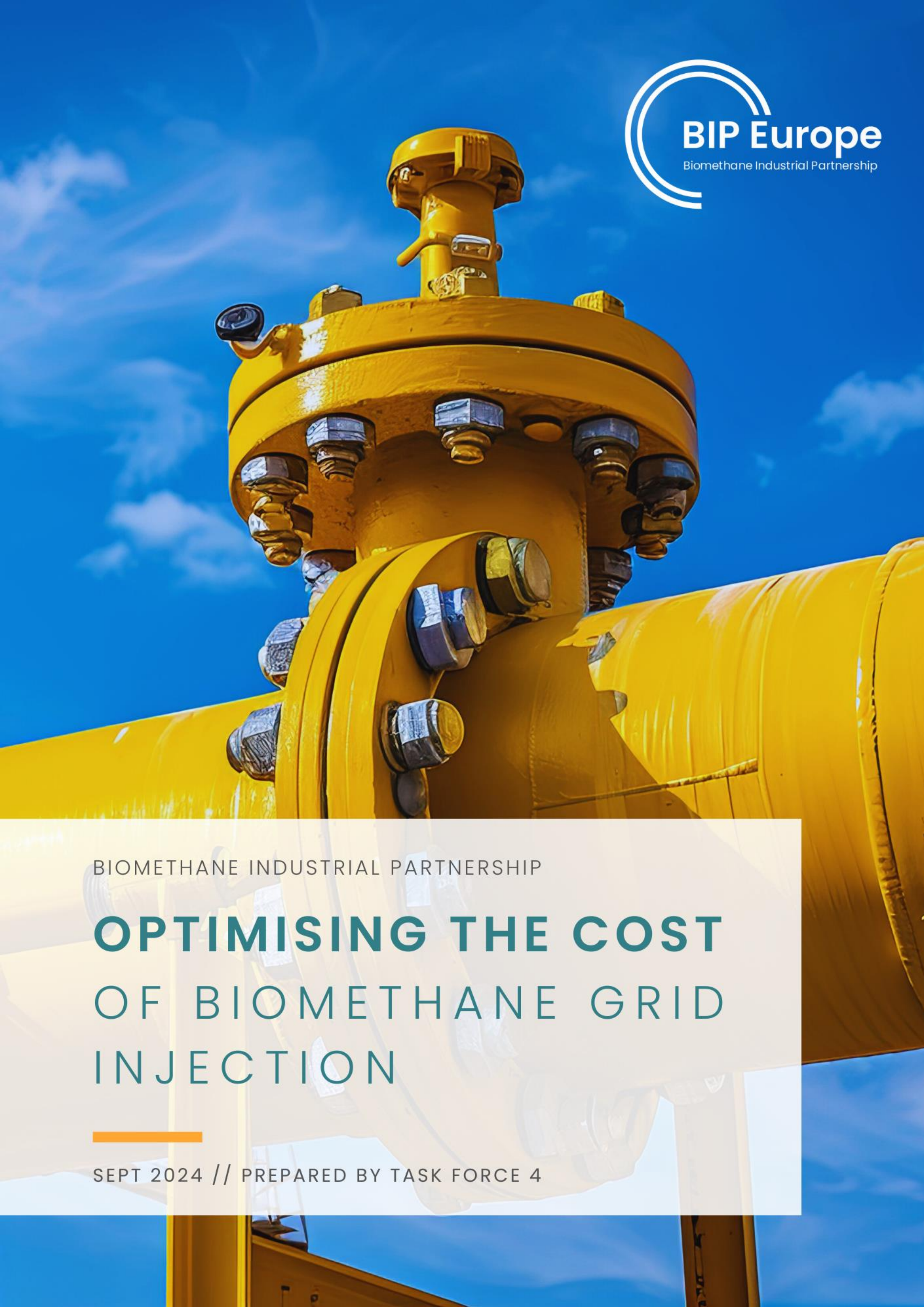

BIP Europe
Biomethane Industrial Partnership

BIOMETHANE INDUSTRIAL PARTNERSHIP

OPTIMISING THE COST OF BIOMETHANE GRID INJECTION

SEPT 2024 // PREPARED BY TASK FORCE 4

This report has been prepared by the Task Force 4.4 of the Biomethane Industrial Partnership, with contributions from the other BIP Task Forces members including a consultation of external stakeholders.

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- GAZ-SYSTEM S.A.
- DEFSA
- REPSOL
- GRTgaz

The report is based on the contribution of several countries: Czech Republic, Denmark, France, Germany, Italy, Latvia, Netherlands, Portugal, Spain, and Sweden, for a total of 18 answers to the questionnaire prepared and sent by the Task Force 4.4.

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Imprint

Date
September 2024

ISBN
9 782960 342840

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Optimising the cost of biomethane grid injection

Executive Summary

This report, prepared by Task Force 4.4 of the Biomethane Industrial Partnership (BIP), focuses on optimizing the cost of biomethane injection into the gas grid, which is a crucial component of the European Union's transition to a sustainable energy system. Biomethane, as a renewable alternative to fossil gas, plays a vital role in achieving the EU's clean energy objectives as outlined in the European Green Deal and the REPowerEU Plan, which targets an annual production of 35 billion cubic meters of biomethane by 2030.

As of 2021, biomethane constituted 11% of the total bioenergy consumed within the EU. Production across Europe reached 4.2 billion cubic meters in 2022, with Germany, France, Denmark, and Italy emerging as leading producers. However, the deployment of biomethane varies significantly among Member States, driven by differences in national policies and infrastructure.

> **To meet the ambitious biomethane production targets set by the EU, it is essential to address the challenges related to grid injection, optimize the existing infrastructure, and establish supportive regulatory frameworks.**

The existing European gas infrastructure, comprising over 2.21 million kilometers of networks, was not initially designed to accommodate decentralized biomethane production. Grid operators encounter challenges in integrating multiple small-sized injection points into the system. Producers require access to firm injection capacity, network connection, and biomethane injection stations that ensure the quality and measurement of the gas injected. These requirements differ widely across countries, further complicating the grid injection process.

The production and injection of biomethane are influenced by a mix of legal, regulatory, economic, and technical factors, with country-specific considerations such as gas market dynamics and infrastructure playing a significant role. Effective grid capacity allocation and

planning demand close collaboration among stakeholders, along with clear regulations that ensure the feasibility and cost-effectiveness of biomethane projects.

The report identifies several technical solutions to enhance the reception capacity for biomethane, including reverse-flow facilities, meshing networks, and virtual pipelines. However, the effectiveness of these solutions depends on careful, case-by-case analyses. France and Italy are highlighted as examples of where regulatory frameworks have been established to optimize biomethane grid injection. These frameworks emphasize strategic capacity mapping, prioritization of production projects, and the provision of cost-effective connection solutions.

Cost reduction in biomethane injection stations is identified as a key factor in making biomethane more competitive. The report advocates for the harmonization of technical solutions across Europe and improving cost-efficiency through the standardization of quality control measures required for grid injection.

To meet the ambitious biomethane production targets set by the EU, it is essential to address the challenges related to grid injection, optimize the existing infrastructure, and establish supportive regulatory frameworks. The strategies and best practices outlined in this report can significantly contribute to scaling up biomethane production and its integration into the European energy system, thereby supporting the transition to a sustainable and resilient energy future.

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1 Introduction

This chapter provides an overview of biomethane's role in the EU's climate strategy. It covers the current state and growth of biomethane production, the challenges of scaling up to meet 2030 targets, and the complexities of integrating biomethane into the gas grid, including infrastructure and regulatory issues.

1.1 EU biomethane production context

Climate change and environmental degradation present an existential threat to Europe and the world. To overcome these challenges, the European Green Deal aims to transform the EU economy into a modern, resource-efficient, and competitive one, by ensuring:

- Net zero emissions of greenhouse gases by 2050
- Economic growth decoupled from resource use
- No person and no place left behind

The European Commission has adopted a set of proposals to make the EU's climate, energy, transport, and taxation policies fit for reducing net greenhouse gas emissions by at least 55% by 2030, compared to 1990 levels.

Biomethane, a sustainable alternative to fossil gas, can be stored, distributed, and used according to demand, playing a significant role in achieving the EU's clean energy objectives. Biomethane also helps to further diversify the EU's gas supplies, phasing out Europe's dependency on Russian fossil fuels and minimizing consumer exposure to volatile natural gas prices.

In addition, biomethane is preferred over other renewable gases due to its high energy content, compatibility with existing natural gas infrastructure, and its ability to be produced from various organic waste materials. This not only provides a renewable energy source but also addresses waste management issues. Its production process captures methane emissions that would otherwise contribute to global warming, making it a crucial component in the fight against climate change.

For these reasons, there is a clear need to scale-up biomethane by 2030, as outlined in the REPowerEU Plan of 18 May 2022. As a renewable and dispatchable energy source, increasing the production and use of biomethane also helps to address the climate crisis. The EU's biomethane production, needs to reach 35 billion cubic meter (bcm) per year by 2030 and the estimated investment need for the period amounts to €37 billion[1].

Such an ambitious target requires an increase in production facilities and a reduction of both production and grid injection costs to incentize potential producers across the EU.

In this view, Task Force 4 aims at providing the best practices to effectively produce low-cost biomethane and reducing costs related to the grid injection. This report, elaborated by Task Force 4.4, specifically focuses on optimizing costs associated with biomethane grid injection, related grid reinforcement and other techniques that may facilitate the process, such as the reverse flow.

1.2 The European biomethane situation

Biomethane, either as the energy content of biogas or upgraded to the fossil gas quality, accounted for 11% of the total bioenergy consumed in the EU27 2021. Energy balances record only the energy content of biogases, without distinguishing the level of purity of the renewable gas consumed. The latest Eurostat figures (2023) report for 2021 production of 14,88 Mtoe (17.71 bcm) of biogases in the EU27. Only biogas upgraded into biomethane, as a fossil gas renewable alternative, can be safely injected to the grid. According to the European Biogas Association, in 2022 the total biomethane production in Europe reached 4.2 bcm, showcasing a growth of almost 20% (+0.8 bcm) over the year, with 1,323 biomethane production facilities (+254 plants).

In absolute numbers, Germany takes the lead with 1.23 bcm produced, followed by

1 Communication from the commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the regions Brussels, 18.5.2022

France (0.66 bcm), Denmark (0.61 bcm) and Italy (0.41 bcm). However, the highest growth rates were observed in France (+0.25 bcm), Italy (+0.20 bcm), and Denmark (+0.08 bcm).

Looking at the percentage of each country's natural gas consumption which could be covered by biomethane, Denmark and Sweden are well on track to replace their fossil gas consumption with biomethane, covering 32.4% and 17.1% of their demand respectively in 2021.

However, despite the sustainable biogas and biomethane potential available, not all Member States deploy this potential as a tool to reduce the dependence on the fossil gas imports. Realization of such potential depends on the policies followed by the countries, making it useful to benchmark against the most successful models.

Factors influencing the injection of biomethane into the gas grid

Biomethane is an alternative to fossil gas that results from the purification of biogas to remove carbon dioxide, water, and other impurities. After purification, its characteristics are essentially the same as those of fossil natural gas– meaning it can be used in the same appliances and have no different grid requirements.

This makes grid injection a very convenient and economical way of delivering it to customers, to fulfil their energy needs.

The gas infrastructure is mature in Europe with over 2.21 million km of networks and a good penetration of natural gas, but the system has not originally been designed for decentralized production such as biomethane injection.

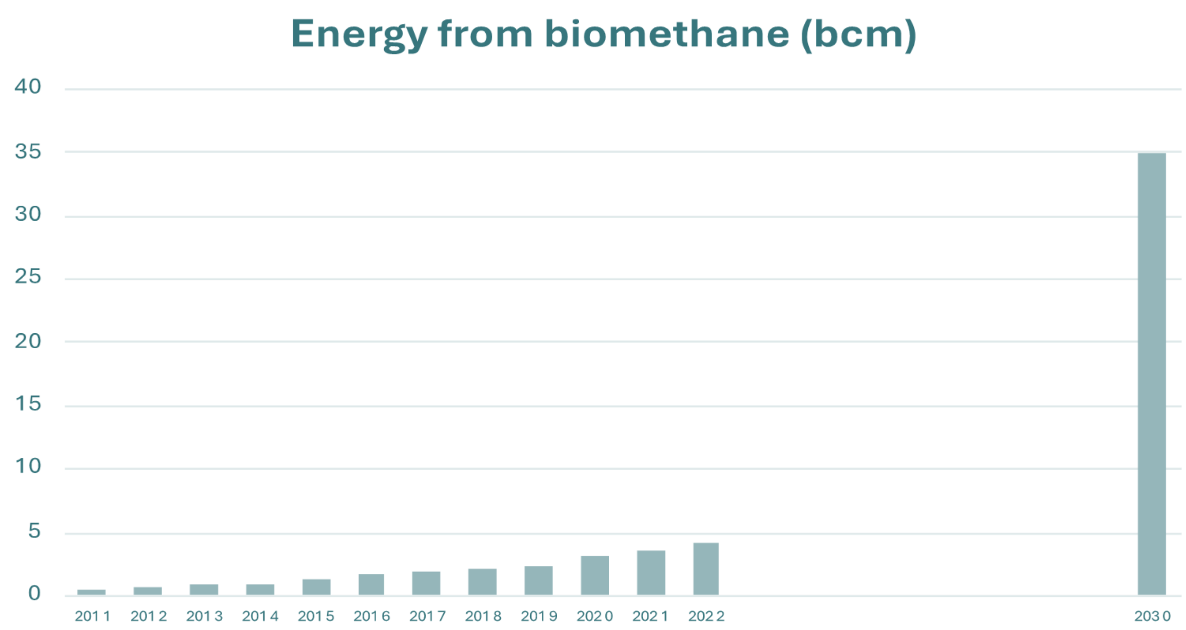

FIGURE 1 BIOMETHANE PRODUCTION IN EUROPE FROM 2011 TO 2021, IN COMPARISON WITH THE REPOWER EU TARGET.

Grid operators are traditionally organized to connect new consumers but not to add multiple and relatively small-sized injection points in their networks.

Apart from other regulatory requirements, such as Guarantees of Origin, or Proof of Sustainability, to be able to inject biomethane, producers require:

- Firm injection capacity: the “room” in the grid allowing the producer to physically inject the gas, especially in summer when gas demand is at its lowest.
- Network connection: a pipeline connecting the plant to the closest gas pipeline from the gas facility, or a virtual pipeline to an injection facility.
- A Biomethane Injection Station to check that the bio methane duly respects the gas quality specified by the norms and regulations and to measure the quantity of biomethane injected (metering).

It can be observed, however, that the situation regarding those aspects varies significantly across European countries, and this diversity can be attributed to each country's distinct policy approaches as well as to the infrastructure already developed in the different contexts.

Production and injection of biomethane into the gas grids are contingent upon a blend of legal, regulatory, economic, and technical factors, which are interconnected. Often the legal and regulatory framework significantly influence both the economic and technical aspects.

Besides economic support to biomethane production and injection focused on CAPEX or OPEX, there are country-specific considerations such as gas market dynamics and existing/planned infrastructure, mandatory quotas, and guarantees of origin. These factors vary significantly between countries and must be addressed through legal or regulatory frameworks.

Grid capacity allocation and planning requires the collaboration of several stakeholders and comprehensive evaluations of proposed ventures per region:

- List of prioritized production projects with planned date of connection and capacity;
- Coordinated DSO and TSO grid developments, that allow to identify and efficiently overcome capacity constraints for biomethane production uptake, through the implementation of appropriate actions. These include the selection of network to connect to (transmission or distribution), but also the possible installation of reverse-flow systems, or centralized injection facilities for compressed, or liquified biomethane.
- Criteria to assess the feasibility of connection and grid reinforcement options.

These aspects must be clearly defined so that all interested parties (TSO, DSO and promoters) may:

- Understand the system, its fairness and predictability over time;
- Know its responsibilities, what type of cooperation can be expected, how it will be financed and by whom.

These conditions are of the utmost importance to de-risk new projects and allow promoters to build reliable business plans.

Finally, the quality requirements for biomethane impact the CAPEX and OPEX of the Injection Station. The cost of these stations depends on which components/characteristics of biomethane are measured and the technologies chosen to do it, opening a wide field of uniformization, improvement, and cost savings. What is measured depends on each country requirements. How it is measured is related to the requirements to fulfil but is ultimately conditioned by the type of on-line analyzers allowed in each country.

This report focuses on the aspects mentioned, with the support of a survey sent to respondents identified by TF4.4 members of BIP.

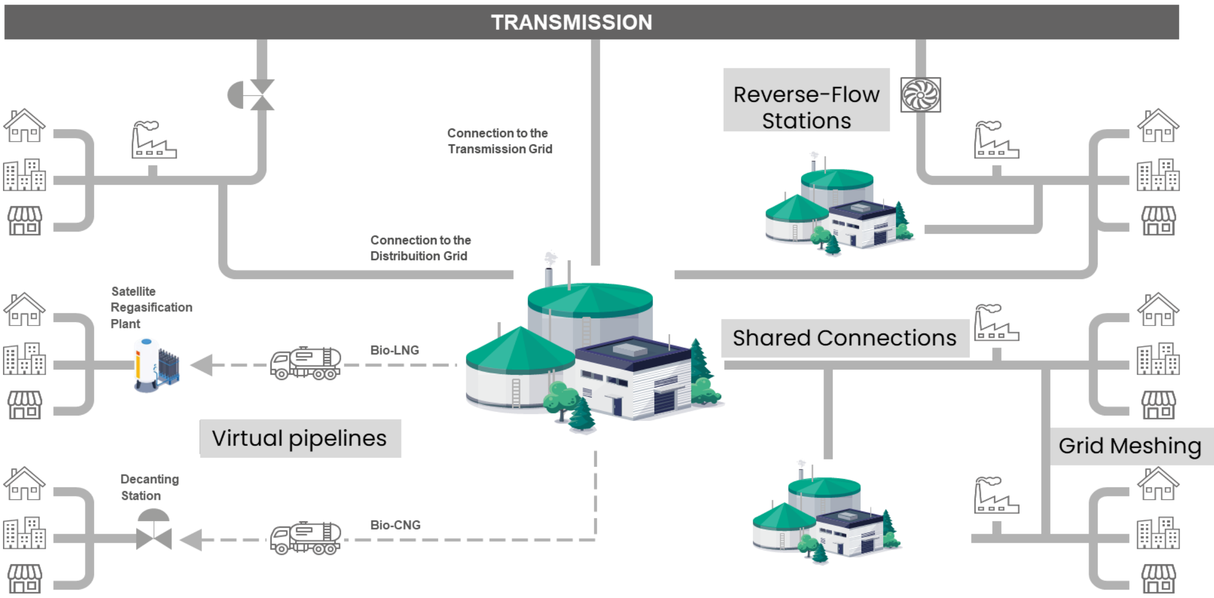

FIGURE 2 AN OVERVIEW OF THE BIOMETHANE TRANSMISSION GRID

2 The role of the network operators

The following chapter deals with a contextualization of European production of biomethane, supported on a survey conducted by Task Force 4.4 among TSO, DSO, and providers in the gas sector.

2.1 Obligations of the network operators

In all the countries that participated in the survey (Czech Republic, Denmark, France, Germany, Italy, Latvia, Netherland, Portugal, Spain, and Sweden) grid operators have legal obligations to assess requests from biomethane producers for gas grid connection.

Upon receiving a request complete with all necessary data (e.g., location, capacity), the grid operator defines the technical requirements and optimal routing of the connection pipeline, evaluates feasibility, and provides an offer to the producer. Depending on the country regulation, the offer may include the cost of the Injection station. In France this station is rented, all included (CAPEX and OPEX) by the DSO over the contract duration (15 years).

Usually, the offer consists of one or more connection options (type of grid/pressure-tier and, or location), along with a technical feasibility project, injection capacity, cost evaluation and construction timeline.

In most cases cost evaluation is based on actual connection conditions and market prices for entailed services.

2.2 Network Injection limits and consequences

Gas networks must keep consumption and injection balanced over time to guarantee security of supply and stable pressure conditions.

Network consumption is driven by demand and usually outside grid operator's control. Depending on the customers' profile, consumption may follow day/night, working day/weekend, and winter/summer cycles.

Biomethane production is usually stable over time, with no significant flowrate variations. To guarantee that all biomethane is injected, consumption at the lowest phase of the cycles must be above production flowrate.

Furthermore, a trend is observed to increase the size of production facilities, that results from the environmental, safety and economic requirements applicable to the plants. This results also from cooperative projects, that serve several feedstock producers (e.g., in France). This trend generates larger, localized, biomethane productions, which become harder to accommodate, especially at DSOs level.

If this is not the case and no other measures are put in place, the grid will not be able to receive all the gas produced, which in extreme cases may lead to gas flaring.

This is detrimental to biomethane producers and to the environment and may cause production projects to be abandoned, wasting production potential.

The problem is prevalently related to local distribution networks, which have smaller capacity. Having much larger reception capacity, transmission networks are less prone to injection limit issues.

2.3 Managing the networks to boost injection

To boost biomethane injection, countries should focus on how they manage and plan their gas networks, emphasizing a higher degree of integration and a comprehensive view of all foreseen biomethane projects.

There are several ongoing discussions about this subject around Europe. For instance, in Italy, the Netherlands and Czech Republic, networks operators, regulators and governments are working to map the capacity of both transmission and distribution grids to optimize the connection of production plants and increase green gas capacity while optimizing cost for the energy system.

The analysis must contribute to making the green transition as cost-effective as possible, as the European energy landscape is undergoing major changes and will look very different in the coming decades. In fact, with increasing electrification in the industry and residential sectors, fossil gas consumption is generally expected to decrease while biomethane production is to increase.

A good example is France, where the network was divided in regions, for which a capacity was determined, and a prioritized list of production projects established. Network development, including the appropriate solutions to promote biomethane injection are based on this analysis. DSO and TSO cooperation and a well-established regulatory framework are key in this process.

Another positive example is Italy, where a recently adopted regulatory framework aims at identifying the most cost-effective solutions at system level for biomethane plants connection to gas grids (with positive effects also for producers and the overall biomethane competitiveness). The newly approved procedures envisage that the main Italian TSO maps the transmission and distribution networks suitable for absorbing biomethane production and their respective current and future capacities.

This makes possible a central evaluation of connection requests that identifies the infrastructure operator providing for the most cost-effective connection realization.

This solution relieves producers from contacting and requesting connection quotes to individual network operators, allowing shorter timeframe to determine the optimal connection solution.

2.4 Technical solutions to expand biomethane reception capacity

Many operators' masterplans include a set of solutions to increase the reception of biomethane in its networks. The appropriate for each case depends on how often the surplus of gas occurs and how large they are. It is not possible to know which will be the best solution without a comprehensive study of each case.

This section presents some of the solutions identified:

- Selecting the network to which it is most efficient to connect. The transmission network has a greater capacity to receive gas, but in some cases might require a more expensive connection due to the higher pressure rating required. Connection length and routing are also important factors – a trade-off between all these factors has to be evaluated to identify the least costly solution for the system.
- Meshing with neighboring networks in the same pressure tier, to allow gas to flow freely over a wider area, providing extra consumption capacity to absorb the gas surplus. Although this is a solution applicable in any type of network, it is much more commonly used in distribution networks, because of their topology and smaller capacity.
- Linepack storage, which consists in allowing the network pressure to increase by temporarily injecting more biomethane that is consumed. The volume of the network is used to store the surplus of gas. This possibility is limited for the distribution networks, while it is significant for transmission grids that also grant the possibility to import/export or store the biomethane volumes, as additional flexibility tools.
- Reverse-flow facilities to push gas from low pressure areas to high pressure areas or transport lines, enabling gas flows towards other consumption areas. Reverse-flow facilities are not mere compression stations, they must guarantee that the gas meets the requirements of the destination grid. When delivering gas to a transmission grid, the facility may include odorant, oxygen and water removal and energy and quality measurement, besides volumetric flow.
- Creating Virtual Pipelines where compressed or liquified biomethane (bio-CNG or bio-LNG) is transported by truck from the production site to a suitable grid injection facility. Production site will not be directly connected to the grid and will have to include a compression, or liquefaction unit. The injection facility will have to be strategically located, regasify or

decompress and odorize the biomethane prior to injection. Virtual pipelines are flexible, for they may serve several producers and adjust easily in case one producer goes out of business. Compression, liquefaction, and transportation costs may be supported by being included in the tariffs[2] through the grid operators.

- Small, transient gas surplus can be managed by asking some large consumers connected to the distribution grid to increase their consumption for a while and in return be compensated for the costs incurred. This would have to be foreseen in the applicable regulation in the customer contracts.

2.5 Regulatory framework concerning solutions

From a legislative and regulatory viewpoint, only Germany, France, Italy, and Denmark have taken steps forward, regulating the process of connection and injection and the articulation between DSO and TSO concerning entailed investment. In the Netherlands, this articulation is not formally defined in the regulation, but is agreed between TSO and DSO and does govern the relationship and investment decisions in this matter.

When and how are projects considered feasible?

While the solutions mentioned are all technically well-known and available to be implemented, it is important to develop feasibility criteria that guarantee the rationality of the choice.

In most countries, no specific criteria regarding project feasibility are defined. Generally, solutions are considered feasible when they guarantee a socio-economic benefit (e.g., economic growth, environmental benefits, and any other positive outcomes that contribute to the overall well-being of society). Only France has defined a threshold of 4700 €/(m3/h) above which an investment is not considered justified under the regulatory framework, although the excess may be borne by a private promoter.

The high number of installations and the progress made in this field by France show that the definition of a feasibility threshold, supported by strategic capacity mapping, is an efficient way of selecting and prioritizing new biomethane ventures requests and speeding up connection.

France divided the country in regions for which information was gathered: Capacity to receive biomethane with and without grid reinforcement; projects already connected; connection cost; reinforcement costs and maximum

[2] Transport, compression, or liquefaction costs may be recovered through tariffs if that is foreseen in the regulatory framework.

In Portugal a LNG virtual pipeline is working for two decades now, the costs being incorporated in the tariffs by the TSO. The service is centrally managed and was recently extended to bio-LNG transportation.

potential production. This information is available to promoters, subject to confirmation upon contact with the grid operator[3].

In Italy, a new regulatory framework has recently been introduced in view of identifying the most cost-effective solutions at system level for connection to the gas grids, with positive effects also for producers and the overall biomethane competitiveness. The main Italian TSO evaluates connection requests by indicating the optimal solution among all the feasible ones, thus relieving producers from the burden of contacting, and requesting connection quotes from individual network operators and allowing shorter times to determine the optimal connection solution.

[3] https://projet-methanisation.grdf.fr/tester-mon-potentiel/evaluer-la-faisabilite-de-mon-projet/carte-de-zonage-indicative

3 Injection station design and optimisation

The goal of Chapter 3 was to propose an "European" harmonized technical solution for the Biomethane Injection Station to reduce its costs. Biomethane Injection Station is the final step of the biomethane plant: it is the "meeting point" between the producers and the natural gas grids. In most cases, the biogas upgraded to biomethane is transported and distributed to the end-user through the gas pipelines.

To reach this goal, the task force focused on collecting, understanding, and analyzing the technical characteristics of the Biomethane Injection Stations currently operating within Europe country by country. A questionnaire was developed asking for information on national regulations and standards, roles, and responsibilities, and most importantly, the physical and chemical analyses required to allow producers to inject the biomethane into the grids.

From the received answers, many countries in Europe have drawn up their own regulations and standards, starting from the EU standard EN 16723-1 "*Biomethane injection into the Natural Gas grid*" (mainly relevant to chemical characteristics of biomethane to be injected). Table 1, in Annex, summarizes the existing legislation in some EU countries, as derived from the replies to the questionnaire.

The Biomethane Injection Station is composed by the following main items:

- An analysis system for quality control of biomethane,
- A fiscal metering skid to measure the quantity/volume of biomethane injected,
- Filtration,
- Temperature, and pressure instrumentation and
- A control system.

For specific applications, it can also include other devices such as odorant injection for safety reasons, and propane injection to increase the calorific value.

For the measurement of the quantity of produced and injected biomethane, a fiscal metering skid is normally provided. It is composed of a gas meter, pressure transmitter, temperature transmitter and volume conversion device: all this equipment must follow Measuring Instruments Directive 2014/32/UE (MI-002).

Regarding the responsibilities for purchase, installation (CAPEX) and operation (OPEX) of a biomethane Injection Station, different approaches were identified:

in 65% of cases, it is the biomethane producers' responsibility (Czech Republic, Italy, Latvia, Netherlands, Portugal[4], and Spain); in 35% of cases, it is the gas grid owners – TSO or DSO - responsibility (Denmark, France, and Germany).

It was also noted that in some countries where the biomethane producers are responsible for injection station CAPEX and OPEX, the TSO/DSO replicate the quality control: in Latvia and the Netherlands it is done with legal requirements, meanwhile in Italy it is done for an internal quality audit. This situation duplicates the CAPEX of quality control, which is the most expensive item of the Injection Station.

3.1 Biomethane quality: why?

Finally, the chemical analysis of biomethane and the list of components required to be analyzed and measured to verify the biomethane characteristics before the injection were taken into consideration.

The gas analysis system is the core of the biomethane injection station.

Its function is twofold. Firstly, it is crucial for measuring the energy content of biomethane. This measurement is necessary for fiscal transactions, as payments and incentives are contingent upon the energy content of the biomethane. Secondly, the analysis ensures that the biomethane meets quality requirements of standards and regulations. This is essential for safety reasons, as it protects public health and prevents pipeline corrosion-related accidents. Ensuring the safety of users is paramount, and thus, biomethane injected into pipelines must comply with quality standards. If the biomethane composition fails to meet local requirements, it must be returned to the processing stage for further treatment.

3.2 Biomethane quality: how?

It is important to note that gas analysis involves two distinct types of analysis: continuous and non-continuous. Continuous analyses are performed with a fixed and field-mounted analyzer set. The results are representative of the instantaneous quality of the biomethane and its trend over time, which is usually recorded and used for automatic injection control.

Non-continuous (or batch, lab) analysis is performed by sampling gas from the plant and analyzing it in a laboratory. In this case, the results represent the conditions at the moment of sampling.

A common approach for biomethane non-continuous analysis was identified: in all countries Volatile Organic Silicon (Si),

[4] In Portugal it was recently ruled that it is up to the promoter to bear the CAPEX of the Injection Station, but it is up to the grid operator to operate it and maintain it.

carbon oxide (CO), ammine, hydrogen (H_2), ammonia (NH_3) total fluoride (F), total chlorine (Cl), oil and dust analysis are performed on samples collected in the field on a regular basis and analyzed in the laboratory.

Continuous analysis strongly impacts CAPEX and OPEX costs.

Energy parameters are the same in every country: methane (CH_4) content, carbon dioxide (CO_2) content, heating value, specific gravity, and Wobbe index.

Oxygen(O_2) continuous analysis is also required everywhere. Regarding safety, H_2O dew point continuous analysis is required in every country, but a different approach for sulfur components was identified. In fact, H_2S continuous analysis is required in every country, while other sulfur compounds (such as total sulfur, carbonyl sulfide, mercaptans – normally present in natural gas) are required as a continuous measurement in less than 5% of the countries. In fact, since biogas and then biomethane are coming from organic matter, many countries decided not to have continuous analysis on these contaminants, also not to impact on the economic sustainability of a biomethane plant. They have considered that monitoring H_2S – with a reliable technology - is enough: in other words, if H_2S is below a certain limit, it's very likely that no other sulfur compounds will be present in the biomethane.

Therefore, a reasonable approach may be to maintain continuous H_2S analysis and to measure the other sulfur compounds through lab analysis.

It will ensure that the safety of the users and pipeline is secured, without impact on the economy of a biomethane producer developing their plant.

3.3 Biomethane quality: reducing costs

Quality control is responsible for a significant part of connection costs – both in CAPEX and OPEX. Several opportunities for cost reduction were identified.

CAPEX reduction is related to the type and quantity of equipment used:

Duplication of analyzer equipment, which was identified as a current practice in several countries, for several reasons should be avoided. This goal can be achieved by sharing the analysis results between producer and gas grid owner, supported by an appropriate operational agreement that clearly establishes the duties of the analyzer's owner concerning maintenance, substitution, and legal calibration.

The type of analyzer chosen is also very important and impacts both CAPEX and OPEX. The most widely used technology to determine the energy parameters is gas chromatography. Gas chromatographs (GC) are flexible, well proven and accepted technology but are also expensive and costly to operate (in consumables and operation/maintenance).

There are other options in the market, that use completely different analytical methods – e.g. inferential methods – and have OIML R 140 certification as CVDD [5]for custody transfer. Less flexible than the GC, these instruments are usually less expensive and much simpler to operate. Depending on the application, it may be a good practice to evaluate these options.

Depending on the country, injection stations may be owned by the producer or by the grid operator. Only grid operators are in a position of accumulating know-how, standardize requirements, and establish larger and more efficient maintenance contracts that may drive costs down.

Thus, assigning the specification, acquisition, and maintenance of this equipment to the network operator presents itself as an overall more efficient option, that also facilitates the sharing of part of the associated costs through tariffs.

[5] OIML: ORGANISATION INTERNATIONALE DE MÉTROLOGIE LÉGALE INTERNATIONAL RECOMMENDATION 140: Measuring systems for gaseous fuel.
CVDD: Calorific Value Determining Devices

4 Connection cost sharing

This chapter explores the mechanisms for sharing network connection costs between biomethane project promoters and grid operators. It outlines how different countries handle these costs, highlighting significant variations in cost-sharing practices and regulatory frameworks. The chapter also discusses ongoing efforts to improve regulatory approaches in countries like Latvia, Portugal, and Italy, aiming to enhance cost-sharing arrangements and incentivize biomethane production.

4.1 Network connection cost sharing mechanisms

Connection cost sharing between biomethane project promoter and grid operator positively contributes to the project business case by passing part of the required CAPEX and OPEX to the system, through the remuneration of the asset base of the grid operator and by the acceptance of operation costs in the regulated cost set.

The process differs from one country to another. Czech Republic, Denmark, France, Germany, and Italy provide a regulated cost-sharing mechanism of the grid connection between network operator and biomethane producers. On the other hand, in Latvia, Netherland, Portugal, Spain, and Sweden all costs are borne by producers.

Table 2, in annex, summarizes the cost-sharing mechanisms in force for each country.

Cost-coverage foreseen by these mechanisms may reach 95 % in Czech Republic and are based on specific evaluation of each connection request.

Table 3, in annex, summarizes the legal, or regulatory references concerning biomethane injection.

Large heterogeneity of regulations between countries may be observed. Many countries do not have a comprehensive legal framework ruling how the regulated gas grid operator should handle requests for connection.

Countries where the cost of connection (connection pipeline and injection station) is shared between the producer and the grid operator are usually those that show a higher development of biomethane as an alternative to fossil fuels and a source of income to organic waste producers.

By sharing the cost of connection these countries bring society to contribute to the goal of decarbonizing the energy market.

Strong involvement of grid operators in the specification, acquisition, erection, operation, and maintenance of these infra-structures generally ensures economies of scale, cost control (investment validated by the Energy Regulators), limit the risk exposure of the biomethane producers, and limit the effect of geography (distance to the grid) between biomethane producers. It is therefore a more efficient global option and facilitates the introduction of cost sharing mechanisms.

Furthermore, it incentivizes grid operators to contribute to the success of the biomethane market, capitalizing on skills they already have – network development and construction, management of construction and maintenance contracts.

4.2 Improvement of regulatory framework

Latvia is currently reviewing its regulatory framework to introduce a cost-sharing mechanism similar to those described above. Latvia's TSO proposed that the expenses with metering and gas quality system be reimbursed over a period of 5 years.

In Portugal, stakeholders are discussing a cost-sharing mechanism to be proposed to the government. A political decision on this matter will need to be made before the regulatory framework can be re-examined. The recent approval of a Biomethane Action Plan, that includes many of the practices and conclusions presented in this report, may signalize a change in Portugal's policy towards renewable gases, in particular biomethane.

Italy is working on an enhancement of the current sharing mechanism consisting of indexing incentives and CAPEX share to inflation to better reflect the actual costs.

Another measure proposed by the Italian grid operators in order to boost biomethane connections is the increase of the connection discount for biomethane producers.

5 Conclusion and best practices

Biomethane production development face several difficulties which were successfully overcome in some countries, through the implementation of regulatory and, or, legislative provisions, concerning the responsibilities of the stakeholders and impacting the predictability and transparency of the sector.

The following are the main recommendations that stemmed from the best practices observed in the biomethane-leading countries in Europe.

The authors of this report believe these practices should be considered by countries with less advanced markets when developing existing or new regulatory framework concerning biomethane production and injection into the gas grid to accelerate biomethane utilization:

- A **well-defined regulatory framework** that imposes procedures, incentives, safety and environmental requirements, and timelines on connection requests. In fact, when a stable regulatory framework is in place, it allows promoters to evaluate the economics of the projects, drive the projects to scale, and exploit all ancillary revenue opportunities. The new gas package addresses this issue in the identified direction.

- **Map capacity** of both the transmission and distribution networks, defining operational zones. For each zone grid biomethane reception capacity, grid reinforcement projects, and biomethane ventures (existing and foreseen) should be mapped. TSO and DSO should participate in the effort, since some of the solutions that may be required to boost reception capacity may require investment on both grids. This tool gives grid operators, biomethane venture promoters, and regulators a clear perspective of the real possibilities to develop biomethane projects, the costs involved and investment timeline, allowing for better and more informed decisions from all stakeholders.

- Grid connection costs should be minimized by **standardizing and simplifying equipment.** This can be better achieved by concentrating specification, procurement, erection, and operation on the grid operators, that may achieve and generalize experience and are able to get economies of scale in these activities.

- **Establish cost-sharing mechanisms** between producers and grid operators that allow that part of the costs of biomethane injection be included in the tariffs charged by grid operators, on grounds of society interest for decarbonization and fossil fuel substitution.

- Consider in the regulatory framework indirect connection of biomethane plants to the grids, through **virtual pipelines**, allowing off-grid biomethane production. **Support the cost of biomethane transportation** by accepting it as a regulated cost for tariff definition.

Annex

TABLE 1 SUMMARY OF THE LEGISLATIONS IN SOME EU COUNTRIES, AS DERIVED FROM THE REPLIES TO THE QUESTIONNAIRE.

Czech Rep	Laws 459/2012, 488/2021, 108/2011 . Technical rules TPG 902 02, TDG 983 01.
France	Articles L.433-13, L.453-4 et R.453-8 du code de l'énergie Article 17 de l'arrêté du 13 juillet 2000 portant règlement de sécurité de la distribution de Gaz combustible par canalisations
Italy	Decreto Ministeriale 5 dicembre 2013 – Modalità di incentivazione del biometano immesso nella rete del gas naturale Decreto Ministeriale 2 marzo 2018 – Promozione dell'uso del biometano nel settore trasporti Decreto Ministeriale 5 agosto 2022 - Attuazione del PNRR: M2C2 I.1.4 - Sviluppo del biometano secondo criteri per la promozione dell'economia circolare - produzione di biometano secondo quanto previsto dal decreto 2 marzo 2018 DECRETO 15 settembre 2022 - Attuazione degli articoli 11, comma 1 e 14, comma 1, lettera b) , del decreto legislativo 8 novembre 2021, n. 199, al fine di sostenere la produzione di biometano immesso nella rete del gas naturale, in coerenza con la Missione 2, Componente 2, Investimento 1.4, del PNRR UNI/TS 11537 Immissione di biometano nelle reti di trasporto e distribuzione del gas naturale Procedure applicative DM 2 marzo 2018, Gestore Servizi Energetici ARERA Resolution 64/2000/R/gas , Autorità di regolazione per energia reti e ambiente
Denmark	https://energinet.dk/media/0xblryeo/app-1-quality_and_delivery_specifications.pdf
Germany	DVGW regulations G 260 / G 262, G 685
Netherlands	1-de Meetcode Gas RNB 2-Ministeriële Regeling Gaskwaliteit 3-Meetvoorwaarden Gas LNB en RNB 4-Richtlijnen beheersprotocol groengas invoedinge
Latvia	https://likumi.lv/ta/id/335532-noteikumi-par-prasibam-biometana-un-gazveida-stavokli-parverstas-saskidrinatas-dabasgazes-ievadisanai-un-transportesanai-dabasgazes-parvades-un-sadales-sistema
Portugal	Standards EN 16726 and EN 16723-1 are adopted. Decreto-Lei n.º 62/2020 Diretiva n.26/2022 – 23/12/2022 – ERSE Portaria n.98-A/2022 Decreto-Lei n.º 30-A/2022 Despacho n.º 806-B/2022 Regulamento n.º 826/2023 Regulamento da Qualidade de Serviço Regulamento n.º 827/2023 Regulamento das Relações Comerciais ISO 13686
Spain	NGTS PD-01: Gas System Technical Management Standards: Detailed Protocol 01: Measurement, quality and odorization of gas (included in Law 34/1998).

TABLE 2 SUMMARY OF THE COST-SHARING MECHANISMS APPLIED IN SOME EUROPEAN COUNTRIES FOR GRID CONNECTION OF BIOMETHANE PLANTS

Country	Level of cost borne by the network operators	Is the cost borne by network operators variable?	How costs are charged to the Producer	How costs are determined by the operator
Czech Republic	The cost is covered by the producer and then the DSO is obliged to buy out the connection plant when legal conditions are met	Variable (0-95%), depending on the complexity of the connection and the CAPEX subsidy received.	Costs are charged before construction. Afterwards, the producer will be refund	Evaluated for each project
Denmark	The cost of the connection plant is borne by the producer. Network operators pay for possible modification/upgrade of the grid	Variable, depending on the complexity of the project	The gas network can hold cost but charges the producer	Evaluated for each project
France	60% of the connection line covered by network tariffs. 40% supported by the producer. Costs for possible grid reinforcement are entirely covered by network operators, with a cap for each investment for the TSOs and an annual investment envelop for both the DSO and the TSO. The biomethane injection service (including the injection station) is paid by the producer, but through a 15-year amortization	Fixed at 60% up to 600k €, then fully charged to the producer	Costs are charged before construction. Injection service is charged quarterly.	Evaluated for each project
Germany	75% of connection costs are borne by the network operator. For up to 1 km of connection line, the operator maximum investment must be €250.000. For connection longer than 10 km, operator bears the additional costs	Variable depending on the connection distance	After commissioning the plant	Evaluated for each project according to the actual costs invested

Ireland	70% of the connection cost is covered by tariff. 30% is paid by the producer subject to an economic test.	70% subject to economic test. Economic test requires volume of gas and tariffs collected over first 10 years of operation must be equal or greater than the 70% contribution or else the producer has to pay a supplemental charge to make up the difference.	30% Capital construction cost paid by producer in advance of construction. Operations cost form part of the customers tariff, part of which is charged as an entry fee on volumes produced.	Evaluated for each project.
Italy	For connection to TSO network: the connection cost is shared between the customer (i.e. biomethane producers) and the network operator: a part of the investment ("eligible investment", proportional to the expected biomethane production), is covered by the TSO and included in the transport tariff, while the remaining part is paid by the customer. On this remaining part, a further 20% discount is applied for biomethane plants. - For connection to DSO: applied an 80/20 sharing on the connection costs between producer and grid operators (not "eligible investment" applied). In addition, producers will receive a 40% CAPEX grant form RRF funds for the construction of production plant	TSO: Variable with the eligible investment +20% discount DSO: Fixed 80-20 contribution	The payment of grid connection can be spread out over time (20 y maximum)	The starting bid is determined by the network operator according to standard unit costs. The submission occurs during the initial offer

TABLE 3 SUMMARY OF THE LEGAL REFERENCES CONCERNING BIOMETHANE INJECTION IN EUROPE

Country	Legal reference	Topic discussed
Czech Republic	Energy Act 458/2000	Legal obligation for grid operators to assess requests for gas grid connection.
	Supported Energy Act 165/2012	Legal obligation of the DSO to buy out the connection plant when the defined conditions are met.
Denmark	Gas Supply Act	Legal obligation for grid operators to assess requests for gas grid connection. Definition of the steps and costs required for the connection.
	Law of Energinet	Obligation of grid Maintenance
France	Loi n° 2018-938 – Article 94	Legal obligation for grid operators to assess requests for gas grid connection.
	Code de l'énergie L452	Cost-sharing mechanism between network operator and producer
	Articles D. 453-20 à D. 453-25 du Code de l'énergie Décret n°2019-665 du 28 juin 2019	Definition of grid reinforcement actions to facilitate biomethane injection
Germany	GasNZV – Art 33	Legal obligation for grid operators to assess requests for gas grid connection.
	GasNZV; KOV; Federal Network Agency BK9;	Cost-sharing mechanism between network operator and producer.
Ireland	• Gas Act, 1976 • Gas (Amendment) Act, 1987 No. 178/1991) • Gas (Amendment) Act, 1993 • Energy (Miscellaneous Provisions) Act, 1995 • Electricity Regulation Act, 1999 • Gas (Amendment) Act, 2000 • Sustainable Energy Act, 2002 • Gas (Interim) (Regulation) Act, 2002.	Legal obligation for grid operators to assess requests for gas grid connection.
Italy	Decreto legislativo 164/2000 Delibera ARERA n. 75/03	Legal obligation for grid operators to assess requests for gas grid connection.
	Delibera n. 64/2020	Cost-sharing mechanism between network operator and producer.

	Delibera ARERA n. 220/2023	Commitment to identify the best solutions to optimize biomethane injection in gas networks (transport and/or distribution)
	Delibera ARERA n. 131/2024	Approval of the procedures biomethane plans connections
Latvia	Ministru kabineta noteikumi Nr. 567	Legal obligation for grid operators to assess requests for gas grid connection.
Netherla	Gaswet Artikle 10 lid 6b; Gas transportation code (Artikle 2.5.1.5 and 3.1a.1)	Legal obligation for grid operators to assess requests for gas grid connection.
Portugal	Decreto-Lei 62/2020	Legal obligation for grid operators to assess requests for gas grid connection and to connect feasible projects.
Spain	Law 24/1998 (articles 54 and article 74)	Legal obligation for grid operators to assess requests for gas grid connection.
Sweden	Natural Gas Act	Legal obligation for grid operators to assess requests for gas grid connection.


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