: France, Greece, Italy, Sweden, and Ukraine (**Figure 1.*1*** BIOMETHAVERSE countries and partners).

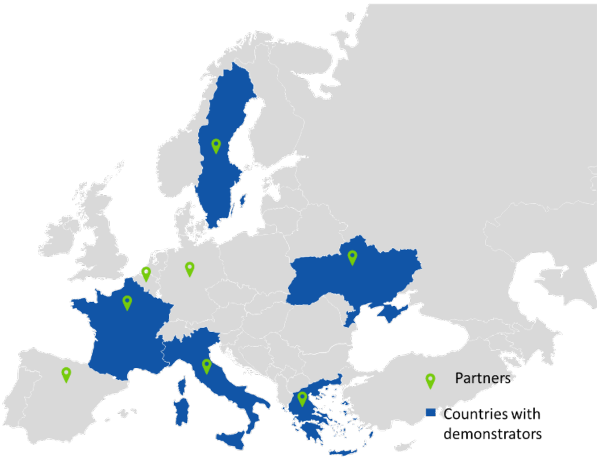


**Figure 1.1** BIOMETHAVERSE countries and partners

The main objectives of the BIOMETHAVERSE project are:

- Demonstrate increased cost-effectiveness and innovative biomethane production.
- Increase biomethane sustainability by reducing GHG emissions.
- Ensure replicability and upscaling of the demonstrated biomethane production pathways.
- Ensure market penetration of the demonstrated technologies and producing policy recommendations.

In the BIOMETHAVERSE demonstrators, the $CO_2$ effluent in the biogas from anaerobic digestion (AD) or from gasification are combined directly with renewable power or in synergy with hydrogen to increase the overall biomethane yield, via thermochemical processes or by exploiting the biomethanation microbial potential.

The five innovative technological concepts address sustainability and circularity as a whole, where waste, emission, and energy leakage are minimized by closing the energy and material loops while aiming at reducing the overall biomethane production costs and increasing its production. In particular, all demonstrated production routes go beyond conventional technologies, contributing towards the European security of energy supply increasing the biomethane production potential by about 60%. Using a participatory process involving stakeholders, BIOMETHAVERSE will ensure the replicability of demonstrated technologies and to facilitate the market uptake for the five demonstrators by developing a strategic vision for project developers and insights guidance to for policy makers.



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The five innovative technological concepts that will be demonstrated and implemented are listed in the

**Table 1.1** Innovative technological pathways in BIOMETHAVERSE and the related

| Innovative Technological Pathway | Country and Demo leader |
|---|---|
| • *In-situ* and *Ex-situ* Electro Methanogenesis **(EMG):** Electricity enhanced biomethane production | France-ENGIE |
| • *Ex-situ* Thermochemical/catalytic Methanation **(ETM)**: Thermochemical/catalytic upgrading of biogas using renewable hydrogen | Greece -BLAG |
| • *Ex-Situ* Biological Methanation **(EBM):** Biological upgrading of biogas using renewable hydrogen, including feedstock pre-treatment via ozonolysis | Italy-CAP |
| • *Ex-Situ* Syngas Biological methanation **(ESB):** biological methanation of syngas from thermal gasification with renewable hydrogen | Sweden-RISE |
| • *In-situ* Biological Methanation **(IBM):** Renewable hydrogen integration in the AD reactor | Ukraine-MHP |

demonstration plants and an overview of the concept is given in the **Errore. L'origine riferimento non è stata trovata.**

**Table 1.1** Innovative technological pathways in BIOMETHAVERSE and the related demonstration plants


| Innovative Technological Pathway | Country and Demo leader |
|---|---|
| • *In-situ* and *Ex-situ* Electro Methanogenesis **(EMG):** Electricity enhanced biomethane production | France-ENGIE |
| • *Ex-situ* Thermochemical/catalytic Methanation **(ETM)**: Thermochemical/catalytic upgrading of biogas using renewable hydrogen | Greece -BLAG |
| • *Ex-Situ* Biological Methanation **(EBM):** Biological upgrading of biogas using renewable hydrogen, including feedstock pre-treatment via ozonolysis | Italy-CAP |
| • *Ex-Situ* Syngas Biological methanation **(ESB):** biological methanation of syngas from thermal gasification with renewable hydrogen | Sweden-RISE |
| • *In-situ* Biological Methanation **(IBM):** Renewable hydrogen integration in the AD reactor | Ukraine-MHP |


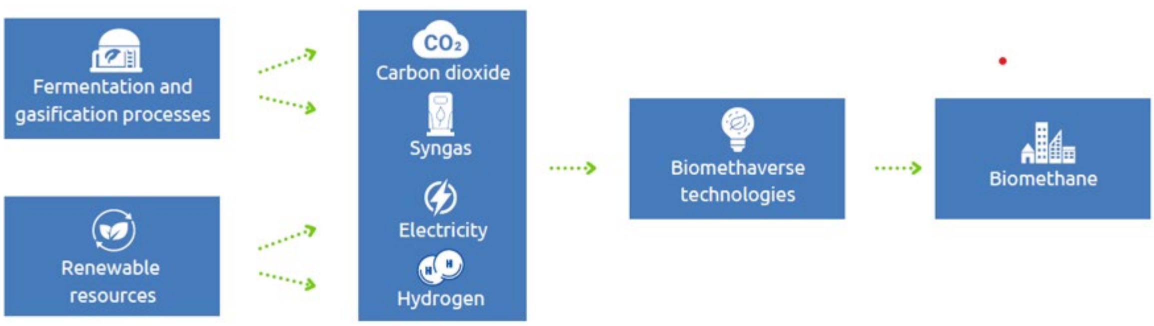


**Figure 1.2** Overview of innovative technological concepts in BIOMETHAVERSE



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# 2. Introduction

The European Commission's REPowerEU[1] plan states the need to increase EU energy security and has set as an indicative target to produce 35 billion $m^3$ (bcm) of biomethane annually in the EU by 2030. In line with this, the EC has been encouraging the inclusion of a 'component' on biogas and biomethane in the draft updates of the National Energy and Climate Plans (NECPs) since December 2022. The document intends to guide Member States (MS) to include specific targets, actions, and indicators related to biogas and biomethane production and use in their national energy and climate plans. Therefore, NECPs are essential framework for each MS to outline their climate and energy goals, policies, and measures from 2021 to 2030.
According to EBA and at the time of writing this report, 26 draft updated NECP were published out of 27 as Austria did not publish its draft. Among those 26 NECPs, almost all mention biogas and biomethane, while 17 include either a biomethane or a generic biogas target, 12 countries include a biomethane target in their draft plant totaling 14.16 bcm/year production of targeted production by 2030.

**Table 2.1** Overview of the draft-NECP biomethane targets, GfC 2030 biomethane potentials for EU-27 countries (as of 25 June 2024)

| Country | Draft NECP biomethane target | 2030 potential (Gas for Climate) |
|---|---|---|
| **Austria** | NECP not published | 0.57 bcm |
| **Belgium** | 0.11 bcm | 0.62 bcm |
| **Bulgaria** | No target mentioned in NECP | 0.67 bcm |
| **Croatia** | No biomethane target. only biogas | 0.21 bcm |
| **Cyprus** | No biomethane target. only biogas | 0.04 bcm |
| **Czech Republic** | 0.5 bcm | 0.72 bcm |
| **Denmark** | 0.4 bcm | 0.83 bcm |
| **Estonia** | 0.04 bcm | 0.1 bcm |
| **Finland** | No biomethane target. only biogas | 0.72 bcm |
| **France** | 4.15 bcm | 6.96 bcm |
| **Germany** | No target mentioned in NECP | 8.14 bcm |
| **Greece** | 0.2 bcm | 0.54 bcm |
| **Hungary** | No target mentioned in NECP | 1.03 bcm |
| **Ireland** | 0.58 bcm | 0.7 bcm |
| **Italy** | 5.7 bcm | 5.79 bcm |
| **Latvia** | No target mentioned in NECP | 0.16 bcm |
| **Lithuania** | 0.13 bcm | 0.38 bcm |
| **Luxembourg** | No biomethane target. only biogas | 0.03 bcm |
| **Malta** | No target mentioned in NECP | 0.01 bcm |
| **The Netherlands** | 2 bcm | 1.34 bcm |
| **Poland** | No target mentioned in NECP | 3.26 bcm |
| **Portugal** | No target mentioned in NECP | 0.63 bcm |
| **Romania** | No target mentioned in NECP | 1.99 bcm |
| **Slovakia** | 0.3 bcm | 0.3 bcm |
| **Slovenia** | 0.05 bcm | 0.1 bcm |
| **Spain** | No biomethane target. only biogas | 4.09 bcm |
| **Sweden** | No target mentioned in NECP | 1.14 bcm |
| **TOTAL** | 14.16 bcm | 41.07 bcm |

[1] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/repowereu-affordable-secure-and-sustainable-energy-europe_en



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Cornerstone of the European Green Deal the Fit for 55 Package put forward several positive drivers for the development and deployment of biomethane, which are crucial for achieving the EU's climate targets.

For instance, the revised Renewable Energy Directive (REDIII) sets a 42.5% target for the renewables share in energy consumption, with a voluntary additional 2.5%. This Directive mandates that Member States report on their progress, ensuring transparency and accountability in achieving the EU renewable energy goals. These measures are designed to accelerate the transition to a greener energy system and support the EU's broader climate objectives.

To ensure that all areas of the economy contribute to the EU's climate goals, REDIII also includes sectors-specific targets for buildings, industry, and transport, sectors in which the integration of renewable energy has been slower.

The buildings sector has an indicative target for the RES share set at 49%. For heating and cooling, there is a national binding target of a 0.8% annual increase in the RES share until 2026, followed by a 1.1% annual increase until 2030.

For the industrial sector, there is an annual target increase in renewable energy sources (RES) of 1.6%, along with specific targets for hydrogen obtained from RFNBOs, aiming for 42% by 2030 and 60% by 2035, with some exceptions.

In the transport sector, Member States have the option to choose between a 14.5% reduction in greenhouse gas (GHG) intensity or ensuring a renewable energy share of at least 29% by 2030. Additionally, there is a combined sub-target of 5.5% for advanced biofuels and renewable fuels of non-biological origin (RFNBOs) in the renewable energy supplied to the transport sector.

In the REDIII framework, biomass gaseous fuels and RFNBOs are defined and treated differently. This can have negative implications, especially for those biogas plants that produce both biomethane from anaerobic digestion (AD) and e-methane from methanation, which would be faced with administrative burden and legal uncertainty.

**Table 2.2** Relevant REDIII definitions

| REDIII Definition | Category |
|---|---|
| (27) 'biomass fuels' means gaseous and solid fuels produced from biomass; | Bio |
| (28) 'biogas' means gaseous fuels produced from biomass; | Bio |
| (33) 'biofuels' means liquid fuel for transport produced from biomass; | Bio |
| (34) 'advanced biofuels' means biofuels that are produced from the feedstock listed in Part A of Annex IX; | Bio |
| (36) "renewable fuels of non-biological origin" means liquid and gaseous fuels the energy content of which is derived from renewable sources other than biomass; | eFuel |

The distinction between biomass fuels and eFuels is especially relevant when looking at the criteria they have to fulfil on order to be considered sustainable and, thus, be eligible to contribute towards the targets set by REDIII.



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**Table 2.3** Relevant distinction criteria according to the REDIII

| Category | Criteria |
| --- | --- |
| **Biofuel / Biomethane from AD** | The **sustainability criteria** set in RED Article 29 (par. 2 to 7), which are used to determine whether biogas can be considered sustainable or not depending on the type and origin of the feedstock used to produce it. |
| | The **greenhouse gas emission savings criteria** set in REDIII Article 29 (par. 10 and 15), which are used to determine whether biogas can be considered sustainable or not depending on the date on which the facilities came into operation and the end use for which the biogas or biomethane is destined. In addition to that, RED III specifies the methodology to calculate the greenhouse gas emission savings and provides default greenhouse gas emission savings values to specific feedstocks (Annex VI). |
| **eFuels / E-Methane from methanation** | The **greenhouse gas emission savings criteria** in REDIII in Article 29a, which sets a greenhouse gas emissions saving of at least 70 %. |

Together with REDIII sectoral sub-targets, other legislative pieces of the Fit for 55 Package drive the production ramp up and utilisation of biomethane, as well as RFNBOs.

For instance, ReFuelEU Aviation[2] and FuelEU Maritime[3] Regulations aim at increasing the share of renewable energy in the aviation and maritime segments by respectively: requiring fuel suppliers provide EU airports with an increasing minimum share of sustainable aviation fuels (SAF) blends up to 70% by 2050; and limiting the GHG intensity of the energy used on board of ships on an LCA basis up to 80% by 2050.

When talking of biomethane targets specifically, the REPowerEU plan aims to significantly enhance the production and use of biomethane in Europe. A key component of this strategy is the Biomethane Action Plan, which outlines various tools and measures to scale up the biomethane sector. The goal is to achieve a production capacity of 35 bcm of biomethane by 2030. To support this ambitious target, the plan also includes the establishment of a Biomethane Industrial Partnership, which will facilitate collaboration between industry stakeholders, policymakers, and other relevant parties. This initiative is expected to drive investment, innovation, and the adoption of best practices within the biomethane sector, thereby contributing to Europe's energy security and sustainability goals.

In line with the RePowerEU Plan, the European Commission has been encouraging the inclusion of a 'component' on biogas and biomethane in the draft updates of the National Energy and Climate Plans (NECPs) to reflect the deployment strategies aligned with the 35 bcm target. Established in 2018, the NECPs are comprehensive strategies developed by the Member States to outline how they will achieve the EU's energy and climate targets for 2030 and delineate how EU countries aim to address the five dimensions of the energy union: decarbonization; energy efficiency; energy security; internal energy market; research, innovation, and competitiveness.

The biogases sector is also faced with a number of legislative barriers hindering the production ramp up and possibly jeopardising its business case.

For instance, the different methodologies to calculate the sustainability criteria of biomass fuels and eFuels will imply for plants producing both biomethane from AD and e-methane from methanation the need for a double certification, which will create costly and unjustified administrative burden for biogases producers.

[2] Regulation (EU) 2023/2405 of the European Parliament and of the Council of 18 October 2023 on ensuring a level playing field for sustainable air transport (2023/2405/EU).
[3] Regulation (EU) 2023/1805 of the European Parliament and of the Council of 13 September 2023 on the use of renewable and low-carbon fuels in maritime transport, and amending Directive 2009/16/EC (2023/1805/EU).


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As per REDIII, fossil $CO_2$ must be phased out in the production of RFNBOs, opening the door for a steeper demand of biogenic $CO_2$ for these fuels' production. Specifically, from 2036 onwards, the $CO_2$ used in RFNBOs production will have to be either from Direct Air Capture or biogenic source. On the other hand, biogas plants capturing $CO_2$ will be able to claim Carbon Capture and Replacement credits only until the end of 2035.

Moreover, as per Delegated Regulation (EU) 2023/1184[4], RFNBOs producers must adhere to specific power-purchase agreement (PPA) requirements, i.e. temporal[5] and geographic[6] correlation. These requirements introduce additional economic burdens that inevitably increase plants operational costs.

[4] Commission Delegated Regulation (EU) 2023/1184 of 10 February 2023 supplementing Directive (EU) 2018/2001 of the European Parliament and of the Council by establishing a Union methodology setting out detailed rules for the production of renewable liquid and gaseous transport fuels of non-biological origin.

[5] Until December 31, 2029, renewable electricity must be produced in the same calendar month as the hydrogen. Starting January 1, 2030, renewable electricity must be produced within the same hour as the hydrogen.

[6] Hydrogen must be produced in the same or a nearby bidding zone as the renewable electricity installation.



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# 3. Increased biomethane potential in EU by 2030-2050 thanks to implementation of the BIOMETHAVERSE technologies

According to the 2024 report from Guidehouse and European Biogas Association (EBA) *Biogases towards 2040 and beyond* [7] Europe has the potential to produce 111 bcm of biomethane by 2040, of which 68% of the total via anaerobic digestion and 33% of the total via thermal gasification (Figure 3.1). The BIOMETHAVERSE technologies can further increase this potential, converting the $CO_2$ present in biogas from anaerobic digestion and CO and $CO_2$ in the syngas from gasification, to additional biomethane.

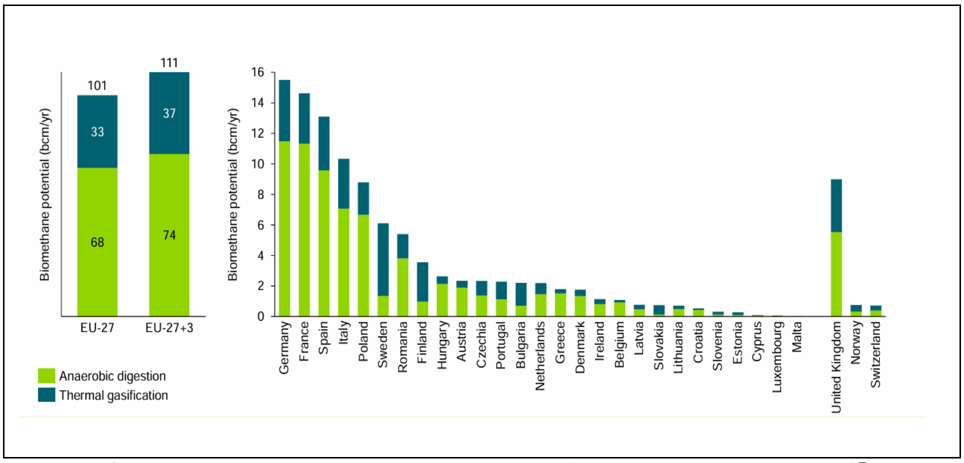


**Figure 3.1** Biomethane potential in Europe (Source 2024, Guidehouse)[7]

In addition to the quantified potential, this assessment includes a qualitative analysis on innovative feedstocks and technologies that can further scale biomethane production. In this regard the methanation technology producing renewable e-methane, is becoming increasingly important as it is an opportunity to diversify the technology basis for biomethane production in Europe, to increase its cost-effectiveness, and to contribute to the uptake of biomethane technologies.
This is thanks to innovative production processes and the ongoing implementation of technologies including those being demonstrated under BIOMETHAVERSE project.
Therefore, it is important to keep developing technologies that store renewable energy and create green gas from recycled $CO_2$ rich stream which is valorised within a circular system approach.
In particular biogenic $CO_2$ from biogases is one of the most promising sources of $CO_2$ for e-methane production because at biomethane plants the biogas separation into $CO_2$ and $CH_4$ already takes place to enable the injection of biomethane into the gas grid. Therefore, a concentrated $CO_2$ stream is already at hand. Moreover, biogases from anaerobic digestion and gasification already contain a relatively large share of $CO_2$ (typically 25-50 vol%) which can also be used directly as input stream for the methanation process. Methanation of biogases can be used to replace conventional upgrading, where the methane content is increased from 50-70 vol% towards nearly 100%.

In 2022, the total availability of biogenic $CO_2$, from biogas and biomethane is calculated at 28 Mt $CO_2$/year. The theoretical potential of biogenic $CO_2$ arising from biomethane production of 35 bcm (as targeted in the REPowerEU Plan) is estimated to be 46 Mt by 2030.[8] [9]

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[7] Biogases towards 2040 and beyond- https://www.europeanbiogas.eu/wp-content/uploads/2024/04/Biogases-towards-2040-and-beyond_FINAL.pdf
[8] European Biogas Association, Biogenic CO2 from the biogas industry, 2022 Biogenic CO2 from the biogas industry | European Biogas Association
[9] Theoretical potential of biogenic $CO_2$ based on biogas and biomethane production in Europe in 2022 (21 bcm)


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# 4. End uses: industry-buildings-transport-electricity

The primary end use of biomethane varies from country to country depending on regulatory frameworks, market demand and the extent of the gas grid infrastructure.

## Power

Biomethane is used in power plants for electricity generation thanks to its high efficiency with a lower heating value (LHV) of around 36 MJ/m³ (compared to 16-28 MJ/m³ for biogas). The transition to a power system dominated by renewables, including variable sources providing fluctuating levels of electricity lead to an increasing need for energy system flexibility. In this context biomethane contributes to greening Europe's electricity not only by producing baseload volumes of green electricity, but also can be used to generate electricity as needed thus by providing flexibility and storage options for the energy system as a whole. In 2022, 6.8 TWh of biomethane was used in Europe for power generation, resulting in an estimated 2.6 TWh of electricity. [10]

## Industry

For industrial processes biomethane serves both as a sustainable fuel and as a feedstock used as a building block for chemical synthesis production of basic materials in the so called 'gas to chemicals'. Biomethane is particularly well suited to use as a feedstock or for high-temperature industrial process, where options for decarbonisation are limited. The glass industry is consuming around 70 TWh/yr of NG and is actively pursuing decarbonisation strategies and is exploring the potential of reducing its carbon footprint by transitioning away from NG with initiatives that consider biomethane as viable fuel substitute option in furnaces for glass melting. Biomethane can be used to produce pharmaceuticals, fertilizers and plastic, as well as to produce chemicals (e.g., ethanol, hydrogen, and ammonia). According to scientific community and experts in the chemical industry, utilizing carbon from methane in the fertilizer value chain and converting also into chemicals could significantly advance net zero objectives.[11]

## Buildings

Biomethane can be used to generate heat and electricity through cogeneration systems, which produce both electricity and heat simultaneously. This is particularly useful for industries or buildings that require both electricity and heat, such as hospitals or industrial processes. the heat can either be generated directly on-site or produced off-site and distributed through a district heating grid for residential and tertiary buildings. As biomethane is compatible with existing gas-based space heating systems, it can decarbonise household heating in a non-invasive manner. Replacing natural gas with biomethane requires minimal additional investment, making it an attractive solution for decarbonizing buildings. This approach is particularly well-suited when other alternatives are not feasible due to technical, regulatory, or financial constraints. Biomethane can complement the electrification of household heating, for example by using hybrid heat pumps.[12] Several examples of the use of biomethane in urban heating networks can be found in Europe.[13] [14]

## Transports

In Europe, biomethane usage in the transport sector reached 8.63 TWh in 2022, serving as significant fuel source. Biomethane can be used as a transport fuel either in compressed form (bio-CNG) or in liquefied form (bio-LNG). It is one of the few readily available fossil fuel alternatives for long distance and energy intensive transport segments (heavy-duty vehicle (HDV). The bio-LNG market is growing in Europe with 27 active bio-LNG-producing plants by the end of 2022. This number is expected to rise to 109 plants by 2025 with a projected production capacity 15.4 TWh per year.[15] Norway and Sweden pioneered Bio-LNG production, with Europe's first plants starting in 2011 and 2012.

[10] EBA (2023) EBA Statistical Report 2023 | European Biogas Association
[11] https://academic.oup.com/nsr/article/10/9/nwad116/7143128
[12] Hybrid Heating Europe. (March 2021). Unlocking the hybrid heating potential in European buildings. https://hybridheatingeurope.eu/wp-content/ uploads/2021/03/hhe_vision-paper_final.pdf
[13] Planbureau voor de Leefomgeving. (September 2020). Startanalyse voor aardgasvrije buurten (versie 2020, 24 september 2020). https://www.pbl.nl/publicaties/ startanalyse-aardgasvrije-buurten-2020
[14] Green Energy Transition Actions (GRETA). (December 2021). D3.2. Case study 2 report: Natural gas-free neighbourhoods, The Netherlands. https://projectgreta.eu/wp-content/uploads/2023/01/GRETA_D3_2_Case-study-2-report_v1_0.pdf
[15] Figures are conservative, as they only include projects that have already been made public. The number of plants and total production capacity may well rise further, if more projects are confirmed.


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## 4.1. Substitution of NG with biomethane in different gas consuming sectors - results of the questionnaire (Output Survey)

Specific Context This section presents results of a survey titled '*Substitution of Natural Gas with Biomethane'* conducted by EBA in collaboration with the Biomethane Industrial Partnership (BIP). The work summarizes and outlines how companies are planning to transition from the use of NG to climate energy solutions to reduce their emissions in the light of the carbon neutrality objective set for 2050. This is achieved by conducting a survey that employed a questionnaire comprised of 3 sections for a total of 13 open questions.

Objective of the questionnaire was to collect information to:

- investigate the usage of NG and biomethane in different sectors
- understand the potential challenges and drivers related to the transition from natural gas to biomethane in different end use sectors
- provide strategies and visions for the contribution of biomethane to decarbonize different end-use sectors in Europe.

### 4.1.1. Research Methodology

Research Method: online and telphone survey. The data collection was conducted between M14-M20 months from December 2023 to May 2024. The survey was launched using online interviews with a link directing potential respondents to the questionnaire. EBA used the online survey platform jotform and sent the link **Survey on end-use of biomethane (jotform.com)** that enabled participation in the survey to the participants.
The questionnaire is presented in Annex- Questionnaire on end use of biomethane
The link was embedded in an 'INVITATION - Survey on the substitution of natural gas with biomethane' e-mail letter to the recipient. The questionnaire was translated in 5 languages and promoted on social media (e.g linkdin), on EBA website, newsletter and on biomethaverse website. The use of telephone interviews presented an added benefit in allowing for conversational exchange. This approach allowed interviewers to gather deeper and more nuanced insights from respondents, as opposed to more structured written methods.
Target: main stakeholders operating in different gas consuming sectors, representatives and to key experts identified within the extensive network of EBA members and among different organizations in the industry, transport, power and buildings.
Output-Sample Size: A total of 23 stakeholders was interviewed by phone and questionnaire. The questionnaire was answered by experts representing different international realities (e.g., USA) and in the EU Member States of 8 countries (DE, IT, FR, NL, BE, SE, ES).
The survey, designed to gather insights on the consumption of NG and biomethane, as well as potential replacement of NG with biomethane, consisted of a comprehensive questionnaire comprising three sections.
The first section included three open-ended questions inquiring about respondents' current state in terms of share in their consumption across different company associated to the specific end use sector (i.e., industry/transport/buildings). This section also addressed internal decarbonization targets, the extent of envisioned forecast for decarbonization and anticipations related to decarbonization, inviting participants to share their thoughts and experiences in the target end use sector.
The second section shifted its attention to biomethane, exploring the current situation and potential usage intentions. Here, 6 open-ended questions queried respondents' perceptions, preferences, adoption timeframe and utilization of biomethane.


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The final section delved into the future, examining respondents' outlook for the scale-up of biomethane. This section featured 4 open-ended questions that inquired about alternatives, potential barriers to its usage, drivers, vision and choices for the growth and development.
By employing this multi-faceted approach, the survey aimed to provide understanding of the market dynamics surrounding natural gas and biomethane along with synergy with hydrogen in the future energy mix.

## 4.1.2. Key findings and main highlights

### 4.1.2.1. Natural Gas - Current situation

The reliance on natural gas compared to the overall energy demand varies widely across sectors and subsectors.

**Table 4.1** Overview the final natural gas consumption in the various sectors in Europe[10]

| Total natural gas consumption | Power | Building | Industry | Transport |
|---|---|---|---|---|
| (TWh) | 546 [16];[17] | 1,280 [18] | 910 [19] | 43 [20] |

The overall trend shows that natural gas purchased of the surveyed end-use sectors represents over 60% of the the total energy consumption with over half of all respondents reported that their energy demand is covered mainly by natural gas.
Natural gas plays an important role in industrial production processes not only as an energy source, but also as a feedstock. The chemical industry is the largest industrial gas consumer in the EU, currently consuming roughly 44 bcm (440 TWh) per year. This comprises around 30% for energy purposes and 70% used as feedstock. Among the different subsectors of industry non-metallic minerals (e.g., glass and ceramics), iron and steel, fertilizer and food industry have the highest NG consumption. The total energy consumption of the glass industry is of about 40 TWh per year of which 78% is covered with NG. Fertilizers production currently relies on fossil fuels and the sector is highly gas intensive accounting for over 146 TWh. Over 70% of ammonia production is via natural gas-based steam reforming, with coal gasification making up the remaing.[21] The NG is mainly used as feedstock with which the fertilizer sector produce hydrogen then transformed to ammonia. In particular, nearly 100% of the production of hydrogen for ammonia comes form natural gas, with 40% of used as a feedstock (for the hydrogen production) and the remaining 60% is used for fuel.
Different end uses can be decarbonised using a wide array of pathways to including electrification, hydrogen, CCS, biomass, biogas and circular economy.
Setting steep GHG emissions reduction trajectories at sectoral level is a crucial commitment that can acceleratee i reduction of GHG emissions and a sustainability choice journey highlighted by the majority of respondents. TFull recognition of market-based approaches by the most used voluntary GHG emission reporting frameworks is key for the further utilization of biomethane as a corporate climate mitigation strategy.

[16] European Council. (May 2023). Infographic – How is EU electricity produced and sold? How is EU electricity produced and sold? - Consilium (europa.eu)
[17] In 2022, the EU produced 2,641 TWh of electricity. Almost 40% of this came from renewables and 20% from natural gas sources. European Council. (2023).
[18] Association of the European Heating Industry (EHI). Reiser, M., Klerks, K., & Hermelink, A. (2022). *Decarbonisation pathways for the European building sector.*
Guidehouse. https://ehi.eu/new-guidehouse-study-decarbonisation-pathways-for-the-building-sector/
[19] Eurostat. News Articles. (12 May 2023). Industry relied mostly on natural gas and electricity. https://ec.europa.eu/eurostat/web/products-eurostat-news/w/ddn-20230512-1
[20] Eurostat. Data Browser. (April 2023). Final energy consumption in transport by type of fuel. https://ec.europa.eu/eurostat/databrowser/view/ten00126/default/bar?lang=en
[21] https://iea.blob.core.windows.net/assets/6ee41bb9-8e81-4b64-8701 2acc064ff6e4/AmmoniaTechnologyRoadmap.pdf


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Targets are set for the majority of companies and sectors interviewed to ensure that they are working towards the common goal of reducing the emissions. For instance, the chemical industry in the EU is subject to a decarbonization trajectory through various policy initiatives and regulations. Among systems and mechanisms ensuring that the sectors contribute to the EU's climate goals, the Emission Trading System (ETS) is a key instrument that sets a cap on GHG emissions and creates a market for carbon allowance, thus creating a financial incentive for companies to reduce their emissions below the cap, as they can sell any unused allowances or purchase additional ones if needed.
The chemical sector has expressed support for the EU's objective of climate-neutrality by 2050, which it currently substantiates with a dedicated Transition Pathway. [22]
While the target is to be fully decarbonized by 2050, the aim is to reduce emissions by 70% by 2040 compared to 2020. To achieve this companies in the fertilizer sector will define their decarbonization roadmap to meet the 2040 target by 2026.
The ceramic industry for example has adopted a decarbonization roadmap in 2012 and a new one in 2021 with a view to meet the net-zero target by 2050. The lattertakes into account energy sources such as hydrogen. Decarbonization pathways include biogas, hydrogen and electricity, each of which has the same share in the final target: 33% biogas, 33% hydrogen, 33% electricity. These targets are not binding but represent a commitment taken by sectors where in some cases the decarbonization strategy aims at reaching climate neurality by 2025.
Other industry targets, like Science-Based Targets Initiative (SBTis), are under development. For instance in some cases companies in the chemical sector set specific target under SBT.[23] The submission of SBTi implies a reduction of 42% of energy need (Scope 1 and 2) for 2030 and Net Zero Emission target for 2040. In the building sector there are companies bounded by internal target (-12% under scope 1 and 2).
Out of the total gas need most of the respondents in the industry sector intend to decarbonize a significant portion of the total gas currently used. The chemical sector for example expects to reach a near substitution of gas methane with biomethane or electrification, whereas lower expectations are found in the building sector and transport.

### 4.1.2.2. Current use of biomethane

The current use of biomethane in Europe varies depending on the sectors and the countries.
In terms of the geographical variations in biomethane end use in Europe, the majority of the biomethane produced in countries such as Italy, Sweden and Norway is used in the transport sector In countries such as Germany, on the other hand, a greater portion of the biomethane produced is used to heat buildings or converted into electricity.

Table 4.1 and Figure 4.1 show how the biomethane produced is distributed across the various sectors overall (in Europe) and in the selected 5 countries of BIOMETHAVERSE project, and later detailed in Chapter 6. In countries such Sweden the distribution of the usage of biomethane among sectors is as follow: transport: 90-98% (LNG/CNG), Industry (energy use): 10-15%, Industry (raw material): <3%, electricity and heating:60-70%, housing: 65-70%, maritime:<3%, other business: 25-30%.

**Table 4.2** Biogases share (TWh) for different end uses in Europe in 2022

| Total biogases consumption | Power | Building | Industry | Transport |
|---|---|---|---|---|
| Total (TWh) | 74.74 | 9.7 | 6.46 | 8.63 |

[22] https://single-market-economy.ec.europa.eu/industry/transition-pathways_en
[23] SBTi-criteria.pdf (sciencebasedtargets.org)



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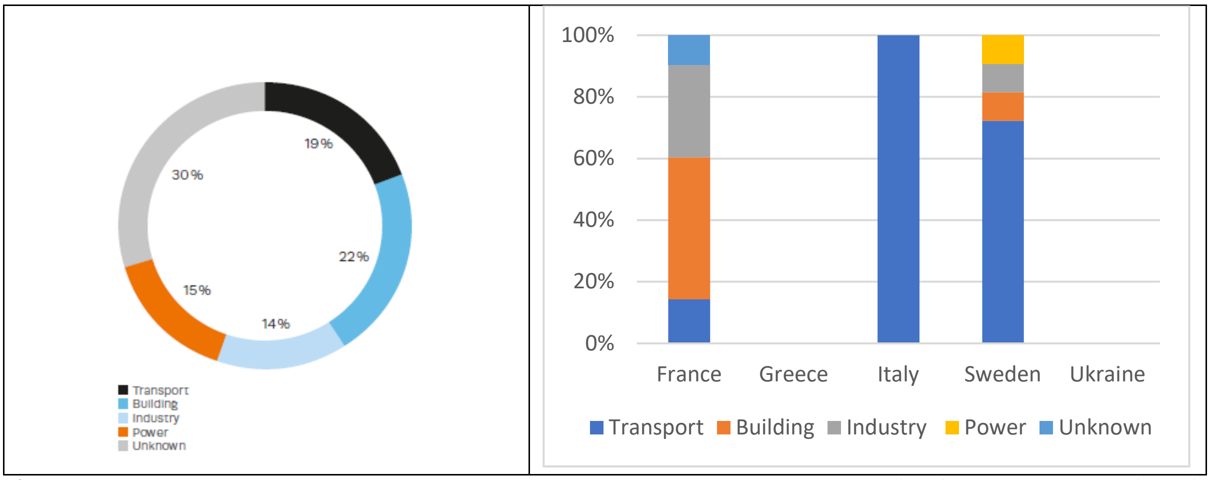


**Figure 4.1** Percentage of biomethane production used in different sectors overall (left) and per country (right) (EBA, source )***Errore. Il segnalibro non è definito. Errore. Il segnalibro non è definito.***

The biomethane is view by different companies, as the main lever to meet decarbonization targets by 2030, however its use is still limited in many sectors. In general, the majority of sectors utilize mainly NG and not biomethane. However, about 30% of respondents from the chemical sector are already using biomethane, for instance as a by-product from fermentation processes, although the extent of its current use is reported to be less than 5% of the total gas supply.

As earlier mentioned, the chemical sector consumes NG not only for energy, but also for feedstock purposes. For instance, biomethane can be used to produce pharmaceuticals, fertilizers, and plastic, as well as to produce chemicals (e.g., ethanol, hydrogen, and ammonia). Nevertheless, exact volumes currently being used are difficult to assess, as the available statistics focuses on energetic uses thus underestimating the role of biogas and biomethane.

#### 4.1.2.3. Outlook for biomethane use in the future

The decision to purchase biomethane is influenced by several factors, beside its availability, including its cost, which is typically higher than NG if not accounting for carbon cost. On the other hand, compared to other decarbonization levers (e.g., electrification) and climate neutral alternatives, biomethane can be more competitive. Additionally, biomethane does not have infrastructure constraints and its adoption switching to this biomethane will not require more resources than what is currently being used.

According to the survey results, market mechanisms, including the GO system, are not yet mature and have a significant negative effect on the adoption of biomethane, as discussed in the next section.

In general, the timeline for increased biomethane use is tied to when more volume is introduced in the networks thus becoming concretely available in the pipes. Additionally, favorable economic conditions and lower biomethane production costs will help achieve pricing that is closer to and more competitive with the fossil natural gas market. The results indicate that significant biomethane utilization across various end-use sectors is expected within a timeframe of 3-5 years although a bigger scale up will occur from 2040 onwards.

The roadmap for different sectors reveals varying expectations regarding the extent of anticipated using of biomethane usage in the future. For instance, in the fertilizer industry expectations of 43 TWh/year by 2030 and 138 TWh/year (corresponding to 10-15% of the available biomethane) by 2050 are projected. For net-zero urea production, biomethane will be needed, as there is still a requirement for $CO_2$ as feedstock for urea production. Biomethane use for fertilizers production is


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projected to reach around 30% of the total sectoral demand anticipated by 2050 by the year 2030. However, the most significant growth is expected to occur after 2040.

In the transport sector, the use of biomethane is expected to evolve significantly over the next decade. While the adoption of biomethane in light vehicles is declining, the heavy-duty vehicle (HDV) segment is experiencing rapid growth. This trend is likely to continue, and it is projected that biomethane could account for 100% of the fuel share in HDVs before 2030. The maritime sector is expected to growth in biomethane use. Most new ships being built are LNG-ready, facilitating the integration of biomethane as a low-blend fuel option. Therefore, biomethane could constitute 10-20% of the maritime fuel mix by 2030 and could play a crucial role in reducing maritime emissions.

Biomethane use in industrial energy applications is anticipated to increase considerably and the share of biomethane in industrial energy use could approach 100% by 2035. This highlights the industry's commitment to sustainable energy solutions, as previous mentioned, and the growing feasibility of biomethane as a primary energy source. Additionally for raw material use, there is readiness to transition high level of interest from the industry in adopting biomethane. pending the introduction of more robust incentive structures as currently lags behind. In the building sector of some countries, for example, Germany, Germany's Building Energy Act (GEG), mandating 65% renewable heating in new buildings by 2024, is likely to drive up biomethane demand in the sector.

The survey results from experts who responded to the questionnaire indicate that biomethane could constitute up to 50% of the raw material input by 2030.For electricity and heating and housing the share of biomethane could reach 100% before 2030.

In summary, aaccording to the survey, to scale up the use of biomethane several conditions must be met including:

- a clear and stable legislative framework setting level of playing field in Europe with no internal market barriers;
- effective support schemes or demand pull (such as a blending mandate).

Additionally, consistency and transparency in the treatment of biomethane within the EU ETS system and GHG protocol are also important. On a more general level, increased EU climate and renewable ambitions can drive the uptake of biomethane while streamlined permit processes are necessary to guarantee timely capacity scale-up. Finally, biomethane should be tracked and traded consistently across different areas, recognizing the amount of biomethane produced and used (mass balance) and allowing it to be bought and sold easily between countries (cross-border trade). Additionally, e-methane should be recognized in support schemes.

### 4.1.2.4. Alternatives to biomethane

The most frequently mentioned alternatives to NG reported by companies were, in order:

- hydrogen (although technological barriers, being hydrogen molecule high energy by weight but very low density by volume, thus necessitates binding it to another molecule for efficient transport)
- electrification (e.g., pumps, solar and wind plants, although full electrification is not feasible due to specific industrial processes which require high temperatures, grid issues and intermittency problems)
- Bio-fuels (e.g. propane, DME, FAME, HVO)
- Combination of green electricity, H2, CCS, CCU



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### 4.1.2.5. Barriers and Drivers

With specific regard to biomethane, it was highlighted that security of supply is the main barrier whereas technological ease to switch from NG to biomethane is the main driver, which would make it easy for almost all sectors to immediately switch to this source. The respondents to the survey highlighted the challenge of securing a reliable source of biomethane through long-term agreements, lasting 10 years. Suppliers might be cautious about committing to these contracts in an evolving market. According to the survey, guaranteeing a fixed supply of biomethane over an extended period has been reported that often can represent risky for both buyers and sellers due to factors like feedstock availability and waste management, which are being influenced by market dynamics and government incentives leading biomethane prices to be subjected to change. Among The Figure 4.2 shows the main challenges, drivers and the enabling conditions highlighted by the respondents necessary to scale up the use and for switch towards biomethane. The role played by the 35 bcm target and the provisions of gas package in stimulating the consumption of biomethane. In particular, it emerges that the 35 bcm target set at EU level in the Repower EU plan has been useful to draw the attention of the market on biomethane (given that all interviewed organization showed interest for the topic, asked more information about it and mentioned they are currently investigating the feasibility of a transition to biomethane or that they are already planning to produce it / buy it more and more in the coming 2 years). Foreseeably, more ambitious targets for the long term, ideally binding, could produce even greater effects considering the impact already generated by the 35 bcm target after only 2 years since the adoption of the plan. Accordingly, it would be detrimental to revise the current level of ambition of biomethane production downwards, considering that some sectors do not see other viable alternatives to meet their 2030 goals and that, in case biomethane loses its actual political support, the overall production risks not increasing as much as needed and end users who are looking optimistically to this solution could give up on their reduction targets, acknowledging the impossibility of meeting them otherwise.

A change in the political narrative would inevitably frustrate all efforts made by investors, producers and end users so far, by undermining their confidence in this decarbonization pathway as well as putting at risk the effective progress towards the 2030-2040-2050 decarbonization goals.

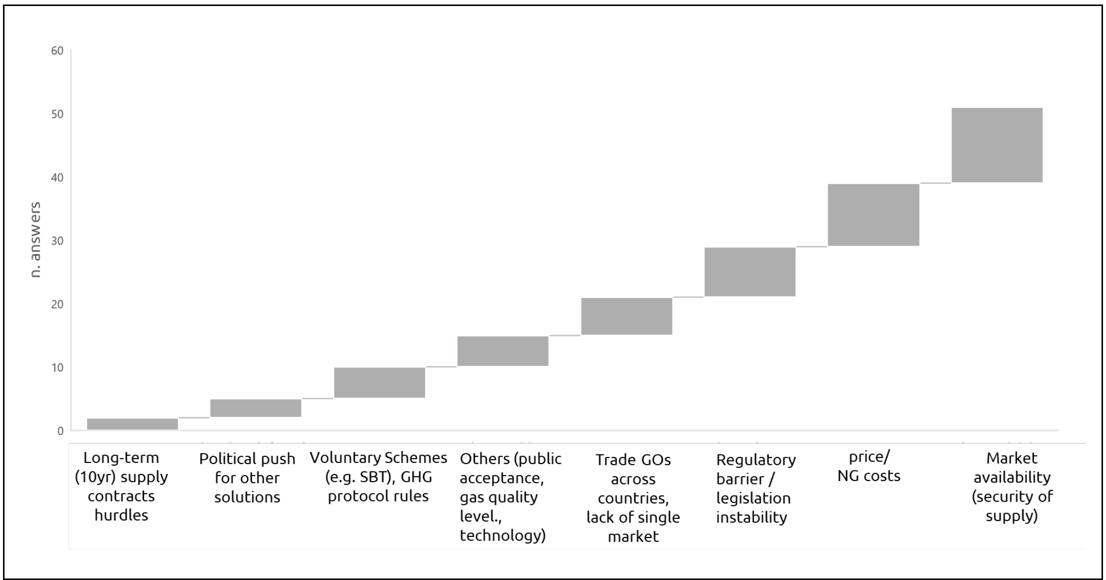


**Figure 4.2** Overview of challenges, drivers and enabling conditions to scale up the use and for switch towards biomethane

**Table 4.3** Barriers, Drivers and overview of conditions necessary to scale up the use of biomethane

| Barriers | Drivers |
|---|---|
| Market availability (security of supply) | Technological driver (no technical changes needed compared to NG) |
| Difficulty to find and sign long term supply contract (10 years) | |
| Price/ lower costs of NG | Cost competitiveness compared to decarbonization alternatives |
| Regulatory barrier and legislation instability | Possibility to sign long-term supply contracts |
| Voluntary Schemes (e.g., SBT) rules, GHG protocol rules (stringent to comply /inconsistent criteria/confusion) | high $CO_2$ prices under EU ETS system |
| Political push for other solutions | National context/incentives, financial support for biomethane |
| Trading of GOs across different countries, absence of a single market | Cross border trade of biomethane certificates, implementation of UDB |
| Others (e.g., public acceptance, gas quality level, technological) | Unavailability of electricity in specific areas Unavailability of alternatives such as Hydrogen or CCS |

The **Figure 4.3** shows the main drivers encountering by respondents that lead to switch toward biomethane as highlighted by the survey.

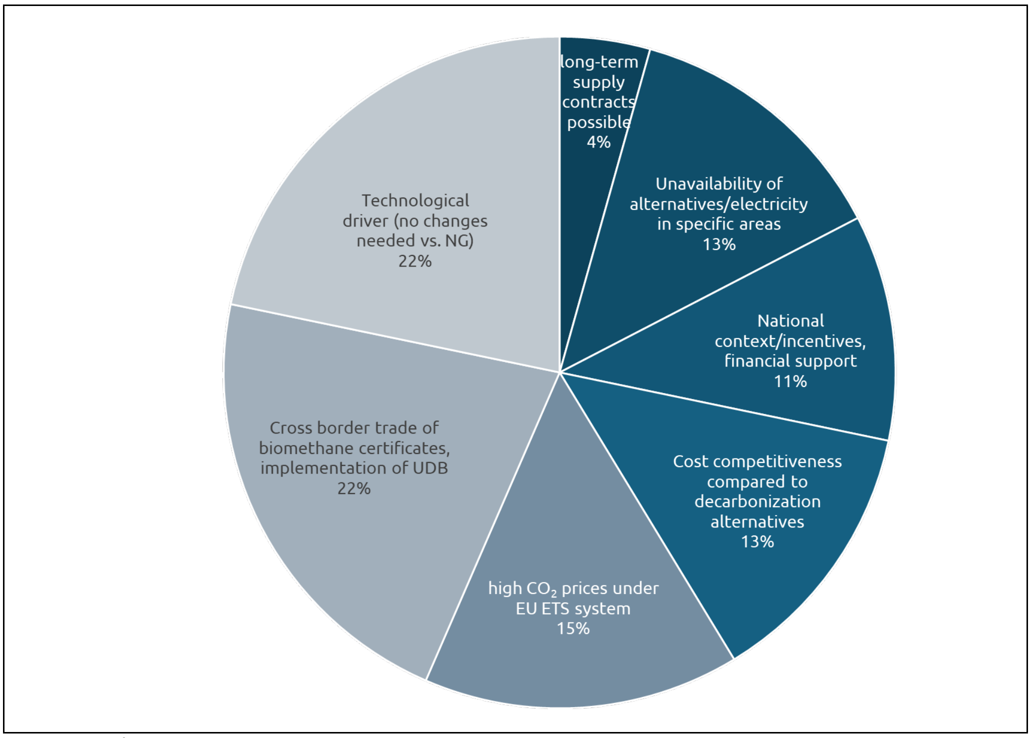


**Figure 4.3** Main drivers encouraging and lead to switch toward biomethane


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# 5. Synergies between hydrogen and biomethane in the future energy mix

In Europe's future energy mix, biomethane and hydrogen are expected to advantageously complement each other benefitting from their synergies. Hydrogen converted to biomethane helps match energy production to usage, providing an important form of seasonal energy storage.[24] Biomethane can be injected into the existing gas infrastructure, which in itself functions as an energy storage unit and has the capacity to cover up to 2-3 months of current gas consumption in the EU.[25]

Power to methane (PtM) and the production of e-methane approach serves as prime example of this, offering an ideal opportunity to store electricity in significant quantities while contributes as strategic method for converting surplus energy from various renewables which experience fluctuating and intermittent electricity levels, therefore supporting electric grid flexibility against demand-response unbalancing.

Green hydrogen, produced from excess green electricity, can be combined with raw biogas to convert the biogenic $CO_2$ into biomethane, which can be used or stored. Therefore, this approach brings the possibility of connecting the power grid to different sectors, where CH4 is needed such as mobility/transport and industry.[26]

Energy Systems Integration (ESI) entails the coordination and efficient planning of the energy systems to deliver reliable and affordable energy while reducing environmental impact.[27] Integrating sectors with the interplay between utilisation of multiple versatile and renewable energy vectors carriers, alongside the production of green electricity[28] [29] brings the possibility of connecting the power grid to the different sectors where CH4 is needed, such as the transport and industry ones.[30] Integrating multiple sectors will allow the optimisation of the energy system as a whole and making separate efficiency gains in each sector independently.[31] The cross-sectoral links in the EU's current system need to become stronger in order to create the conditions enabling and encouraging further integration, where different energy carriers can compete on a level playing field while maximizing the use of existing energy infrastructure and providing flexibility in Europe's decarbonization efforts. Such integration will build a more flexible, decentralised and digital energy system, in which consumers are empowered to make their energy choices. Achieving a perfect integration of implemented competitive alternatives systems, opens the door to a better utilization of autochthonous resources, mitigating energy dependence.

The European Union is increasingly energy dependent. As its primary energy consumption mostly derives from fossil fuels. The EU's rate of dependence on natural gas imports rose to 97% in 2022 (when 342 bcm of natural gas was imported). Natural gas consumption currently represents almost 40% of the total energy share, with many industries and sectors relying on this energy source.

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[24] Decarbonising Europe's hydrogen production with biohydrogen EBA (2023) https://www.europeanbiogas.eu/decarbonising-europes-hydrogen-production-with-biohydrogen/
[25] https://www.europeanbiogas.eu/wp-content/uploads/2023/03/EBA-Campaign_Energy-system-integration.pdf
[26] Ghaib K., and Ben-Fares F.Z. http://dx.doi.org/10.1016/j.rser.2017.08.004
[27] Aljburi, MT. et al.,2024, Exploring decision-making techniques for evaluation and benchmarking of energy system integration frameworks for achieving a sustainable energy future, Energy Strategy Reviews,51, ,101251, https://doi.org/10.1016/j.esr.2023.101251.
[28] Gas for Climate 2020. Decarbonisation-Pathways-2020-2050.
[29] 57 European Commission. (July 2020). COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS. Powering a Climate-Neutral Economy: An EU Strategy for Energy System Integration. COM/2020/299 final. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0299 The Energy System Integration Strategy aims to facilitate the integration of renewable energy sources into the electricity system, optimise the use of renewable energy sources, increase the share of renewable energy, ensure system stability/security of supply, enhance system flexibility, and facilitate the transition towards a decarbonised energy system.
[30] Ghaib K., and Ben-Fares F.Z.
[31] EU strategy on energy system integration (europa.eu)


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Therefore, Europe heavily relies on a diverse mix of renewable energy sources to mitigate the risks of energy shortages, reduce dependence on outside energy suppliers or even deindustrialization due to a lack of alternative suppliers within EU.

Currently the solar and wind sectors encounter different challenges due to: (i) their intermittency and fluctuations and (ii) inability of storing growing production surpluses over long periods of time. Therefore, to manage this variability, to compensate for the drop in dispatchable power, mitigate grid congestion, ensure grid stability, while providing significant support to the development of renewable energy storage infrastructure, a strong connection between the electricity and gas systems is required towards flexible resources that can adapt throughout the year, as periods of surplus and reduced generation become prolonged.
In this context, biogases and the development of advanced biofuels such as biomethane, are keystone to sustainable energy transition because they act as 'energy carriers' /hub for energy storage, thus able to store, transport and distribute the energy.
In this light, renewable and synthetic methane not only boosts energy supplies volumes and contribute to greening the gas grid, but It also offers flexibility, seasonal energy storage capacity and the ability to generate dispatchable power, supporting applications in industry, transport and improving existing fossil-based district heating systems while aiding in the grow of Intermittent Renewable Energy (IRES)[32] or variable renewables (VRE) or unprogrammable non-dispatchable renewables (i.e., solar PV and wind). Therefore, in Europe's future energy mix, biomethane and hydrogen are expected to advantageously complement each other benefitting from their synergies. Hydrogen converted to synthetic methane helps match energy production to usage, providing an important form of seasonal energy storage.[33] Synthetic methane can be injected into the existing gas infrastructure, which in itself functions as an energy storage unit and has the capacity to cover up to 2-3 months of current gas consumption in the EU[34], therefore it can provide a short-medium term solution for reducing the external NG imports.
Power to gas, in particular Power to methane (PtM), serves as prime example of this, offering an ideal opportunity to store electricity in significant quantities while offering a strategic method for converting surplus energy from various renewables which experience fluctuating and intermittent electricity levels, therefore supporting electric grid flexibility against demand-response unbalancing. Green hydrogen, produced from electricity, can be combined with raw biogas to convert the biogenic $CO_2$ into synthetic methane (e-methane), which can be used or stored. Therefore, this approach brings the possibility of connecting the power grid to different sectors, where $CH_4$ is needed such as mobility/transport and industry.[35]

Crucially, PtM offers a way to recycle captured $CO_2$ while integrating the power and gas grid management. This aligns well with circular carbon economy opening new revenues opportunities alongside mitigating climate change. Despite of these advantages, installations constructed today in Europe are still scarce and limited by several factors including policy and financial conditions.

This process allows renewable methane to function as an energy storage solution: excess green electricity is stored in the gas grid in the form of e-methane / renewable methane. Therefore, it is important to keep developing technologies that store renewable energy and create gas from recycled $CO_2$ rich stream within a circular system approach.

In summary, among the renewable gas production technologies, methanation is becoming increasingly important and because:

- In contrast to other energy carriers, there are hardly any technical restrictions for using, transporting, and injecting synthetic methane into the existing gas grid with little or no

[32] Bendikova V., Patterson T., Savvas S., Esteves S., Economic and policy requirements for the deployment of Power to Methane (P2M) for grid-scale energy management, Energy Reports, 10, 2023, Pages 4271-4285, ISSN 2352-4847, https://doi.org/10.1016/j.egyr.2023.10.049.
[33] Decarbonising Europe's hydrogen production with biohydrogen EBA (2023) https://www.europeanbiogas.eu/decarbonising-europes-hydrogen-production-with-biohydrogen/
[34] https://www.europeanbiogas.eu/wp-content/uploads/2023/03/EBA-Campaign_Energy-system-integration.pdf
[35] Ghaib K., and Ben-Fares F.Z.


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modification thus allowing immediate deployment as eliminating the need to wait for specialized hydrogen grids.

- Synthetic methane can be produced from renewables, is safe to handle and the technical risk is very low, easy to store in large quantities and is seamless to use with existing end devices and. being methane a denser fuel more easily and cheaper transported, used and stored in existing / proven gas storage facilities, whereas challenges with $H_2$ include embrittlement and slippage leading to GWP.[36]
- It is a suitable and efficient drop-in solution to drive a fast and allows to start reducing fossil fuel use immediately for real transition especially for heavy industry, transportation, and shipping sectors, allowing the end users to adopt the product without modification,
- Methanation can be uses as technology to valorise $CO_2$ and produce more methane,
- The technology is also as upgrading technology of biogas/sewage gas.

[36] https://www.nature.com/articles/s43247-023-00857-8



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# 6. Vision and strategies – 5 demo countries

This chapter focuses on each specific country's vision and scenario for biomethane.
It examines which end-use sectors currently utilize biomethane, including available data. It also explores the most promising end-use sectors for biomethane over the next 5-10 years, identifying main barriers, favorable conditions, The following sections provide recommendations to facilitate usage of biomethane considering key highlights also related to regulation for using Emission Trading System (ETS) and GO[37], which are currently being implemented and still evolving. In each country, the partners and the EBAs responsible for the activities within this task were:

- France: ENGIE and AERIS (project partners)
- Greece: CERTH (project partner)
- Italy: Consorzio Italiano Compostatori-CIC (project partners)
- Sweden: Energigas Sverige (project partner)
- Ukraine: UABIO (project partner)

Figure 6.1 provides an overview of the various sectors and their share of biomethane consumption in the five demo countries.

| | Sector | FR | SE | IT | UA | EL |
|---|---|---|---|---|---|---|
| TRANSPORT | Transport (e.g BioCNG Fuel) | 1,536 | 1,700 | 4,371 | - | - |
| BUILDINGS | Buildings Residential/ Tertiary Heat | 2,374 | 200 | - | - | - |
| HEAT & POWER | Urban Heating Networks | 1,047 | | - | - | - |
| | Power and Heat | | 900 | - | - | - |
| | Power | 70 | | - | - | - |
| INDUSTRY | Industry Heat/Process | 1,536 | 1,400 | - | - | - |
| others | Other Uses | 419 | 200 | - | - | - |
| | | 6,982 | 4,400 | 4,371 | >1,000 export | |

**Figure 6.1** Biomethane (GWh)/year consumption per sector

## 6.1. France

### 6.1.1. Biomethane usage today

In 2022, France delivered 6,982 GWh of biomethane guarantees of origin (with respect to 1 GO = 1MWh of injected biomethane). This figure represents a total of 6,684,900[38] guarantees, accounting

[37] Guarantees of Origin (GO) are energy certificates defined under the Renewable Energy Directive (REDIII) providing consumers with the proof that a given quantity of energy was generated from renewable sources. This system is used within the European Union to ensure transparency and accountability in the renewable energy market.

[38] The difference with the first number of 6,982 GWh stems from the fact that guarantees of origin can be issued up to 5 months after the end of the injection period.



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for 98% of the biomethane volume injected into the natural gas networks. The biomethane volume neared 2% of the total gas quantity in the networks (350.2 TWh). The primary uses of biomethane in France include residential heating (32%), but it also played a crucial role in industrial processes (22%), gas mobility CNG (22%), and urban heating networks (15%).[39]

**Table 6.1** Biomethane (GWh)/year consumption per sector in France

| Sector | GWh in 2022 |
|---|---|
| **Residential/Tertiary Heat** | 2373.88 |
| **Heat/Process Industry** | 1536.04 |
| **BioCNG Fuel** | 1536.04 |
| **Urban Heating Networks** | 1047.3 |
| **Power Generation** | 69.82 |
| **Other Uses** | 418.92 |

As presented in the following graph, the number of delivered guarantees of origin, further increased in 2023 to reach the number of 7,907,571 accounting for 95% of the biomethane volume injected in the networks.

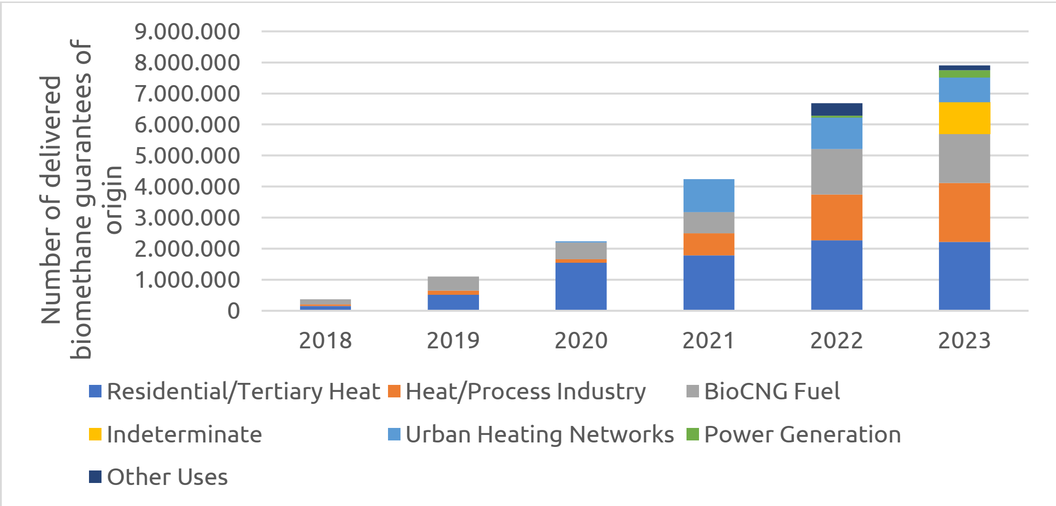


**Figure 6.2** Evolution of the valorisation of the biomethane GO between 2018 and 2023 in France

## 6.1.2. Most promising end-use categories

The most promising end-use sector for biomethane in France is transport

In the last version of "perspective gaz"[40], 2022, French TSO and DSO adapted their "TERRITORY" scenarios based on the recent evolution of the energetical framework. Together, GRDF, GRTgaz, Téréga and SPEGNN described the picture of the gas supply and consumption for 2030 and 2050.

[39] https://www.eex.com/fileadmin/EEX/Downloads/Registry_Services/French_Biogas_Guarantees_of_Origin_Registry/Rapport_d_activite_du_Registre_des_GOs_biogaz_2023.pdf
[40] GRDF_PerspectivesGaz2022_Web-PaP.pdf



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It should be noted that the different outcome of this study only highlights possible scenario and modification due to external parameters are susceptible to modify to different prevision highlighted in Figure 6.3 below.

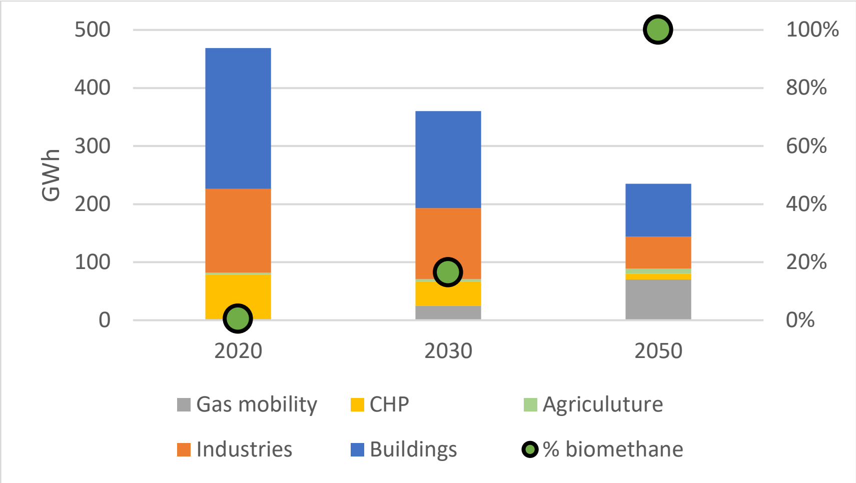


**Figure 6.3** Production and consumption trajectories of methane in the "adjusted territorial scenario" in France

The first observation that can be made is that the decrease of the overall gas consumption which is already observed since few years and is believed to be amplified. This can be explained by the strong incentives regarding electrification of the building and industry sector. However, one can see that among the different usages, gas mobility is believed to play a major role in the future as the technology is already mature and the possibility to use biomethane as a fuel for direct replacement of natural gas.

## 6.1.3. Barriers for the use of biomethane in France

In France, strong electrification incentives of the different sectors are currently ongoing. Overall, the use of gas as an energy vector is believed to decrease over the year. The industrial actors today are increasingly turning towards decarbonization solutions, with a particular focus on electricity due to the lack of clear schemes on how biomethane carbon emission will be considered in the future (for instance on the transport sector).

The Table 6.2 indicates for each end-use category, the main barriers for the use of biomethane.

**Table 6.2** Barriers for the use of biomethane in France

| Sector | Main Barriers |
|---|---|
| **Transport** | • Deployment of refueling stations<br>• Competition with electrification of the sector,<br>• Vehicle offer on the market. |
| **Buildings** | • Competition with electrification of the sector<br>• French incentives to electricity<br>• French regulation RE 2020 impacting the installation of new gas boilers |



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| | |
|---|---|
| **Industry** | • Competition with electrification of the sector<br>• Cost of biomethane compared to natural gas |
| **Power** | • Non applicable [a] |

[a] In France power energy mix is based relies on nuclear

### 6.1.4. Favorable conditions for the use of biomethane

The Table 6.3 indicates for each end-use category, the specific favourable conditions for the use of biomethane.

**Table 6.3** Favourable conditions for the use of biomethane in France

| Sector | Specific favorable conditions |
|---|---|
| **Transport** | • Available distribution and transport network<br>• Incentives for low carbon vehicle fleets |
| **Buildings** | • Available distribution |
| **Industry** | • Available distribution |
| **Power** | • Not applicable [a] |

[a] In France power energy mix is based relies on nuclear

### 6.1.5. Infrastructure

French gas infrastructures currently in place were set in order to deploy natural gas over the whole territory. France has 2 networks: transport and distribution (with main operators being: GRTgaz, Teréga, and other local operators for transport, GRDF[41], RGDS "reseau gaz de Strasbourg" and other local operators for distribution).
Biomethane is injected in those 2 networks. This offers the possibility of different sectors to make use of natural and biomethane for all different end uses (i.e. heat, industry, transport and buildings)
The CNG stations is France (delivering both natural gas and biomethane) are currently deployed over the whole territory. However, one can see that most of them are located near the main urban area where the transport sector is the densest.
Towards improving the use of biomethane as a fuel, deployment of CNG stations along every road in France would offer the possibility for operator to implement new stations and gain new customers keen to decarbonize their fleets with biomethane.
The availability of networks is also a subject when considering injection of biomethane.
France already possesses some of reverse flow station in (4 already commissioned and 20 under study) able to compress the gas from "low" pressure (distribution network) to "high" pressure (transport network). Developing new reverse flow station, would offer room for implementing new anaerobic digestion units and increase quicker the biomethane shares.

[41] https://opendata.grdf.fr/explore/dataset/cartographie-du-reseau-grdf-en-service/map/?disjunctive.etat_serv&disjunctive.insee_commune_admin&disjunctive.commune_admin&disjunctive.code_departement_admin&disjunctive.departement_admin&disjunctive.region_admin


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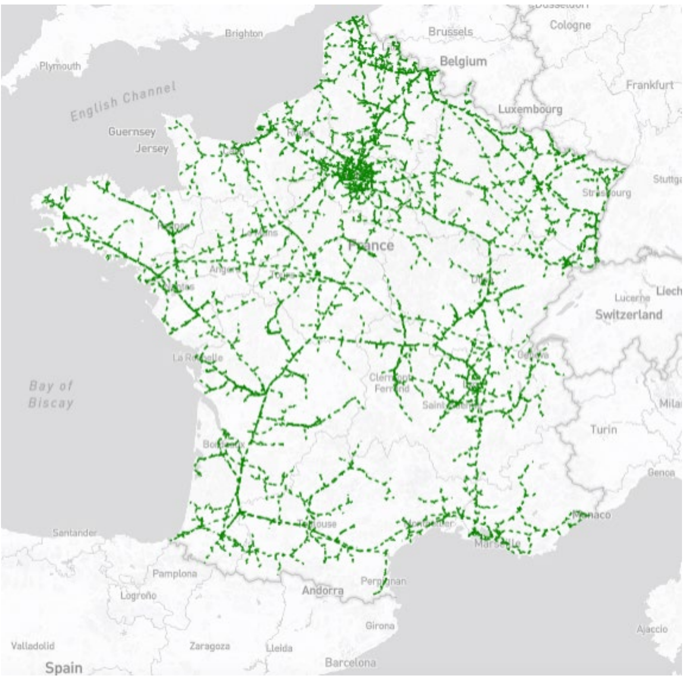


**Figure 6.4** Mapping of gas and electricity network infrastructures |(Source ORE Agency) [42]

### 6.1.6. Policy Recommendations

- Simplify the necessary administrative procedure for reducing the time between the project setup and the injection of the first cubic meters
- Improve the long-term visibility of the biomethane support mechanisms
- Decorrelate the cost of biomethane to the cost of natural gas
- Consider using a well-to-wheel approach for calculation carbon footprint of the transport sector (or life cycle assessment of the fuel)

## 6.2. Greece

### 6.2.1. Biomethane usage today

Currently, Greece does not have any biomethane production or consumption. The potential for biomethane usage offers significant opportunities to boost entrepreneurship and contribute to the energy transition of Greece. According to EBA [43], the development of biomethane can leverage existing biogas plants, providing a solid foundation for future expansion. [44]

**Errore. L'origine riferimento non è stata trovata.** provides a comprehensive analysis of the potential for biomethane production in Greece. [45]

[42] Cartographie des infrastructures de réseaux de gaz et électricité | Agence ORE

[43] EBA, "Biomethane Map 2022-2023", https://www.europeanbiogas.eu/biomethane-map-2022-2023/

[44] European Comission, "BIOMETHANE FICHE – Greece (2021)," pp. 2021–2023, 2021,https://energy.ec.europa.eu/document/download/5aa98acf-07f8-43c2-8895-e9961c1a7ae3_en?filename=Biomethane_fiche_GR_web.pdf

[45] E. CRES, DESFSA, "Strategy & Analysis Report", https://www.desfa.gr/



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It should be highlighted that this analysis is based on estimations of available biomass in Greece rather than the existing capacity of plants that currently only produce biogas The map indicates various regions in Greece which are particularly suitable for biomethane production. Thessaloniki and Larissa could contribute significantly, with potential biomethane productions of 0.12 bcm/year and 0.08 bcm/year, respectively. The overall maximum exploitable biomass potential for biomethane production is estimated at 13.6 million tons per year. However, this figure is refined to an addressable potential of 9.6 million tons per year, and further to a target potential of 6.9 million tons per year when considering logistical and practical limitations. The target volume of all waste translates to 0.46 bcm/year of biomethane, which reduces to 0.23 bcm/year when excluding more complex organic waste types.

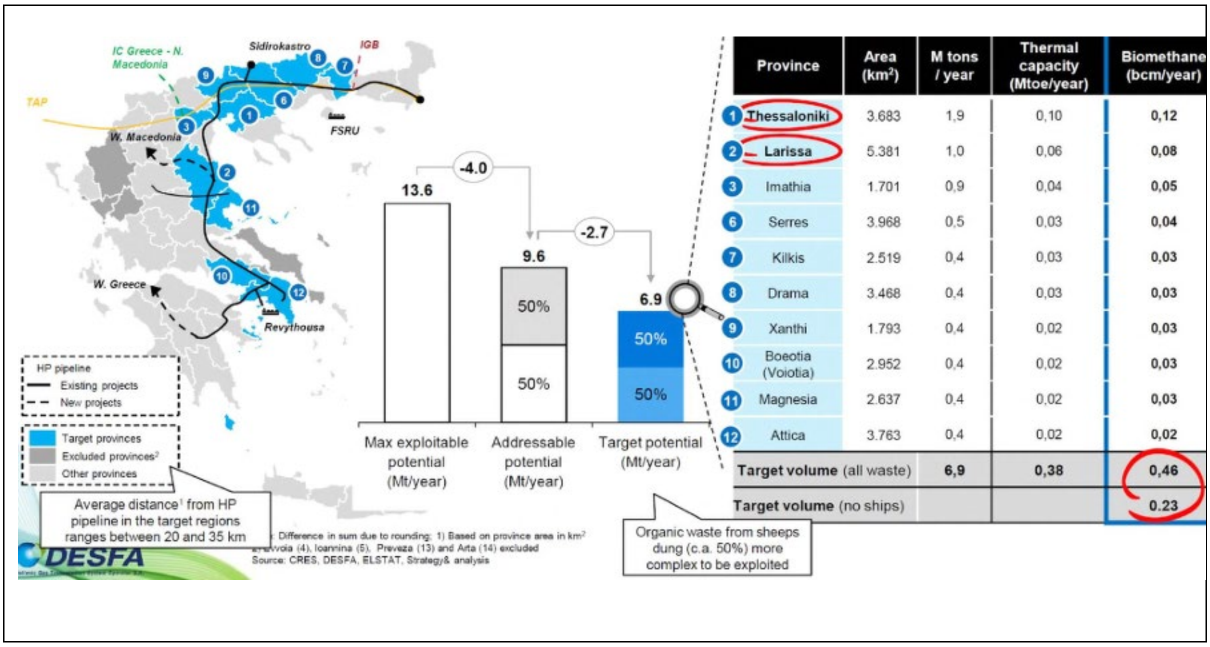


**Figure 6.5** Biomethane Market Potential in Greece

Key stakeholders in Greece's natural gas and biomethane sector include ENAON (formerly DEDA), which develops and operates gas distribution networks across multiple regions; EDA Attikis, which manages the gas distribution network in Attica; and EDA Thessaloniki, which oversees networks in Thessaloniki and Thessalia. HENGAS also operates as a gas distribution system operator. DEPA Infrastructure, the parent company of ENAON, EDA Attikis, and EDA Thessaloniki, is owned by the Italian DSO Italgas. DAPEEP is the manager of Renewable Energy Sources and Guarantees of Origin (GoO) and manages the RES and the High Efficiency Cogeneration of the National Interconnected System, as well as the Power Supplies that have been supplied by CHP and RES. It is the auctioneer of pollutant rights in Greece. DAPEEP will implement the biomethane production certification system through Guarantees of Origin.

## 6.2.2. Most promising end use categories for biomethane

The updated draft NECP sets ambitious targets for renewable energy sources (RES) by 2030, aiming for an overall share of 44% in gross energy consumption (Targets about RES share by 2030 included in the updated draft version of NECP ).
Additionally, specific targets for biomethane include production goals and biomethane blending targets by 2030 and 2050 (Table 6.4).


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**Table 6.4** Targets about RES share by 2030 included in the updated draft version of NECP[46]

| Category | Overall Share of RES | Electricity Generation | Transport Sector | Heating and Cooling Sector |
|---|---|---|---|---|
| **Target** | 44% of gross energy consumption | 80% of gross electricity consumption from RES | 29% RES participation | 46% RES participation |

**Table 6.5** Targets about biomethane included in the updated draft version of NECP[46]

| Category | Biomethane production | | | Biomethane blending | |
|---|---|---|---|---|---|
| Year | 2030 | 2035 | 2050 | 2030 | 2050 |
| Target | 2.1 TWh/year | 3.3 TWh/year | 9.7 TWh/year | 10.8% of the gas distributed | 20.4% of the gas distributed |

The most promising end-use sectors for biomethane in Greece over the next 10 years encompass transport, industry, and power. Each of these sectors presents distinct opportunities for integrating biomethane, contributing to Greece's sustainable energy transition. Towards 2030, main emphasis is given in energy and transport sector.

- **Power Production Sector**

  In the power sector, biomethane can play a critical role in combined heat and power (CHP) plants, offering a renewable and lower-emission option for electricity and heat generation. By 2030, it is anticipated that biomethane will contribute around 5-10% of the total power generation mix in Greece. Biomethane aims at replacing the natural gas in the power sector, enhancing the overall sustainability of energy production. Biomethane units are strategically foreseen to be located near to the gas pipelines, which minimizes the costs associated with connecting these units to the gas grid. The additional costs for the connection to the distribution network, as well the stakeholder to undertake the implementation of the foreseen implementation activities should be identified. IEA projects that the use of biomethane in CHP plants could lead to a reduction of up to 10% in power sector emissions by 2030. Furthermore, utilizing biomethane in the power sector will contribute to energy security by diversifying the energy mix and reducing dependence on imported fuels (currently Greece imports 99% of its natural gas).[43] [47]

- **Transport Sector**

  The transport sector is anticipated to be a major beneficiary of biomethane integration in Greece. By 2030, it is projected that biomethane will account for approximately 15-20% of the total transport fuel mix in Europe [4]. This growth will be driven by the adoption of compressed natural gas (CNG) and liquefied natural gas (LNG) vehicles, particularly in long-haul road freight and public transportation systems. The use of biomethane in municipal buses, refuse collection vehicles, and heavy-duty trucks will play a crucial role in reducing greenhouse gas emissions. In specific, it is estimated that around 5-10% of the transport sector in Greece could be powered by bio-CNG and bio-LNG 2030. [44] [47]

  Currently, Greece has 27 CNG filling stations, and this infrastructure is expected to expand significantly to support the increased use of biomethane in transport. [43] [44] EBA reports a considerable potential for Bio-CNG and Bio-LNG supply in remote areas (such as the Greek islands) due to their isolation from the main natural gas grid. [44] [47]

[46] Hellenic Republic Ministry of the Enironment and Energy, *National Energy and Climate Plan (Preliminary Draft Revised Version)*. 2023.
[47] IEA, "Outlook for biogas and biomethane," 2020, https://iea.blob.core.windows.net/assets/03aeb10c-c38c-4d10-bcec-de92e9ab815f/Outlook_for_biogas_and_biomethane.pdf


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- **Industrial Sector**

  Industrial applications are expected to see a marked increase in biomethane usage as industries apply measures to reduce their environmental impact. By 2030, biomethane is projected to supply approximately 10% of the energy needs in the industrial sector. Industries that currently rely on natural gas for process heating and power generation will potentially shift towards biomethane to meet regulatory requirements and sustainability goals. This transition is expected to result in a reduction of industrial carbon emissions by up to 15% by 2030. [44 47] The development of biomethane production plants can also mitigate the environmental impact of waste management by utilizing industrial organic waste as feedstock for biomethane production, promoting the circular economy concept [47], especially in the processing agro-food sector.

- **Buildings Sector**

  Buildings in Greece present a substantial opportunity for biomethane usage, particularly in residential and commercial heating applications. By 2030, it is expected that biomethane will constitute around 10-15% of the natural gas supply used for heating across Europe. In 2021, buildings accounted for 38.7% of Greece's total final consumption (TFC). The European Commission's biomethane strategy highlights that blending biomethane with natural gas for heating purposes could lead to a reduction of up to 20% in carbon emissions from the buildings sector by 2030 [44] The deployment of biomethane in buildings is also expected to enhance energy security by reducing dependence on imported natural gas.[47]

### 6.2.3. Barriers for the usage of bio$CH_4$

The integration of biomethane into Greece's energy mix faces numerous barriers across various sectors. These barriers are primarily legislative, regulatory, logistical, and infrastructural, affecting the transport, buildings, industrial, and power production sectors.

The absence of a cohesive set of laws governing the production, distribution, and usage of biomethane creates regulatory uncertainties, deterring investment and development.[48] The current National Energy and Climate Plan (NECP) for 2020-2030 emphasizes electricity generation from bioenergy, with limited provisions for biomethane use in other sectors. [49] The NECP includes a tariff system for electricity generation from bioenergy, which has provided financial incentives for investment in this area. Similarly, a new tariff system for biomethane is proposed, which aims to provide financial incentives and encourage investment in biomethane production and integration. Specifically, the updated draft version of NECP outlines that biomethane tariffs should align with the competitive framework established for other renewable energies, ensuring it is economically viable for producers and attractive for investors.[46]

The biomass supply chain is still underdeveloped in Greece, affecting the reliability and cost of raw material supply. Collecting and transporting raw materials for biomethane production is challenging due to the dispersed nature of biomass sources and long distances between them.[48] The current infrastructure for biomethane production and distribution is inadequate, requiring significant expansion to meet potential demand. However, there are insufficient financial incentives to encourage investment in biomethane infrastructure and production, making it less competitive compared to fossil fuels.[49] A major issue currently is who will be responsible bear the additional costs for the distribution pipelines and based on which economic incentives. Securing the necessary capital, loans, and grants for the construction of the required reception and injection equipment for biomethane is crucial. Additionally, there is a need for provisions to be established for the collection of raw materials for biomethane production and the disposal of solid residues from the processing.

- **Transport Sector**

  With only 27 CNG filling stations in Greece, the infrastructure to support biomethane use in transport is severely lacking, hindering the expansion of biomethane-powered vehicles. Many biogas units are not located near the natural gas distribution network, complicating the integration of biomethane into the existing fuel infrastructure.[48]

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[48] EBA, "EBA Statistical Report 2021," *Eur. Biogas Assoc.*, p. 68, 2021, [Online]. Available: https://www.fuelseurope.eu/publication/statistical-report-2017/

[49] H. R. M. of the E. and Energy, "National Energy and Climate Plan," 2019.

- **Buildings Sector**

  The NECP does not adequately address the use of biomethane in heating applications, limiting its potential in residential and commercial buildings.[49] Without financial incentives, the cost of biomethane remains higher compared to natural gas, making it less attractive for consumers. [48]

- **Industrial Sector**

  Only 38 out of 78 biogas units are close to the natural gas distribution network, limiting the availability of biomethane for industrial use. However, the larger of these units, from a capacity perspective, such as those at landfills, are located near the network. The dispersed nature of biomass sources and long transportation distances pose significant logistical challenges, making it difficult for industries to adopt biomethane.

- **Power Production Sector**

  The NECP's focus on electricity generation from bioenergy neglects the broader potential of biomethane in the power sector. [49] Establishing biomethane production close to biomass sources and reducing storage and transportation costs are significant hurdles. [48]

### 6.2.4. Favourable conditions for the usage of biomethane

Several favourable conditions support the usage of biomethane in Greece. These conditions span regulatory initiatives, infrastructure development, and strategic advantages offered by Greece's unique geographic and economic context. Additionally, key European policies, such as the European Green Deal, the Fit for 55 package, and the REPowerEU plan provide a strong foundation for the growth of the biomethane sector.

The European Green Deal, established in 2019, sets the path towards climate neutrality by 2050. This framework drives the adoption of renewable energy sources, including biomethane, as part of the EU's green transition strategy. [49] The Fit for 55 package updates the EU targets for greenhouse gas emissions reduction to 55% by 2030, creating a favourable regulatory environment for the expansion of biomethane usage. This ambitious target necessitates significant increases in biomethane production in order to substitute fossil gases. [50] The REPowerEU plan, introduced in 2022, sets a target of 35 billion cubic meters (bcm) of biomethane production by 2030. This plan includes actions to streamline the permitting process for renewable energy projects and offers financial incentives to reduce production costs, encouraging investments in the biomethane sector. [51]

Additionally, Greece's existing biogas plants provide a strong foundation for scaling up biomethane production. With 78 biogas units already in operation, efforts to upgrade these facilities for biomethane production are underway. This existing infrastructure offers a significant advantage, reducing the need for new installations and leveraging existing capabilities. [52] Greece's gas distribution network is well-positioned to support biomethane injection. Located close to agricultural areas and designed with high-capacity potential, the network can efficiently handle biomethane. [53]

All regions under ENAON are located within or near areas of high agricultural and livestock intensity, making them ideal for the installation of biomethane production units. These units can inject biomethane into the distribution networks with minimal transportation costs. The infrastructure is ready, with large capacity pipelines operating at 16 bar and 4 bar pressures, constructed from PE and steel, ensuring full compatibility with biomethane and virtually zero leaks. The broad consumer base ensures the consumption of the entire biomethane production.

Greece's geographic location and its numerous islands offer unique opportunities for biomethane production and usage. The isolation of many Greek islands from the main natural gas grid makes them ideal candidates for localized biomethane production and consumption[51]. The forthcoming extension of the Emissions Trading System (EU ETS) into the maritime sector presents an interesting opportunity for decentralized Bio-LNG production to supply small and medium-sized vessels which

[50] European Commission, *Fit for 55 Package*. 2021. [Online]. Available: https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/delivering-european-green-deal_en

[51] European Commission, "Biomethane," 2023. https://energy.ec.europa.eu/topics/renewable-energy/bioenergy/biomethane_en

[52] IBKK, "Biogas in Greece - Status Quo and Opportunities," 2023. https://ibbk-biogas.com/

[53] Gasworld, "Greece gas network boosts energy security with biomethane project," 2022. https://www.gasworld.com/



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are widely used in the country. The same infrastructure can also support Bio-LNG supply for heavy road transportation. [50] The agricultural sector in Greece produces substantial amounts of organic waste. Utilizing agricultural residues as feedstock not only supports the circular economy concept but also provides a steady supply of raw materials.[52]
The roadmap for biomethane development includes medium-term (2030) and long-term (2050) targets. By 2030, the goal is to produce about 16 TWh of renewable gases, with 8 TWh coming from biomethane. By 2050, the target is for biomethane to account for 30% of total renewable gas production, equating to 12 TWh.[49]

### 6.2.5. Infrastructures

**Current State of Gas Infrastructure**
Greece's natural gas infrastructure is crucial for the country's energy strategy, especially as it plans to integrate biomethane. Currently, the gas distribution network is relatively limited, with only 8.3% of buildings connected to natural gas. The network primarily serves major population centers such as Athens and Thessaloniki. As of 2022, there are four main gas distribution system operators (DSOs) in Greece (Table 6.6).

**Table 6.6** Overview of gas distribution system operators (DSOs) in Greece

| Operator | Regions Covered | Network Length (km) | Customers Served | Ownership | Sources |
|---|---|---|---|---|---|
| *ENAON* | -Sterea Ellada<br>-Macedonia<br>-Thrace<br>-Epirus<br>-West Greece<br>-Corinth | -330.75 km (Medium Pressure)<br>-176 km (Low Pressure)<br>-Expanding to 2,372 km by 2036 | -62,000 customers<br>-Target for 173,562 connections by 2036 | Part of DEPA Infrastructure, acquired by Italgas in 2022 | [54 55 56] |
| *EDA Attikis* | Attica, including Athens | Approximately 1,600 km | Around 410,000 customers | Part of DEPA Infrastructure, acquired by Italgas in 2022 | [55,56, 57] |
| *EDA Thessaloniki-Thessalia* | -Thessaloniki<br>-Thessalia | Approximately 1,800 km | Over 450,000 customers | Part of DEPA Infrastructure, acquired by Italgas in 2022 | [55,56,57] |
| *HENGAS* | Various areas across Greece | 106.2 km | Around 2,800 customers | Independent operator | [58] |

**National Natural Gas System (NNGS)**
The NNGS is critical for transporting natural gas from upstream interconnected systems in Bulgaria, Turkey, the Trans Adriatic Pipeline (TAP), and the Liquefied Natural Gas (LNG) terminal at Revithoussa island. There are four main entry points for natural gas. Exit Points are 44 across the Greek mainland, including the reverse flow exit point at SIDIROKASTRO, which connects to Bulgaria.[51]
DESFA's transmission network extends to Northern and Central Greece, areas with high agricultural potential for biogas production, which can be upgraded to biomethane. These regions can connect their upgraded biogas units to DESFA's network, allowing biomethane to be consumed domestically and internationally via the interconnected system. This network covers significant agricultural areas ideal for biogas and biomethane production.[53]

[54] DEDA, "Company Information and Strategic Plans," 2022. https://deda.gr/
[55] ENAON, "Company Profile and Infrastructure Data," 2022. https://edaattikis.gr/
[56] Χ. Κολώνας, "ΕΔΑ Αττικής: Φυσικό αέριο σε 30 ημέρες και επενδύσεις 41,49 εκ. το 2023," *OT*, 2023. [Online]. Available: https://www.ot.gr/2023/07/06/energeia/fysiko-aerio/eda-attikis-fysiko-aerio-se-30-imeres-kai-ependyseis-4149-ek-to-2023/
[57] EDA Thessaloniki-Thessalia",: https://www.edathess.gr/
[58] Hengas, "Δημοσίευση Στοιχείων Μεριδίων Αγοράς," 2024. https://www.hengas.gr/dimosiefsi-stoicheion-meridion-agoras/


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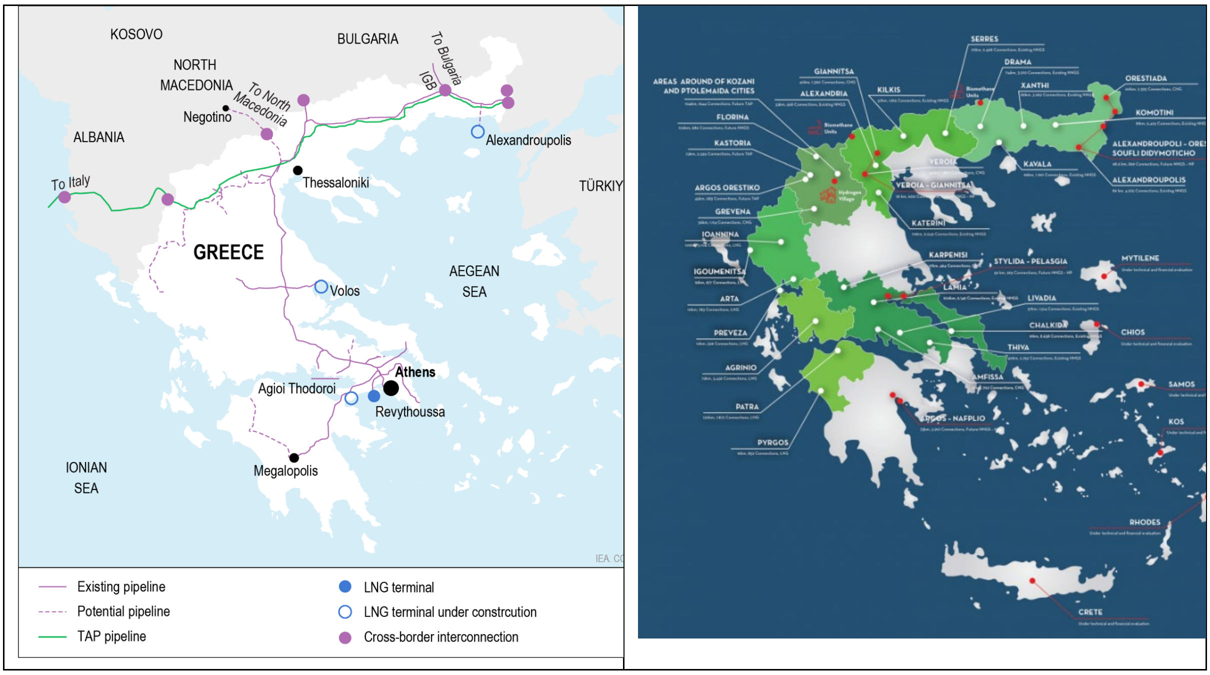


**Figure 6 6** : a) The natural gas grid in Greece; b) the natural gas distribution networks of ENAON

**Future Developments and Opportunities**

Significant expansions are planned to enhance the overall network capacity and connectivity, facilitating broader access to natural gas and renewable gases like biomethane.

ENAON plans to extend its network to 2,372 km by 2036, involving an investment of €450 million and targeting 173,562 new connections. This expansion will increase the reach of the gas distribution network, particularly in regions currently underserved. ENAON is actively promoting hydrogen and biomethane as distributed fuels.[54]

For regions without a natural gas transport network, such as Western Greece, the Peloponnese, and the islands, biomethane can be supplied via road transport in compressed (CNG) or liquefied (LNG) form using virtual pipelines.[53]

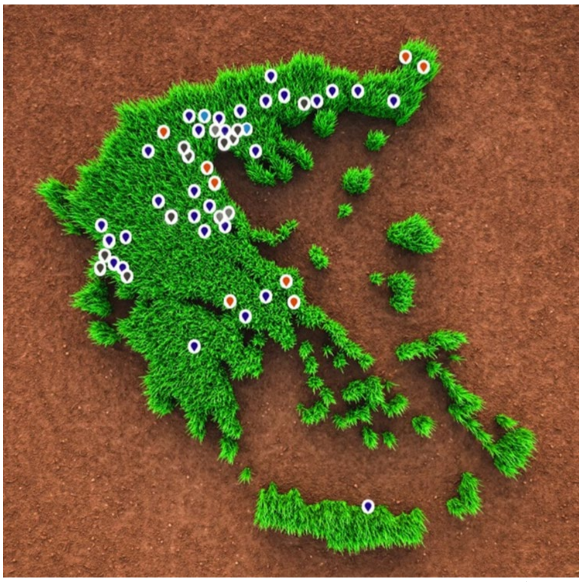

**Figure 6.7** Distribution of anaerobic digestion facilities in Greece (HABIO members only)



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### 6.2.6. Policy recommendations

To capitalize on the potential of biomethane and align with Greece's energy and environmental goals, an integrated policy framework is essential. This framework should address legislative, economic, and technical aspects, leveraging both national and European initiatives. [59] [60]

#### Legislative and Regulatory Policies

- Setting ambitious targets for biomethane production: The draft NECP sets a target for biomethane production at 2.1 TWh/year by 2030.
- Establishing laws that facilitate biomethane production: Legislative measures include the creation of a state aid framework to support private sector investment in biomethane, given that the cost of production is currently higher than natural gas
- Simplifying and accelerating the permitting process for biomethane plants: The draft NECP highlights the importance of upgrading existing biogas plants to biomethane plants and establishing new plants, particularly in agricultural and livestock areas
- Developing a biomethane production certification system: The draft NECP plans to issue renewable gas certificates to ensure quality and traceability of biomethane production
- Encouraging the use of biomethane in transportation: The plan includes converting produced biomethane into compressed or liquid forms for use in transport, supported by state aid frameworks.

#### Economic Policies

- Providing incentives for converting existing biogas plants to biomethane plants: The draft NECP aims to convert more than half of the existing biogas plants to biomethane production
- Implementing production support tariffs for self-consumption and prosumers: Economic incentives include competitive procedures for investment and/or operating aid for biomethane production
- Evaluating the economic impact of each action: Prioritization is based on the added value to the country, with a focus on sustainable and efficient energy sources
- Doubling investments in gas networks: To support biomethane infrastructure development, the draft NECP emphasizes necessary upgrades and expansions of the existing gas distribution networks.

#### Technical Policies

- Developing a competitive market for biomass: The draft NECP recognizes the need to establish a reliable supply chain for feedstock, involving agricultural producers and other stakeholders
- Establishing a reliable supply chain for feedstock: The collection system for raw materials will be organized with local government assistance, focusing on agricultural and livestock residues
- Ensuring that the existing gas distribution infrastructure can support biomethane injection: Necessary upgrades to handle increased capacity and maintain safety standards are planned
- Promoting partnerships between the biomethane industry and other sectors: The draft NECP supports collaborations between the biomethane industry and sectors such as agriculture and transportation to drive innovation and leverage synergies
- Ensuring a stable and secure energy supply during the transition period: The draft NECP includes measures to use captured $CO_2$ in biomethane production for synthetic fuels and plans for the collection of raw materials to ensure a stable supply.

## 6.3. Italy

[59] BIP Europe, "Policy recommendations on biomethane project development," 2023. https://bip-europe.eu/
[60] OECD, "Greece 2023 Energy Policy Review," 2023, [Online]. Available: https://t4.oecd.org/



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## 6.3.1. Biomethane usage today

Italy is currently prioritizing the expansion of biomethane production over its consumption. The 100% is used for transport.
Up to December 2023, the use of biomethane was transferred for 2 main reasons:

- All the plants producing biomethane in operation before December 2023 under MD 02/03/2018, which foresee incentives only for the production of biomethane for transport usage.
- The new MD 15/09/2022 for incentivising biomethane production that foresees other uses became the only one in force by January 2024. This MD establishes less restrictive targets on GHG emissions reductions when the destination of the biomethane is transport (see next section).
  By now, the government has provided the results from the first 2 of the 3 awarding calls launched (one in summer 2023, the second one in October 2023 and the last one in Dec 2023): a total of 92 plants (17 from the bio-waste sector + 75 from the agriculture) have been awarded. The total capacity for the awarded plants covers 36 % of the total awarding capacity of the call.

From the 17 plants treating bio-waste, 16 dedicate the biomethane for transport whereas only 1 for other uses (it is not possible to know which one). From the 75 plants from the agriculture sector, the biomethane produced in 68 of them is used for transport and the remaining 7 for other uses.

None of the 17 plants from the bio-waste sector awarded (total production capacity of 98 kSm$^3$/yr, considering 8,100 hours/yr operation) are already in operation.

## 6.3.2. Most promising end-use categories

Transport will still be the main promising end-users sector in Italy since sustainability targets fixed in the MD 15/09/2022 are less restrictive in comparison with other sectors. This means that the target of GHG emissions reductions with respect of fossil fuels are less restrictive (transport: requirement of 65% reduction; other uses: around 80%).

It should be also highlighted that Italy has an important network of methane distribution stations (1 station in a radio of 8 km, national average) and a significant amount (2%) of vehicles being fuelled with gas.

Even though transport will be the main use in the future, other promising uses would be more likely those that can benefit most from the substitution of more polluting fuels in sectors subject to environmental improvement obligations (e.g., Emission Trading System).

It is the case of the industrial sector, not so much on the building sector. However, it should be taken into consideration that big industrial plants need an important amount of biomethane, so maybe there won't be enough offered to cover their demand

## 6.3.3. Barriers for the use of biomethane

The main barriers up to now for the bio-waste recycling sector in what concerns the production of biomethane are:

- Return of the investments from the production sites; in particular, uncertainty is related to meeting for the whole incentives period the sustainability targets set (above all in case of biomethane for uses different from automotive, that are more challenging).
- Bureaucracy with public administration for the authorization and with the grid manager.
- Public opinion against the treatment of bio-waste through Anaerobic Digestion (they state that AD does not respect the hierarchy of waste since it fosters energy production instead of material recycling.



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## 6.3.4. Favourable conditions for the use of biomethane

There is a policy commitment in whole EU (and also in Italy) to reach the self-sufficiency in terms of energy supply. This is the most favorable condition for the development of biomethane production. Actually, the PNRR (*Piano Nazionale Ripresa e Resilenza* = Funds from EU after the crisis to support MS) is being dedicated to promote the construction of plants producing innovative biomethane, this support consists of a mix between feed-in tariff (for 15 years) and support to plant construction costs (all the costs related to bio-waste recycling, including bio-waste pre-treatment, biogas/biomethane production, digestate management).

According to the Roadmap for climate neutrality drawn up by Italy for Climate, national consumption of natural gas should be just over 50 billion $m^3$ in 2030 and the expected biomethane production from bio-waste is 300 $Mm^3$. To this it should be added the quantity produced by the agriculture sector: around 10000 $Mm^3$ (according to CIB).

## 6.3.5. Infrastructure

In Italy the main barrier is not linked to the infrastructure since the whole country is already well covered by the gas network (38,000 km of network) as it can be seeing from the Figure 6.8.


**Figure 6.8** Italy gas network (source: SNAM)

## 6.3.6. Policy Recommendations

One of the main barriers is the bureaucracy with public administration for the authorization procedure and with the grid manager. The main policy recommendation is to facilitate the procedures from the administrative point of view (i.e., not only the permitting stage but also shortening the time for the acceptance of the connection to the grid). In addition to the simplification of the authorization and connection paths to the gas transportation networks, it should also be pointed out the need to facilitate collateral elements to biomethane, acting in the different points of the overall value chain: $CO_2$ (politically support the use of this biogenic gas), digestate/compost


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(effort on the current inapplicability of the EU Fertiliser Regulation 2019/1009, in particular on the implications with the Regulation on Animal By-products), work on the RES directive so that it considers the composting process of bio-waste digestate as "sustainable".

## 6.4. Sweden

### 6.4.1. Biomethane usage today

The total biogas/biomethane use in Sweden 2015-2022 is shown in the Table 6.7. The total biogas/biomethane use 2022 was 4,4 TWh of which 49% was imported, mainly from Denmark.

**Table 6.7** Total biogas/biomethane use (GWh) in Sweden 2015-2022 and share of domestic and imported biogas/biomethane (Source: Swedish Gas Association)

| Year | Swedish biogas/ biomethane GWh | Imported biomethane GWh | Total biogas/ biomethane use GWh | Change | Share of imported biogas/ biomethane |
|---|---|---|---|---|---|
| **2015** | 1, 939 | 0 | 1, 939 | *9%* | *0%* |
| **2016** | 2 ,018 | 289 | 2 ,307 | *19%* | *13%* |
| **2017** | 2 ,040 | 814 | 2 ,854 | *24%* | *29%* |
| **2018** | 2 ,044 | 1 ,647 | 3 ,691 | *29%* | *45%* |
| **2019** | 2 ,111 | 1 ,838 | 3 ,948 | *7%* | *47%* |
| **2020** | 2 ,161 | 1 ,860 | 4 ,021 | *2%* | *46%* |
| **2021** | 2 ,265 | 2 ,555 | 4 ,820 | *20%* | *53%* |
| **2022** | 2 ,279 | 2, 164 | 4 ,443 | *-8%* | *49%* |

The statistics on the use in different sectors is incomplete, but below is an estimation by Swedish Gas Association. The figures include both biogas and biomethane. The share of liquified biogas (LBG) in the figure is around 0.4 TWh, used mainly in transport and to some extent in industry.

**Table 6.8** Biomethane (GWh)/year consumption per sector in France

| Sector | GWh in 2022 |
|---|---|
| **Transport** | 1,700 |
| **Buildings** | 200 |
| **Industry** | 1,400 |
| **Power and Heat** | 900 |
| **Others** | 200 |

The total use of methane for transport (CNG/CBG and LNG/LBG) was 1.9 TWh 2022, which is about 2 % of the total energy use for transport. The average biomethane share 2022 in the CNG/CBG used for transport was 97 % and 92 % for LNG/LBG.[61]

Examples of industrial use is in food, paper and manufacturing industries – mainly industries within EU ETS and/or where the energy and carbon taxes is significant – where biomethane is used as

[61] Source: Swedish Energy Agency



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process heat due to its high temperature and/or cleanliness. The use of biomethane for maritime transport, for raw material or in metallurgical processes (steal industry) is still small due to less economic incentives but the potential is large. In the figure below is shown the estimated share of the total gas use (natural gas and biogas/biomethane) and the share of biogas/biomethane for various end-use sectors in 2022 (Source: Swedish Gas Association –estimation). Power and heat include both direct use of biogas in smaller CHP or district heating at biogas plants and a few CHP connected to the gas grid.

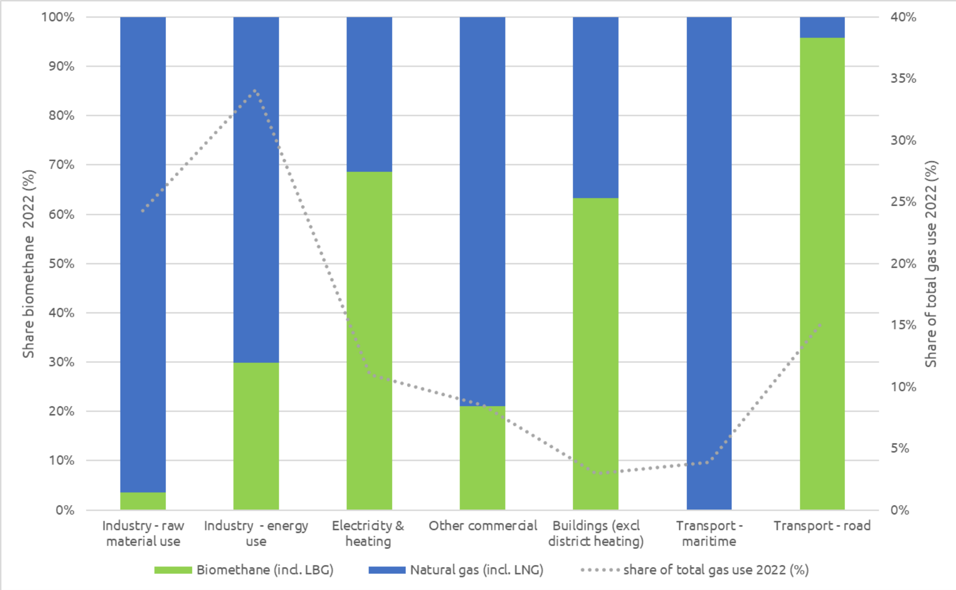


**Figure 6.9** Share of the total gas use and biogas/biomethane share in different end-use sectors in Sweden 2022 (estimation by Swedish Gas Association)

## 6.4.2. Most promising end-use categories

The largest increase for biomethane use the coming years is expected in industry – where the use of fossil gases is the largest – mainly steel (metallurgical processes) and chemical industry including refineries. It includes both gas grid connected industries using Natural gas and off grid industries using LNG or LPG today. There is also a growing interest for LBG in the maritime sector with a potentially large market ahead as many new ships the last couple of years are LNG/LNG-ready ships. Liquid biogas for long haul heavy-duty vehicles is already increasing rapidly and the market is growing.

The number of LNG heavy-duty vehicles are increasing rapidly in Sweden, as is the number of filling stations and sold volumes (Figure 6.10).



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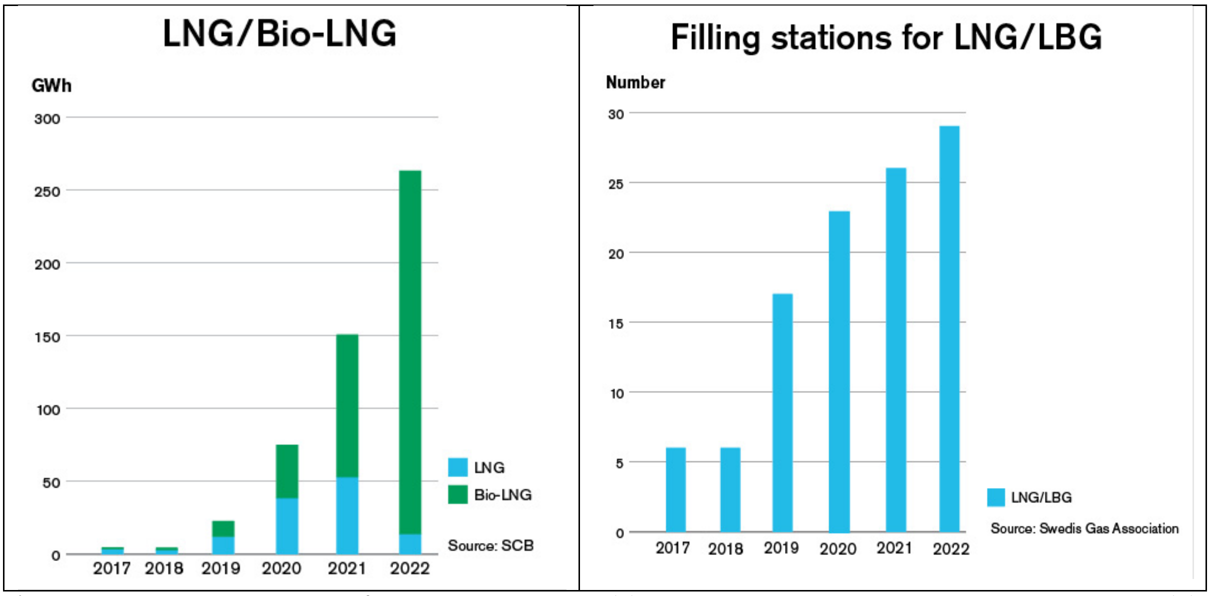


**Figure 6 10** Sold volumes of LNG/Bio-LNG for transport (a); number of filling stations in Sweden 2017-2022 (b).

The importance of power production from biogas is expected to grow for increased stability and flexibility for the electricity system e.g., via gas turbines and locally for increased capacity – but volumes will likely be rather limited compared to other end uses.

The Swedish Gas Association is currently updating the Swedish gas industry´s Roadmap for fossil free energy gases (to be published late 2024). The preliminary goals for biomethane production and use in the coming roadmap is shown in Table 6.9.

**Table 6.9** Some biomethane related goals discussed within the Swedish gas industry in the coming upgraded Roadmap for fossil free energy gases (to be published late 2024). Requires new policies to be achieved.

| | |
|---|---|
| 2035 | All energy gases are fossil free* |
| 2035 | Production of 20 TWh biomethane and other biogases* |
| 2030 | Production of 10 TWh biomethane* |
| 2030 | 100% biomethane in all gas grids* |
| 2030 | Industry uses 10 TWh biomethane and other biogases* |
| 2030 | 100% biomethane in households* |

*preliminary goal - discussions are ongoing. Requires new policies to be achieved.

## 6.4.3. Barriers for the use of biomethane

- Acknowledgment of market instruments and mass balance principles for trade and compliance to various policies such as ETS, taxation, RED sustainability criteria and GHG-accounting schemes are crucial for efficient market development. It is still not fully recognised in all important schemes or accounting programmes and the uncertainty and different rules hamper the market and increase costs. The lack of a biogas registry/GO system in Sweden is an increasing problem – particularly for cross border trade. A law is in place to extend the existing GO-system to gas (following Article 19 of REDII), but the Government has still not decided when it shall come into force. It has been waiting for more clarity in EU rules such as the delayed revision of the mandatory GO standard EN.
- 16325, the implementation of the Union Database for sustainable biogas and biofuels and how it will integrate with GOs and the adoption of REDIII.



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- The long-term policy conditions have been too uncertain for biomethane production to take the next step. The last years biomethane use has increased more rapidly than the production. Some important barriers for investments in production have been removed the last years. Important is the new long-term production support for biomethane from 2022 and the purchase bonus for heavy duty gas vehicles. The production support scheme has been confirmed by the new government until 2026, the support is now open to any biomethane end use and the premium for manure-based biogas has finally become a part of the long-term biogas support scheme.
- However, the biogas production support is subject to annual Governmental budgets and its political certainty is not guaranteed long term. Implementing a biogas strategy and setting a target for biomethane would decrease the political uncertainty and further strengthen the investor confidence.
- Lack of incentives such as production support for large scale production of biomethane from new technologies such as biomass gasification or e-methane.

| Sector | Main Barriers |
|---|---|
| **Transport** | • See "General for all end-use sectors"<br>• The so important 10-year EU Commission approval of the tax exemption for biomethane from 2021 gave more long-term confidence and trust in the market. The sudden revoke of the tax exemption leading to full energy and CO2 tax for biogas and biomethane use from March 2023 due to an EU General Court ruling was therefore detrimental to the market and for investments. Especially for the very promising and quickly increasing LBG-market for heavy duty vehicles. A quick re-implementation of the tax exemption is crucial to not severely cause long term harm to the biomethane market development.<br>• The EU policy phasing out of the internal combustion engine – particularly in the EU CO2 standard regulation for road vehicles (only considering tail-pipe emissions, disregarding the climate performance of biofuels) – severely negatively affect the development for biomethane in road transport. Potential lack of local biomethane demand in a country with limited gas grid infrastructure will be a challenge for many biomethane producers. Liquefaction to LBG will be key to reach other potential large gas users in industry, long haul heavy road transport or maritime transport in the future.<br>• The conditions for biomethane in road transport have been further worsened by decreased taxes and reduced emission reduction quota for diesel and gasoline 2023-2024 and onwards.<br>• The former (2018-2022) bonus for purchasing new low emission cars (electric, hydrogen or gas vehicles) in the Bonus-malus taxation system for light vehicles was cancelled by the new government from 8$^{th}$ of November 2022. |
| **Buildings** | • See "General for all end-use sectors"<br>• Lack of gas grids in most part of the country<br>• The revoked tax exemption |
| **Industry** | • See "General for all end-use sectors"<br>• The revoked tax exemption<br>• The economic incentives for biomethane in some industrial sectors are too week for biomethane to be competitive to fossil fuels. Particularly for use in the iron and steel sector and for use as raw material in the chemistry industry since exemption from energy and $CO_2$ taxes are not effective in these sectors and/or they are not included in the ETS. |
| **Heat and Power** | • See "General for all end-use sectors"<br>• The price signals (or policy) for electricity supporting services (balancing etc.) are too week and electricity prices too low for biomethane power and/or CHP to be very competitive<br>• The acknowledgement of the importance for plannable, flexible, and local (heat and) power production from biomethane has been week by authorities and policy makers – but is increasing |


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## 6.4.4. Favourable conditions for the use of biomethane

### General about policy condition developments in Sweden

In Sweden general economic incentives in terms of high $CO_2$ and energy tax on fossil fuels and tax exemption for renewables have been the main drivers for decarbonising since the 1990's and has been the main driver for biogas and biomethane, but has recent years been complemented by productions support, investment support and increasing prices in the EU emission trading scheme (EU ETS). Since the taxes have been highest in the transportation sector, most of the biomethane has been used for road transport, but also to some extent for heating (district heating or process heat). It is only during the last 3-4 years that the biomethane demand in industry has risen dramatically. Biomethane has become more competitive in parts of the industry due to increased tax on natural gas for heating and increasing $CO_2$ prices within ETS.

The gas use in general as well as the biomethane use and imports dropped significantly in 2022 due to the high energy prices caused by the Russian war on Ukraine. Since the abrupt change in tax on biogas and biomethane use 7 March 2023 (from full exemption of energy and $CO_2$ tax to be fully taxed as natural gas) both production and biomethane demand are under high pressure with decreased competitiveness.

The biomethane production has increased steadily since 2005 mainly driven by investments by municipalities and regions in biomethane driven public transport (buses) and new biogas plants with upgrading for recycling of organic household waste (co-digestion plants). Biogas production has occurred for several decades in many sewage plants but since 2005 the share of biomethane upgrading has increased. There have been several investment support programmes that have facilitated this development. In recent years, a large part of new production is run by private companies mainly focusing on agricultural and industrial organic waste and residues such as manure and waste from food industry and slaughterhouses. It is also in the private sector where most of the additional production capacity investments are foreseen in the future.

### Existing economic (policy) drivers

**Production support scheme for biogas and biomethane**[62] from 1st July 2022. The support scheme consists of three premiums, which are additional:
Max 0.40 SEK/kWh (~35 €/MWh) support for biogas produced from manure.
Max 0.30 SEK/kWh for biogas upgraded to biomethane.
Max 0.15 SEK/kWh additional for biomethane that is liquified to LBG.
Eligible for all substrates except landfill gas and food and feed crops including for biomethane produced with other technologies than anaerobic digestion such as biomass gasification. Only eligible for plants producing up to 50,000 tonnes biogas/biomethane/LBG per year. The support was before limited to use in transportation or for very small-scale production of heat and power but is since 2023 eligible for any final use.

Local climate investment programme (Klimatklivet) since 2015. Investment support (up to approx. 45-65 %) for all types of investments or measures that leads to high GHG emission reductions, 2015-2028. The budget for 2024 is 4.1 Billion SEK/year (~0.36 Billion €). A significant part of the investment support so far has been granted to biomethane investments (many biogas plants, several CBG and LBG filling stations and LBG-trucks) but also other measures such as EPV charging infrastructure.

[62] https://www.energigas.se/media/amrji21q/biomethane-in-sweden-230313.pdf



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| Sector | Specific favourable conditions |
|---|---|
| **Transport** | • $CO_2$ and energy tax exemption (temporarily revoked)<br>• Investment support for filling stations via Local climate investment programme (Klimatklivet)[63]<br>• Climate purchase premium for HDVs and working machines[64], including gas vehicles, of up to 20 % of purchase cost.<br>• Environmental information about all transportation fuels must be displayed at the filling station, including origin and $CO_2$ reduction from 1st Oct 2021.<br>• Incoming EU policies: ETS2 for road transport and ETS1 extension to maritime and Fuel EU Maritime emission intensity quotas |
| **Buildings** | • $CO_2$ and energy tax exemption (temporarily revoked) |
| **Industry** | • $CO_2$ and energy tax exemption (temporarily revoked)<br>• EU ETS – increased carbon price and extension<br>• The specific demand for the properties in methane in industrial processes (high temperature & clean energy and carbon molecule for chemicals) |
| **Heat and Power** | • $CO_2$ and energy tax exemption (temporarily revoked)<br>• EU ETS |

### 6.4.5. Infrastructure

The gas pipeline infrastructure is limited to the south-western part of Sweden where the transmission network is connected to European gas network only via Denmark. There is also a regional gas network in Stockholm, fuelled with locally injected biogas and shipped LNG/LBG. Consequently, the Swedish biomethane market is to a large extent off-grid with several small local and regional grids or stand-alone biogas plants and filling stations. A large part of the biomethane in Sweden is transported on the road as compressed gas (200/260 bars) and to a small but steeply increasing extent as liquefied gas (LBG). Local and regional gas grids also gain more attention aimed to connect industries, cities and biomethane production plants with an LNG-terminal at the coast. The lack of extensive gas grid network increases biomethane distribution costs and make market penetration more challenging (the need for local demand and/or development of the LBG-market to connect production with potential end-users). Investments in both extended gas grids (connecting biomethane plants and new end-users) as well as LBG/LNG distribution facilities (LNG-terminals and liquefaction plants, LBG-production, storage etc) are needed.

Transport: Most of the produced biogas (67 %) is upgraded and mainly used for road transport and CNG buses in public transport. The market for biomethane as transportation fuel is now rather developed in Sweden. Today there are more than 200 public filling stations for CNG/CBG in addition to the 63 non-public stations dedicated to certain vehicle fleets, including busses. For a couple of years, the number of filling stations for LNG/LBG has increased rapidly to around 30. The investments in the filling station network especially for LBG need to continue, for which investment support is still important.

[63] The Climate Leap (naturvardsverket.se)
[64] Transporteffektivt samhälle (energimyndigheten.se)



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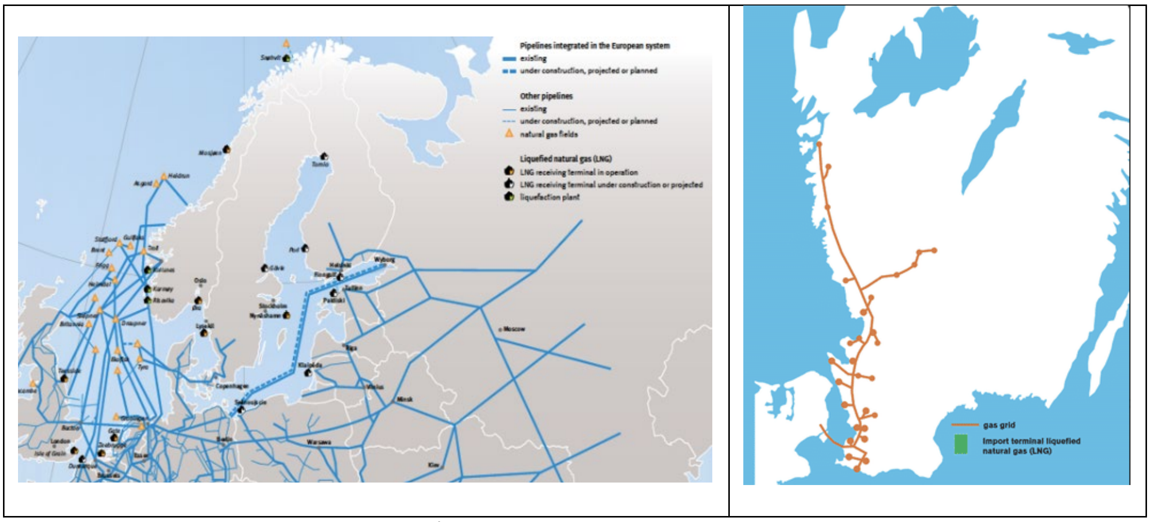


**Figure 6. 10** Swedish gas network

### 6.4.6. Policy Recommendations

- Reinstate the revoked energy and $CO_2$ tax exemption for biomethane (a new long-term state aid approval from European Commission is needed)
- Assure long-term favorable conditions in existing policies (investment and production support, tax exemption etc.) to reduce the uncertainty in the market. Adopt a national biomethane strategy and set a national biomethane production target of 10 TWh 2030 and 20 TWh biogenic gases for 2035 to assure political commitment over time.
- Assure that efficient and harmonized market instruments and the mass balance principle are developed and accepted for trade and compliance to all relevant regulations and policies such as ETS, taxation, RED sustainability criteria and GHG-accounting schemes. Implement a guarantees of origin scheme for gas in Sweden which can work efficiently together with RED sustainability criteria and the Union Database (UDB).
- Introduce additional economic incentives for use of biomethane in end-use sectors outside EU ETS and with no or low energy or CO2 tax such as biomethane use as raw material in chemical industry and metallurgical processes as well as for maritime transport, such as an industrial premium or a Contracts for Difference scheme.
- Complement the existing production support scheme for biomethane with production support scheme for large scale production of biomethane and other renewable gases from lignocellulose and electricity and recovered $CO_2$.

## 6.5. Ukraine

### 6.5.1. Biomethane usage today

Ukraine has already seen the launch of its first biomethane plant in April 2023. The plant was commissioned by Gals-Agro Company, located at Chernihiv region and has a production capacity of 342 $m^3/h$. This happened on the basis of one of the company's six biogas plants working on agricultural feedstock. Biomethane plant was connected to local low pressure natural gas distribution grid. The Company has intention to sell biomethane to European traders and has already obtained ISCC certificate for this purpose.

It is expected that at least seven plants with a total annual capacity 110 million $m^3$ of biomethane may be commissioned in Ukraine by end of this year. Four plants will be connected to NG distribution system, one plant is already connected to high pressure NG transportation system, and two plants are planning to produce bio-LNG. All project developers have intention to export biomethane to EU market.

**Table 6 10** Biomethane projects planned for launch in Ukraine in 2024.

| | Location | Capacity, million m3/year | Connection | Sustainability certificate |
|---|---|---|---|---|
| Hals Agro LLC | Chernihiv region | 3 | GDS | ISCC |
| VITAGRO group of companies | Khmelnytskyi region | 3 | GDS | ISCC |
| "Theofipol Energy Company" LLC | Khmelnytskyi region | 56 | GTS | ISCC |
| Hals Agro LLC | Kyiv region | 3 | GDS | |
| "YUM LIQUID GAS" LLC | Vinnytsia region | 11 | Bio LNG | |
| MHP | Vinnytsia region | 24 | Bio LNG | ISCC |
| MHP | Dnipropetrovsk region | 11 | GDS | ISCC |
| **TOTAL** | | **111** | | |

## 6.5.2. Most promising end-use categories

By end of 2024, biomethane production can be at least 110 million m$^3$, and in 2027 it can reach 250 million m$^3$. Under certain conditions, the first of which is the cessation of military invasion on the territory of Ukraine, the production of one bcm of biomethane in 2030 can be considered as an ambitious but achievable goal. It is expected that Ukrainian biomethane will be important as export product to European countries.

Biomethane should be used not only by road transportation, but also by maritime and rail transportation, not only in compressed (CBG), but also in liquefied (LBG) form. However, so far there are any examples of biomethane use for transportation in Ukraine including both separately or blending with natural gas.

## 6.5.3. Barriers for the use of biomethane

Ukrainian potential biomethane producers face numerous inherent in new markets. This includes the unsettled legislation, the lack of regulated procedures and answers to arising practical questions, and the fear of officials to take responsibility for the necessary decisions.

In conditions of low natural gas prices and lack of incentives for biomethane consumption, it is impossible to sell biomethane profitably in Ukrainian domestic market. Therefore, the preferable option for project developers is to supply their biomethane to the European market.

The important issue faced by the first Ukrainian producers of biomethane is the sceptical attitude of natural gas system operators towards biomethane. This results in barriers in the form of a long process of connecting biomethane plants to gas distribution networks and other operational obstacles:

1) Long periods of time for obtaining technical conditions for connection from GDS operators. The reason for this is that technical specifications are provided by branches, but all decisions and approvals are made through the central office of the operator.
2) Long terms for signing a technical agreement that regulates the relationship between the biomethane producer and the gas system operator. Despite the fact that the standard agreement is written in the code of gas distribution systems, biomethane producers often



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agree on the final agreement with gas system operators for several months. Project developers must cover all associated expenses.
3) Ukraine lacks a modern accredited laboratory for biomethane analysis. Accordingly, producers are forced to look for laboratories that can perform the necessary biomethane quality analyses (e.g., internal laboratories of the GTS Operator).
4) Limited capacity of the GDS to accept biomethane in certain periods, as there are inequalities in natural gas consumption during the calendar year (summer/winter) and even within one day (day/night).
5) Requirements for a higher calorific value of biomethane. The calorific value of biomethane can differ from that of natural gas by 1-2% due to the fact that biomethane does not contain impurities of other combustible gases, as in natural gas.
6) Lack of simplified procedures for connecting biomethane plants to gas distribution and electricity networks.

Other types of barriers are connected with the further sustainable development of the biomethane sector in Ukraine.

1) The need to designate a ministry responsible for implementing the policy on the development of the biomethane industry in Ukraine and for coordinating the work of ministries and agencies in this area.
2) Ensuring Ukrainian biomethane producers' access to the European Union database, without which Ukrainian producers will not be able to export biomethane to the European market.
3) The need to cancel the export duty on biomethane for countries such as Switzerland and the UK, whose companies are interested in importing biomethane from Ukraine but are not members of the Energy Community.

The result is a long process of signing a technical agreement that regulates the relationship between the biomethane producer and the gas system operator. Despite the fact that the standard agreement is written in the code of gas distribution and gas transportation systems, often biomethane producers have been agreeing the final version of agreement with gas system operators for several months. Project developer should cover all associated expenses.

### 6.5.4. Favorable conditions for the use of biomethane

There are no specific favourable conditions for the use of biomethane in Ukraine so far. However, in August 2023, the Verkhovna Rada of Ukraine amended the law "On State Support of Investment Projects with Significant Investments in Ukraine", including a provision on state support of businesses with significant investments. The law covers biogas and biomethane projects with total investments of more than 12 million euros. These significant legislative changes will facilitate the construction of new biogas and biomethane plants by making them more attractive to potential investors due to:

- exemption from income tax for 5 years,
- exemption from VAT and import duty upon import of new equipment and components,
- exemption from payment of land tax and compensation of costs for connection to engineering transport networks.

### 6.5.5. Infrastructure

Biomethane is particularly attractive in Ukraine due to several reasons.
Ukraine has the largest area of agricultural land in Europe, and, accordingly, one of the best agricultural raw material potentials for biomethane production in the world. Ukraine can offer the cheapest raw materials for the production of biomethane and compete with any countries on the biomethane market. The structure of agricultural enterprises is favourable for the production of biomethane (a large share of large and medium-sized enterprises).


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The present biogas projects range in size from 125 kWe to 26 MWe, covering various industries and feedstock types.
There is a long-term tradition to use compressed natural gas (CNG) as a motor fuel for buses and heavy vehicles In Ukraine. More than 200,000 vehicles were running on CNG in 2022.
The Ukrainian natural gas transmission system and natural gas distribution system network (i.e. GTS and GDS) is spanning 33,400 km and approximately 300 CNG filling stations distributed all over the country. The figure 6.12 shows the developed GTS of gas networks (281 bcm per year and 146 bcm per year of entry and exit capacity respectively). [65]
Biomethane can be injected directly into the existing gas network without significant infrastructure modifications, offering a cost-effective renewable gas option.

**Figure 6.11** Gas Transmission System Operator of Ukraine LLC

The Ukrainian GTS is internationally connected potentially enabling biomethane and other renewable gases physical or virtual delivery from Ukraine to Western Europe. However, there is a downward trend in the transit of natural gas to Europe by Ukrainian GTS. Ensuring the maximal possible load of the Ukrainian GTS with natural gas of own production and alternative renewable gases is urgent.

## 6.5.6. Policy Recommendations

The first biomethane Law of Ukraine, enacted in 2021, introduced definitions and regulations for biomethane production, establishing a biomethane register and guarantees of origin. The National Energy and Utilities Regulatory Commission (NEURC) has also approved amendments to support the biomethane sector, including changes to gas transmission and distribution system codes.

To overcome barriers, better dialogue between different stakeholders (producers, users, decision-makers, officials, and others) is needed. There are a large number of different stakeholders, as the biogas sector is strongly involved in sectors such as energy production, agriculture, transportation, and waste management.

In August 2023, the Verkhovna Rada of Ukraine amended the law "On State Support of Investment Projects with Significant Investments in Ukraine", including a provision on state support of businesses with significant investments. The law covers biogas and biomethane projects. These significant

[65] https://tsoua.com/en/

legislative changes will facilitate the construction of new biogas and biomethane plants by making them more attractive to potential investors due to:

- exemption from income tax for 5 years,
- exemption from VAT and import duty upon import of new equipment and components,
- exemption from payment of land tax.

There are no specific targets for the use of bio-CNG or bio-LNG, despite the great potential to lower the emission of the transport sector in Ukraine. Creating a mid-term vision and legislative incentives is essential to promote the use of biomethane in the transport sector.

The medium-term actions may include but not limited:

1. Creating a mid-term vision and legislative incentives to promote the use of biomethane in the transport sector.
2. Fastening the regulatory framework for nutrient recycling (e.g., obligations, rights, incentives). Development the market for recycled nutrient products and support in production of new products.
3. Adjusting the electricity grid operation by increasing the role of biogas for electrical load regulation.
4. Development and adaptation of Roadmap for bioenergy development including biomethane until 2050 and Action Plan until at least 2035.
5. Adaptation of Ukrainian gas system for use of biomethane including distribution grids interconnection and use of reverse flow compressors.
6. Support of expansion of the bio-CNG and bio-LNG distribution network.
7. Creating legislative incentives to promote the use of biomethane as efficient factor of circular economy implementation.
8. Introduction of separate collection of the biodegradable fraction of municipal waste with subsequent biogas production.
9. Development and approval of a standard form of technical conditions for connecting biomethane plants to the GDS.
10. Development and approval of a standard form of a technical agreement on the terms of acceptance and transfer of biomethane by the gas distribution system.
11. Introduction in the GTS Code requirements for biomethane regarding higher calorific value of at least 10.0 $MJ/m^3$.
12. Extend the simplified procedure for connecting to the power grid during martial law to biogas, biomethane plants, and CHP plants.
13. Creating a "one-stop shop" mechanism in organizational structures of GTS/GDS operators, to provide biomethane projects with prompt and qualified advice on the conditions for connecting biomethane plants to the GTS/GDS.
14. Designation of a ministry responsible for implementing the policy on the development of the biomethane industry in Ukraine.
15. To ensure effective communication with the European Commission and fulfillment of the requirements for connection to the Union database, in particular, the verification of data on biomethane volumes.
16. Involvement of the Ukrainian GTS Operator in the exchange of data with the Union database, namely on the injection and withdrawal of biomethane from the Ukrainian gas transmission system.


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# Annex I: Survey-Questionnaire on end-uses of biomethane

**Current situation natural gas / data:**

1. How big is the share of natural gas used by the sector compared to its total energy demands?
2. Are there sectoral targets established for decarbonization? (Either legal or upon the initiative of the industry)
3. Are there specific sectoral targets for the decarbonization of natural gas?

**Current situation biomethane / data:**

3. Is the sector already currently using biomethane?
4. To what extent? Are there data/reports available?

**Outlook for biomethane usage in the future**

5. Is the sector anticipated using biomethane in the future?
6. What do you expect to be the demand for biomethane in the future for your sector? (Total volume or %)
7. What timeframe do you foresee for the utilization of biomethane?
8. Which conditions are necessary to scale up the use of biomethane?
9. Are there specific countries in which the use of biomethane is more favorable than others?
10. What are the alternatives to biomethane to decarbonize your sector?
11. What are the barriers / drivers you might encounter for this switch towards biomethane?
12. Do you see specific advantages and possible developments for synergies between biomethane and hydrogen within your sector?

**Concluding questions**

- May the name of your company / association in relation to your replies be disclosed in the final report following this survey? (specify email address)
- Are you open for a more detailed interview on the end-use of biomethane within your association?



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