



REGATRACE

Renewable Gas Trade Centre in Europe

Renewable GAs TRAdE Centre in Europe



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1. What is biomethane, and why should we encourage it?

Biomethane is a renewable energy source identical to “natural gas” and distributed via the gas transmission and distribution network to many businesses and households across Europe. It is made by cleaning up biogas to pure methane, and then injecting it into the network.

Biogas is produced by the biological degradation of organic biomass, primarily agricultural substrates such as manure, other agricultural by-products, cover crops (crops grown to enrich the soil), energy crops (maize, sorghum, rye, sugar beet, etc.), and organic waste from rural districts, towns and villages, such as cut grass, waste food and food industry by-products. These materials are fermented by bacteria in air-tight tanks, called digesters, producing biogas in a multi-stage process (anaerobic digestion). Biogas can also be produced through thermal gasification (syngas), while there is increasing interest in combining and

integrating biogas with hydrogen produced from renewable electricity (Power-to-Gas).

Like natural gas, the essential component of biogas that makes it a source of energy is methane (CH_4), a flammable gas. Depending on the substrate feeding the biogas plant, the methane content of the biogas can fluctuate between 50 and 65%. The second component of biogas is carbon dioxide (CO_2), which accounts for 35 to 50%. The carbon dioxide (CO_2) generated in the biogas process is considered climate neutral because the biogenic material draws it from the atmosphere for its growth. Other components of biogas are water (H_2O), oxygen (O_2), and traces of sulphur and hydrogen sulphide (H_2S). If the biogas is upgraded to biomethane – with about 98% methane – that biomethane has the properties of natural gas.



1.1. Turning waste into additional residue

The sources of feedstock for producing biomethane and biogas makes it a very good option when it comes to waste recycling, turning waste into valuable resources. Food waste or wastewater can be recovered to produce renewable energy, which also tends to support the local bioeconomy in most parts of Europe. Residues from animal farming or biomass are converted into energy, while the digestates produced are used as an organic fertiliser, creating additional business options in the farming sector.

Moreover, biomethane can help abate emissions across the whole value chain. The use of biomethane is essential in accelerating the reduction of GHG emissions in multiple sectors, including buildings, industry, transport, and agriculture.

It is estimated that more than 350 municipalities within Europe are already successfully producing biomethane from their bio-waste and reducing methane emissions from landfills, which are the second biggest source of methane emissions in the EU (the highest being from agricultural production). Besides its positive contribution to the reduction of GHG emissions, the anaerobic digestion (AD) of bio-waste produces digestate, an excellent organic soil improver. As such, biogas and biomethane form an essential part of a truly sustainable circular approach.

Biomethane production can enable EU cities and regions to develop integrated circular city concepts and make optimal use of their resources. This is essential if we are to make our municipalities more sustainable and develop local economies with more green jobs, while also safeguarding the quality of the environment and the wellbeing of their inhabitants. Biomethane is a true enabler of the circular economy: we can produce biomethane by separately recycling collected local bio-waste and thus reducing landfill; we can make wastewater treatment less expensive and more energy efficient with integrated renewable energy production; the renewable gas obtained can be used, for instance, to fuel both public transport and private vehicle fleets (once upgraded to biomethane), or provide heat or cooking gas for households and renewable power for industry.



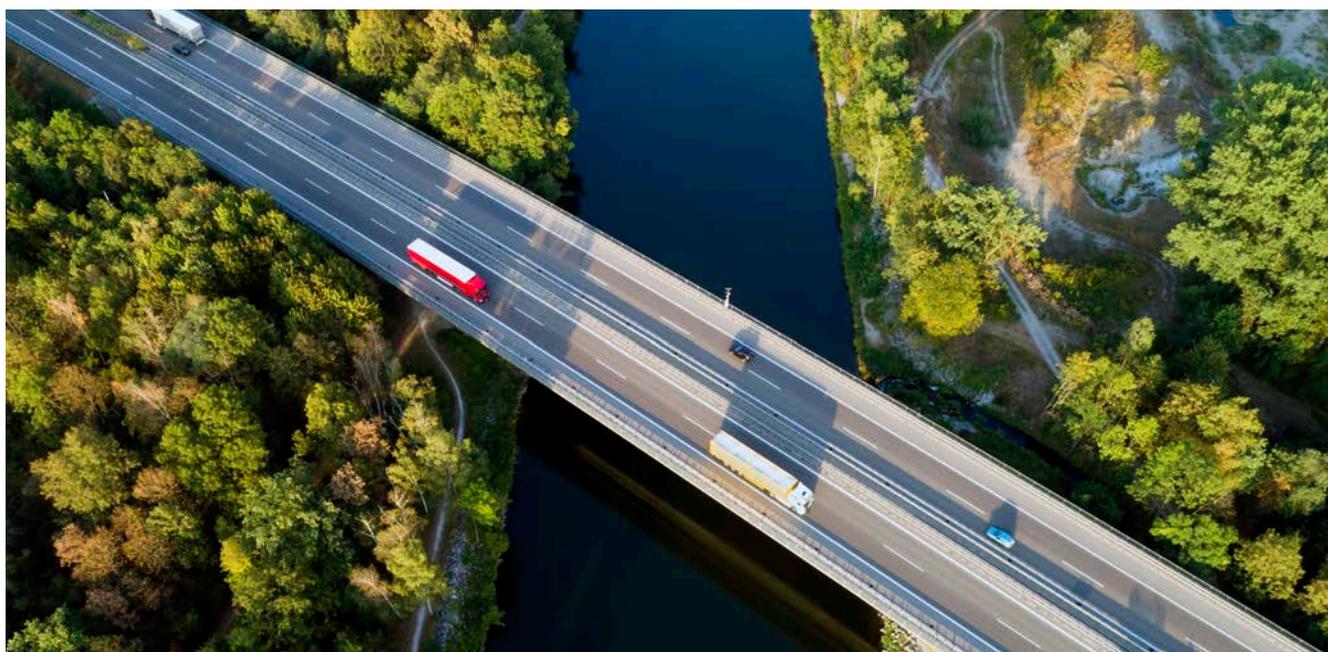
1.2. Supporting clean mobility and the circular economy

To decarbonise the transport sector in Europe, biomethane offers a unique set of benefits and constitutes a powerful weapon against climate change. Anaerobic digestion of manure and similar materials helps avoid methane emissions, which are up to 23 times more harmful than CO₂. Without biogas technology, methane is released into the atmosphere from decomposing manure and waste, such as sewage sludge, municipal waste, agro-industrial runoff and agricultural residue. While burning biomethane does emit CO₂, the amount produced is of biogenic origin, meaning it is produced by natural, biological processes, and so it has no carbon footprint. In addition, methane emissions that arise from decomposing waste that is not processed into biomethane are avoided. As a result, the total carbon footprint is very low compared to fossil fuels and can even go into negative territory.

The use of biomethane or a blend with natural gas as a vehicle fuel significantly reduces pollutant emissions, such as hydrocarbons and carbon monoxide, compared to petrol- and diesel-powered engines, and is also well below the levels of biodiesel and bioethanol. This offers an ideal way to reduce harmful emission levels in cities, which currently cause 400,000 premature deaths a year in Europe.

Biomethane use in transport also has the indirect environmental advantage of contributing towards a circular economy. In addition to energy, the anaerobic digestion process that produces biomethane also supplies digestate, a valuable organic substance that can be used as an organic fertiliser in agriculture, replacing millions of tons of CO₂-intensive mineral fertiliser. Digesting waste and repurposing it for fuel is a much cleaner alternative to landfill and incineration.

There is also increasing interest in the mixture of hydrogen and biomethane as a way to increase biomethane production in the coming years. Some countries are looking at how to develop/adapt gas distribution networks to inject biomethane and also methane/hydrogen mixtures; improving access to the grid, with a defined quality of injected biomethane/green gas.¹



¹ More details are in deliverable D6.3 “Long-term visions and roadmaps”, www.regatrace.eu/work-packages/wp6-support-for-biomethane-market-uptake/



2. Paving the way towards a European common renewable gas market

2.1. REGATRACE in a nutshell

From 2019-2022, REGATRACE (REnewable GAs TRAdE Centre in Europe) worked with 16 partners and 15 third parties from 23 countries (AT, BE, CH, CZ, DE, DK, EE, EL, ES, FI, FR, IE, IT, LT, LV, NL, PL, RO, SE, SK, SI, UA, and UK)

REGATRACE aimed to create an efficient trading system based on the issuing and trading of biomethane/renewable gases certificates/Guarantees of Origin (GO)², with the exclusion of double sales.

The founding pillars of the project were:

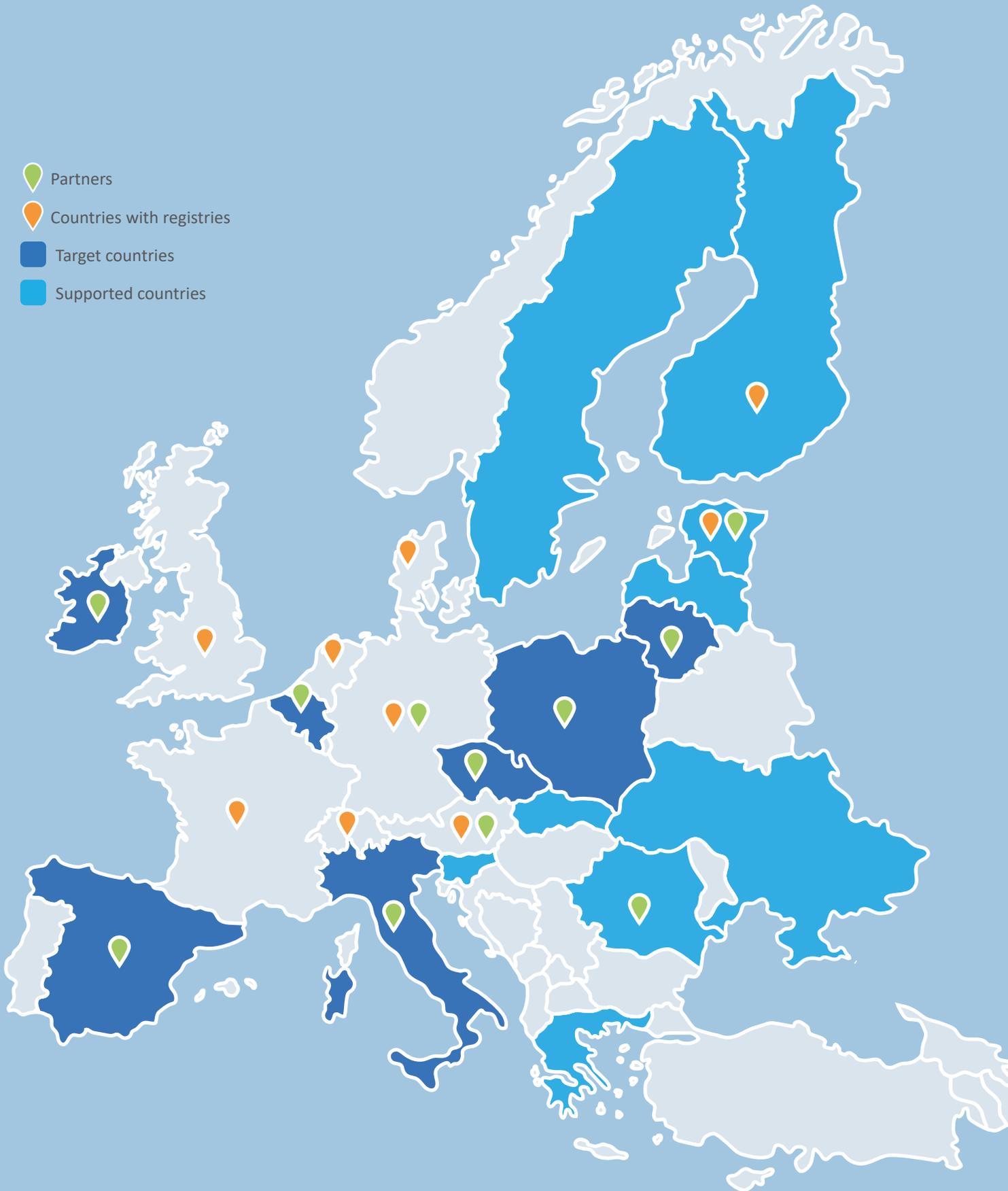
- European biomethane/renewable gases certificate/GO system
- Establishment of national certificate/GO issuing bodies
- Integration of GOs from different renewable gas technologies with electric and hydrogen GO systems
- Integrated assessment and sustainable feedstock mobilisation strategies and technological synergies
- Support for biomethane market uptake
- Transferability of results beyond the project's countries

The project helped to develop the biomethane market in target (also for the establishment of biomethane registries) and supported countries.

As an EU-funded project under the Horizon 2020 programme for research, technological development and demonstration, REGATRACE was considered, within the REPowerEU Plan, one of the reference projects on innovative solutions and research on barriers to and integration of sustainable biomethane to the gas grid.³

² Depending on the regulatory framework and the research question either GOs or both GOs and other types of renewable gas certificates are addressed

³ Commission Staff Working Document Implementing the REPowerEU Action Plan: Investment Needs, Hydrogen Accelerator and Achieving the Bio-methane Targets, SWD(2022) 230 final, 18 May 2022



2.2. State of play of the renewable gases market in Europe

Both biogas and biomethane are being produced in increasing quantities in Europe. Over the last decade, the delivery of dispatchable power and heat from biogas has been very important and its role will continue to some extent. The current trend places the emphasis squarely on biomethane production, and it is expected that this tendency will be amplified in the coming decade: biomethane is a versatile energy carrier, suitable for a range of sectors, including transport, industry, power, and heating.

In particular, biomethane production has risen from 0.5 bcm in 2011 to about 3.5 bcm in 2021. It is evident that more European countries have been clearly heading towards biomethane production in recent years. In some countries, such as Denmark, Sweden, Norway and Estonia, biomethane has overtaken biogas production. Other countries such as France, the Netherlands, Italy, Switzerland and the UK are showing the same trend of increasing biomethane production year in, year out.

Every year, more European countries are shifting incentives from biogas production to biomethane production, resulting in sustained rapid growth of the biomethane industry. The fact that existing AD-biogas plants are being converted to AD-biomethane plants highlights the flexibility of the biogas sector. An analysis on the combined biomethane and biogas production per country shows Germany is in the lead with 84 TWh, followed by the UK (26 TWh), Italy (26 TWh) and France (10 TWh). The countries with highest growth in their biomethane production in 2021 were France (+ 2,130 GWh), Denmark (+ 1,642 GWh) and Germany (+ 1,553 GWh). In absolute numbers, the largest producers of biomethane in 2021 were Germany (12,753 GWh), the UK (6,183 GWh), Denmark (5,683 GWh), France (4,337 GWh), the Netherlands (2,374 GWh) and Italy (2,246 GWh).

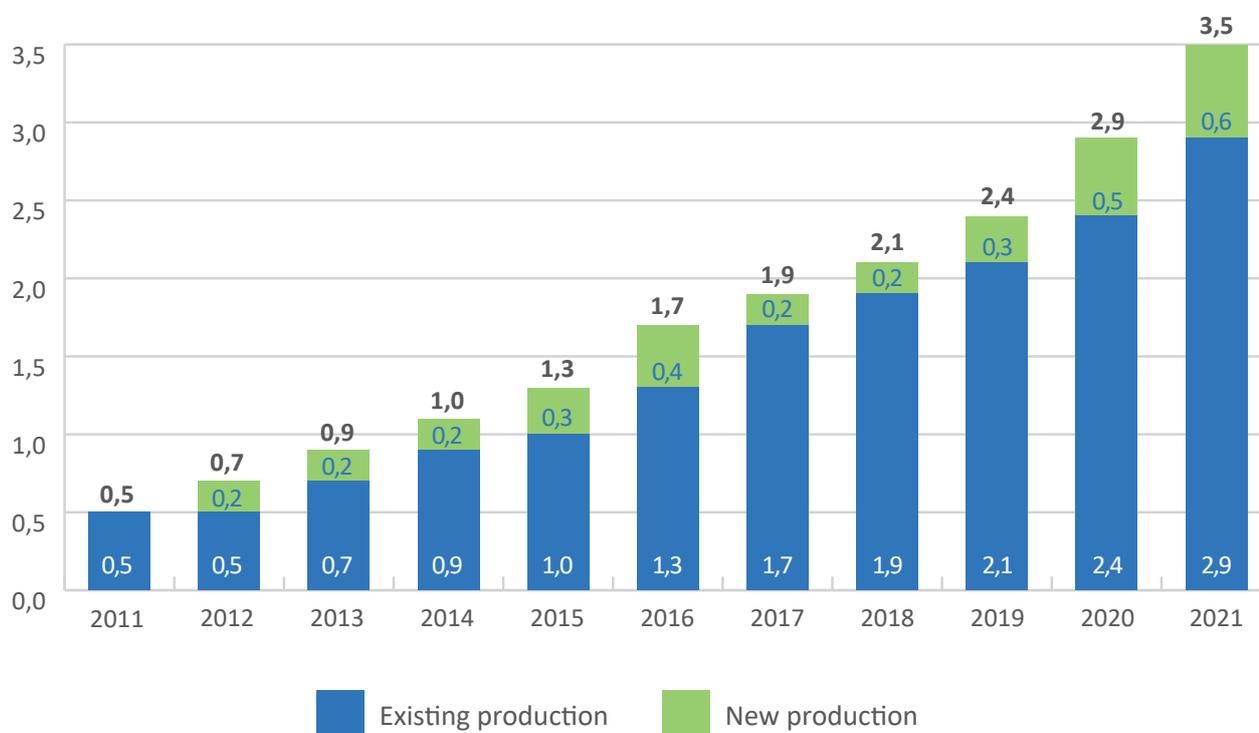


Figure 1: European biomethane production (bcm); source: EBA Statistical Report 2022

2.3. Benefiting a variety of target groups and stakeholders

The development of the biomethane market in Europe has several important benefits. The top benefit is the availability of a renewable energy source that is secure, flexible, storable and has several applications, such as electricity generation, heat production or use in the transport sector. Another benefit is the use of waste and residue streams that otherwise would be disposed of, which in turn contributes to the circular economy. The stakeholders involved in the biomethane value chain comprise the following:

1. Farmers whose waste and residues from their harvests and livestock are used as feedstock by biomethane production plants;
2. Operators of power plants benefitting from possible incentives to use biomethane for electricity and heat production;
3. Operators of wastewater treatment plants selling the biomethane resulting from their handling processes;
4. Industry replacing the use of natural gas by biomethane and decarbonising their processes;
5. Research institutions collaborating with industry;
6. Policymakers realising the benefits of biomethane for the economic, environmental and energy agendas of their country;
7. The transport sector, by replacing the use of fossil fuels with biomethane;
8. The society, benefiting from potential job creation in the biomethane sector, and from the environmental benefits of replacing the use of natural gas by biomethane.

In this regard, the knowledge and expertise developed in the REGATRACE project can be further used by policymakers to create an adequate legal framework that will quickly boost the biomethane sector in their countries, contributing not only to their energy security, but also to that of the European Union.



3. REGATRACE: paving the way to the development of the biomethane market in Europe

3.1. Long-terms visions and roadmaps

REGATRACE promoted the development of the biomethane market through the definition of shared strategic visions and roadmaps in the Target countries (BE, ES, IE, IT, LT, PL, and CZ) and in Supported ones (EL, EE, FI, LV, UA, and SI).

The first step was to identify and involve a number of key national stakeholders in dedicated Biomethane Working Groups through a participatory process. The rationale of this group was to open and maintain a communication channel across the different stakeholders and main players of the biomethane sector, with the ambition of working together in an integrated manner to define common visions and roadmaps.⁴

Then, four participatory workshops were organised in each Target and Supported country, according to a common sequence in all countries:

- The first workshop aimed to define a vision;
- The second workshop aimed to define a roadmap;
- The third workshop aimed to define a country-tailored guidance on feasibility analysis;
- The fourth workshop aimed to sum up the entire process with final results and lessons learned.

A final joint event was organised with all Target and Supported countries to share and exchange results and lessons in a cross-country perspective.

A comparative analysis of the visions and roadmaps was undertaken according to some aspects identified during their drafting, i.e., current status of the biomethane market, barriers, drivers, and main actions in future years.

The comparative analysis enabled the identification of commonalities and specific features of the different countries:

- Some countries are already producing biomethane (BE, EE, FI, IT, and ES), while others are not yet doing so (CZ, EL, IE, LV, LT, PL, SI, and UA).
- Common and specific barriers were identified: low profitability of biogas/biomethane production; technical and administrative constraints; lack of a common quality standard and of cross-border certificate trade; lack of a Guarantee of Origin (GO) system; availability of low-cost fossil fuels and differential cost with natural gas; lack of a stable and long-term regulatory and legal framework; lack of long-term incentive schemes; no natural gas infrastructure for transport; lack or limited number of methane vehicles.

⁴ More details are in deliverable D6.3 “Long-terms visions and roadmaps”, www.regatrace.eu/work-packages/wp6-support-for-biomethane-market-uptake/

- Common and specific drivers were identified: closing nutrient loops; interest in advancing nutrients; improving soil management; need of biofertilisers in the market; carbon neutrality targets; national energy self-sufficiency; vitality of rural areas; large or increasing number of filling stations; biomethane as a solution for multiple domains, i.e., agriculture, environment, agriculture, transport, employment.
- Common and specific features of visions and roadmaps were identified: implementation of several incentives schemes; setting up of a GO and certification system; appropriate legislation on waste management, nutrient recycling and energy; technical and regulatory framework for the connection to medium- and low-pressure networks; supply network with distinct biomethane distribution points; development/ adaptation of gas distribution networks to inject biomethane and also methane/ hydrogen mixtures; improving access to the grid; adjusting the electricity grid operation; strong role of public procurement policies; increased research on innovative technologies; integration with the energy systems, especially where electrification is not possible.⁵

⁵ REGATRACE Deliverable D6.1.

3.2. Europe and country profiles



Europe – EBA

The biomethane sector at a glance

There were 1,067 biomethane-producing facilities in total in Europe at the end of 2021. Biomethane production in Europe in 2020 reached 31 TWh or 2.9 bcm, and this figure grew to 37 TWh or 3.5 bcm in 2021, an increase of 20%. Out of this 3.5 bcm of biomethane, 2.8 bcm was produced in the EU-27, and 0.7 bcm represents the combined production of the United Kingdom, Norway, Switzerland and Iceland.

Development of the biomethane sector

Europe's biomethane production has enjoyed remarkable growth in the last decade, and 2021 saw the biggest year-on-year increase so far, with an additional 6.1 TWh or 0.6 bcm of biomethane production versus 2020. An even bigger increase is expected for 2022, as a record number of new biomethane plants started production in 2021 and are due to become fully operational by the end of 2022. Europe's total biomethane production in 2021 amounted to 37 TWh or 3.5 bcm. Figure 2 shows the split in biomethane production between the EU-27 and the additional European countries (United Kingdom, Norway, Switzerland and Iceland).

There were 1,067 biomethane-producing facilities in total in Europe at the end of 2021. This represents an additional 184 plants versus 2020, making 2021 the year with the biggest increase in biomethane plants to date. 2022 is expected to see even faster growth, as there are already 155 biomethane plants known to have started operations by September 2022 (source: EBA database). On top of that, in France alone, a further 1,149 projects are at various stages of development. Italy is also expected to launch a significant number of new plants in 2022 and thereafter.

The way ahead: goals/objectives and the future vision of the biomethane sector

Most studies reach similar conclusions regarding potential biogas and biomethane production by 2030 and 2050. There is consensus that by 2030, the biogas and biomethane sectors combined can more than double production, from 18.4 bcm in 2021 to approx. 35-45 bcm in 2030. By 2050, production can increase at least fivefold from today's production levels, with production of up to 95-167 bcm. The European Commission's REPowerEU Communication and Action Plan includes the need to promptly scale up the production of biomethane to reach 35 bcm in 2030 and to create the preconditions for a further ramp-up of its potential by 2050, in order to increase EU energy security. According to the Gas for Climate study "Biomethane production potential in the EU", the countries with the highest 2050 production potential are France (22 bcm/year), Germany (22 bcm/year), Spain (20 bcm/year) and Italy (14 bcm/year).

The potential production range calculated to be achievable by 2050 (95-167 bcm) is significant, as EU gas consumption was 412 bcm⁶ in 2021. The 2050 production potential thus represents 23-41% of the EU gas consumption in 2021. Assuming reduced total gas demand in 2050 of 271 bcm⁷, it is estimated that biomethane will be able to cover 35-62% of gas demand by 2050.

Furthermore, research and innovation can unlock additional biomethane potential. The anaerobic digestion of algae is currently being researched, and the REPowerEU plan has announced additional funds to explore the biomethane potential of biomass from marginal and contaminated lands as well as from seaweed. Renewable methane produced from combining biogenic CO₂ captured during biogas upgrading and renewable hydrogen can furthermore contribute additional potential.

⁶ https://energy.ec.europa.eu/system/files/2022-04/Quarterly%20report%20on%20European%20gas%20markets_Q4%202021.pdf

⁷ The Gas for Climate report "Gas Decarbonisation Pathways 2020-2050" considers gas demand to be 2,880 TWh (equal to 271 bcm) by 2050

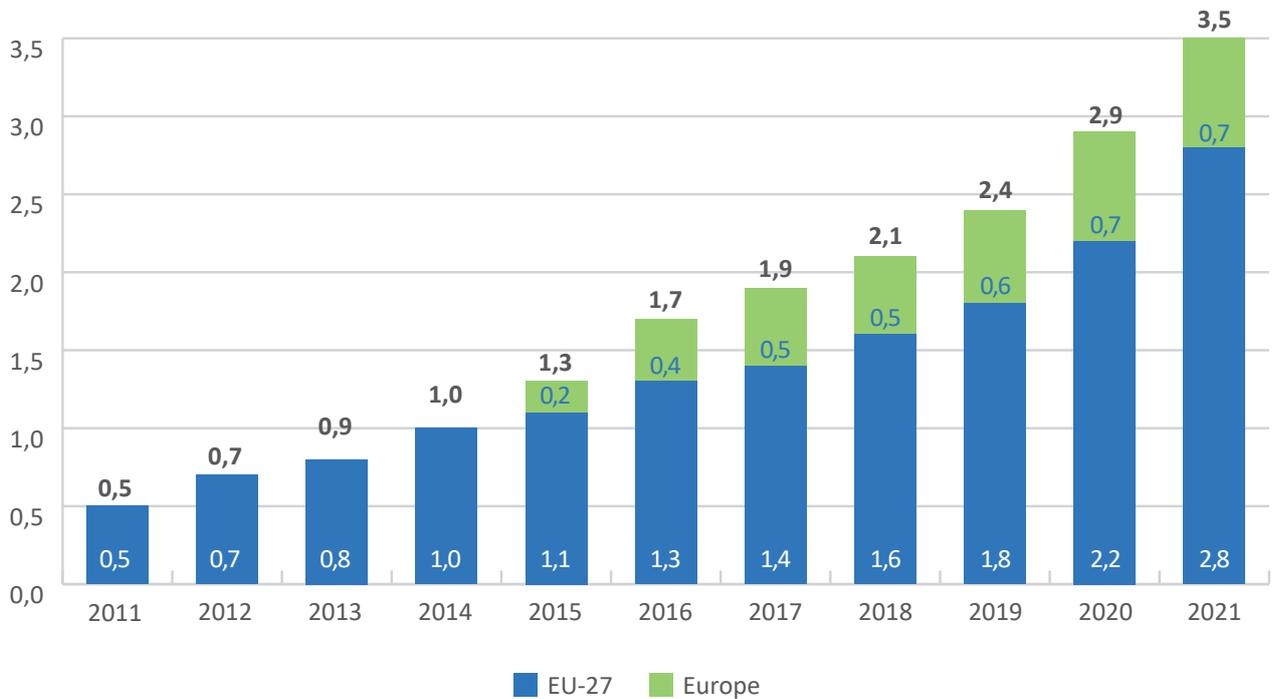


Figure 2: European biomethane production in EU-27 and Europe (bcm); source: EBA Statistical Report 2022



Belgium – Fluxys

The biomethane sector at a glance

By the end of 2022, around 200 GWh/y of biomethane will have been injected in the gas grids by three plants in Flanders and three in Wallonia. It is expected that another 100 GWh/y will become operational in 2023. Biomethane injection is only supported in Wallonia when it is used in Combined Heat and Power (CHP). This mechanism will end for new plants as from 2023. In Flanders, there is a support mechanism in place for local biogas CHP, but not for biomethane.

Development of the biomethane sector

By 2025, three new projects (with injection between 1000 – 5000 m³(n)/h) are planning to come on-line in Flanders. In the absence of support, their sales will be targeted at the biofuel market. In this respect, two of these projects are assessing the possibility of liquifying the biomethane locally to bio-LNG. Currently, 2.6 TWh of biogas (2 TWh Flanders) is still

used to produce green electricity in local CHP. In Flanders, around 70 of those plants (1.4 TWh/y) are reaching the end of their support. They could simply convert to biomethane whilst financing an upgrade facility, knowing that the gas grid is very dense, and connectivity should not be an issue.

The way ahead: goals/objectives and the future vision of the biomethane sector

In Wallonia, the government plans to investigate the broader deployment of biomethane and how to implement this, while in Flanders, the focus remains on production of renewable electricity from biogas in local CHP. From this perspective it is uncertain that – of the 15 TWh/y potential feedstock in Belgium (injectable today) – more than 5 TWh/y will be produced by 2030. It remains very much to be seen if biomethane will be injected in the gas grid or locally liquified into bio-LNG.



Czech Republic – CzBA

The biomethane sector at a glance

With its biogas production of 0.66 MWh per capita, the Czech Republic is one of the top biogas-producing countries in Europe and along with a well-developed high density natural gas grid distribution system in place, the country has considerable potential for biomethane production and its use. The bulk of its biogas comes from energy crops, however, and the biogas is used in CHP production, while heat is often wasted, making its efficacy questionable. The biogas field therefore needs to be modernised and transformed towards more sustainable feedstock usage and better energy use, where biomethane should play a major role. At the moment, biomethane production is practically non-existent in the Czech Republic, with the exception of one biogas plant and one wastewater treatment plant.

Development of the biomethane sector

Legislative barriers have been the main reason for the Czech Republic lagging behind in the development of the biomethane sector. Currently, there is no legislation that would define, regulate and support biomethane. Obsolete decrees regulating the natural gas industry have made it very difficult and sometimes impossible to inject biomethane into the gas network. In November 2019, the Czech Republic's National Energy and Climate Plan brought biomethane into the frame and highlighted its benefits when used in the field of heat industry and transport.

The way ahead: goals/objectives and the future vision of the biomethane sector

Rapid growth is expected in biomethane field, once the legislation is clear and settled. It is mainly large cities, such as Prague and Brno among others, that are planning to build new biomethane stations. Wastewater treatment plants with anaerobic sludge stabilisation will most probably switch to biomethane production about five years earlier than agricultural biogas plants due to the end of operational support for electricity generation. Specialised industrial biogas plants will produce biomethane from waste and by-products that arise in the production of food,

animal feed or in the processing of vegetable and animal oils and fats. The biggest challenge for the future is definitely to set the right conditions for the conversion of agricultural biogas plants that produce electricity into modern sources that will process more waste and produce biomethane from biogas.



Estonia – Elering

The biomethane sector at a glance

Biomethane production in Estonia started in 2018, with an annual quantity of 39.993 GWh in the first year. This has increased since then, reaching 63.080 GWh in 2019, 97.408 GWh in 2020 and 152.352 GWh in 2021. A national biomethane registry has been in operation since 2018 for the issuance, transfer and cancellation of biomethane Guarantees of Origin, as well as the submission of biomethane production subsidy applications.

Development of the biomethane sector

There are currently six biomethane producers in Estonia, producing gas from sewage sludge, animal manure, food industry waste, other biowaste and biomass. All biomethane produced in Estonia is consumed in the transport sector. There have been multiple support schemes available over the years to enhance biomethane production and consumption. For biomethane producers, there is a production support scheme in place, under which producers can receive a subsidy after their production has been consumed in line with the natural gas market price. A transport sector offsetting platform has been developed to replace the administrative production support scheme with a market-based solution, in order to increase the value of biomethane Guarantees of Origin and promote biomethane consumption in the transport sector. Additionally, there is a subsidy scheme to support biomethane introduction in the public transport service and to open new biomethane stations. As a result, public transport is running on biomethane in four areas, creating a market demand for it. Also, the number of CNG stations in Estonia has increased from just a handful to 24 in total, of which 15 have received the subsidy.

The way ahead: goals/objectives and the future vision of the biomethane sector

Estonia's 2030 National Energy and Climate Plan published in December 2019 set an objective to fulfil the transport sector target of 14% renewable fuels as a percentage of the total fuels consumed in the transport sector, with domestic biomethane producing up to 340 GWh of biomethane annually.



Finland - Suomen Biokaasuyhdistys ry

The biomethane sector at a glance

Finland was home to 23 biomethane plants by the end of 2021. Total biomethane production in that year amounted to 156 GWh. Finnish energy and climate strategies promote biomethane particularly for use as transport fuel. In 2021, almost all biomethane produced in Finland was used in the transport sector. From 2022 onwards, biomethane is part of the national biofuel delivery obligation along with other types of transport fuels, which is expected to provide a stable outlook for increasing biomethane production and use until 2030.

Development of the biomethane sector

The Finnish biomethane sector has seen significant and consistent growth over the last decade, with the number of biomethane plants in Finland rising from 1 plant in 2011 to 23 in 2021. Similarly, Finnish biomethane production increased significantly in the same time frame, reaching 156 GWh in 2021.

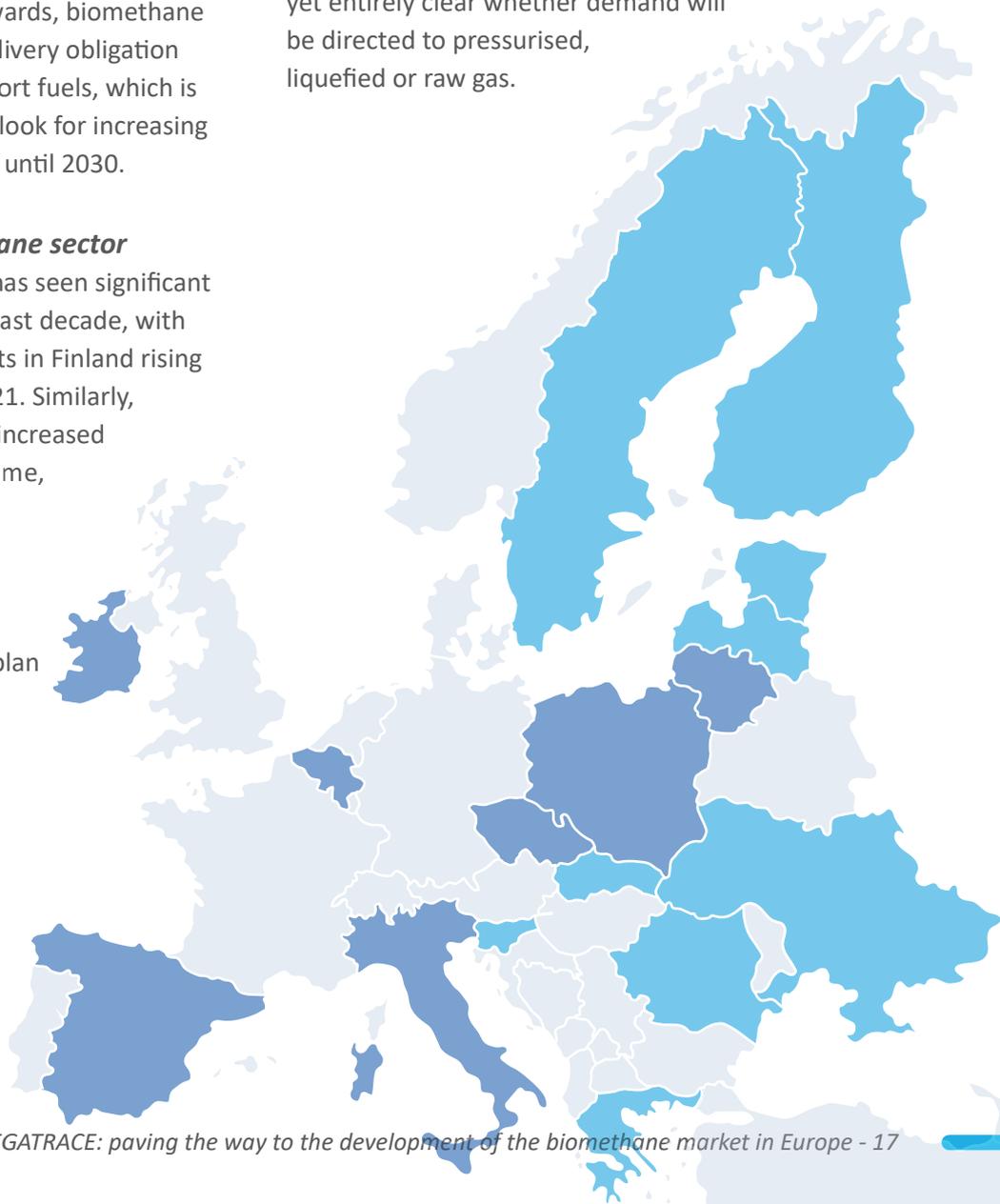
Growth is expected to continue under the auspices of Finland's national biogas action plan, published in January 2020. The plan outlines the measures that will underpin the sector up to 2024 and was drafted in collaboration with all the relevant ministries and stakeholders. Demand for biomethane in the transport sector is the main growth driver and will continue to grow as, starting from 2022, biomethane is part of the national biofuel

delivery obligation. Additionally, the Finnish biogas association expects industrial demand for biomethane to grow.

Off-grid biomethane production plays a vital role in Finland, as only the southern part of the country has a gas network. For the same reason, LNG terminals are also central to Finland's gas infrastructure. Of the 23 active biomethane plants in Finland, six are connected to the grid and 17 operate off-grid. In 2020, around 40% of the biomethane produced in Finland was injected into the gas grid.

The way ahead: goals/objectives and the future vision of the biomethane sector

The Finnish Biocycle and Biogas Association (Suomen Biokierto ja Biokaasu ry (SBB)) estimates that growth in biomethane production will continue in the coming years (and reach 4-11 TWh in 2030). Demand for transport biogas is the main growth driver of biomethane production. Industrial demand is also expected to grow in the coming years, but it is not yet entirely clear whether demand will be directed to pressurised, liquefied or raw gas.





Greece - Hellenic Association of Biogas Producers

The biomethane sector at a glance

In 2021, Greece had 78 operational biogas units with a total capacity of 84 Mw. According to the existing legislative framework in Greece, the use of biogas is intended exclusively for electricity production. For 2021, the total production of biogas units, excluding those in landfills and sewage treatment centres, amounted to 148.9 GWhe, with a total exploitation of only 52% of the installed power on average. There is no biomethane production in Greece or any kind of infrastructure dedicated to biomethane except for natural gas infrastructure. Moreover, there is no institutional framework for the production, distribution and marketing of biomethane. The installed biogas plants (excluding landfill and sewage treatment centres) could still receive at least another 1,000,000 tn of organic waste and double their production immediately to offer 375 GWh of biomethane.

Development of the biomethane sector

An institutional framework is expected. In the meantime, the existing biogas sector needs extra support for 2022 (increased feed-in tariff for electricity), since many are no longer viable and are reducing their capacity.

The way ahead: goals/objectives and the future vision of the biomethane sector

Biomethane produced, upgraded and purified according to the national specifications can be injected to the grid, and the existing Greek gas distribution infrastructure can support the biomethane injection. Moreover, Greece has a significant potential for the production of biomethane from raw materials such as organic municipal waste and liquid municipal waste, livestock waste, agro-industrial waste and agricultural residues. Greece seems to have a total exploitable potential of 626 million m³ of biomethane, and thus reaching production of 400 million m³ of biomethane by 2030 is realistic. However, a strong political framework needs to be established so that the national biogas sector can be developed through a fruitful dialogue between the various stakeholders (producers, users, decision-makers, distribution grid operators and others).



Italy – CIB

The biomethane sector at a glance

With approximately 2,000 anaerobic digestors, Italy is the second largest European market in biogas production after Germany. For the moment, Italy's biogas plants, with installed capacity of 1,400 MW, are producing almost exclusively renewable electricity production.

By 2027, most of them will reach the end of the current FiT-based support scheme for electricity generation from renewable energy. To ensure a future for existing plants, the Italian government plans to facilitate the conversion (upgrading) of existing biogas plants to biomethane ones, rather than introducing a new incentive for electricity generation.

Currently in Italy there are 35 biomethane plants, with a production of 350 Mm₃/y, but the number is growing rapidly. By the end of 2022, Italy will have 10 bio-LNG plants, with a further 15 forecast in 2023.

Development of the biomethane sector

Currently in Italy, the sector benefits from incentives through two decrees:

- Decree of 2 March 2018, which will remain in force until 31 December 2023. It has a production limit of 1.1 billion cubic meters of biomethane per year and gives subsidies only if the biomethane is used in the transport sector. The biomethane promotion scheme is based on the allocation of certificates of release for consumption, better known as «CIC», to be provided to parties that release non-renewable fuels for consumption. The number of CIC that these parties are obliged to hold must be sufficient to cover the share of energy corresponding to the obligation to release non-renewable fuels for the consumption of biofuels, which is determined every year.
- Ministerial Decree no. 340 of 15 September 2022, which aims to promote investments in new plants or reconverted plants (from biogas to biomethane), and encourage the development of this renewable gas and its

injection into the national gas grid for use also in sectors other than transport (e.g. heating for industrial, tertiary and residential sectors). The introduction of the new scheme provides innovations and extensive modification on multiple lines and specific new incentives, such as feed-in tariffs and Guarantees of Origin.

The way ahead: goals/objectives and the future vision of the biomethane sector

An overall production target for biomethane of around 3 bcm/year has been set, and should be achieved by 2026. Thanks to this number, Italy will become a world leader both for the number of bio-LNG plants installed and for the production of liquified biomethane.



Ireland – RGF1

The biomethane sector at a glance

In 2021, Ireland had 31 biogas plant for a production of 482 GWh, with one demonstration facility injecting 4,972 MWh of biomethane into the grid. The current status of biomethane in Ireland is that the Climate Action Plan 2021 for the first time recognises biomethane as a zero-emissions gas that can contribute to decarbonising key sectors of the economy and is essential to delivering net-zero targets.

The potential of sustainable biomethane production in Ireland is for 9.5TWh, providing for significant opportunities to decarbonise difficult-to-decarbonise sectors of agriculture, transport and thermal demand.

Development of the biomethane sector

The Climate Action Plan 2021 recognises the role of biomethane in decarbonising sectors of the economy, including electricity, buildings, agriculture and industry. The National Energy and Climate Plan (NECP) is currently being reviewed, with a target for biomethane revised from 1.6 TWh to 5.7 TWh by 2030. This will mean a significant ramping-up of the industry from near-zero biomethane production to 180-200 AD biomethane plants by 2030, which will require incentives and financial supports to achieve this target.

The way ahead: goals/objectives and the future vision of the biomethane sector

There are opportunities and potential to develop a robust biomethane industry in Ireland, which can contribute significantly to the decarbonisation and climate change agenda. The goals are to develop a robust indigenous biomethane industry, which can deliver on the decarbonisation agenda, collaborating and co-ordinating the implementation and development of the industry at scale, promote clustering with economies of scale, and work closely with industry and government on agreed targets for biomethane, with appropriate and sufficient funding resources to achieve the 2030 and 2050 targets.



Latvia – Latvian Biogas Association

The biomethane sector at a glance

Latvia has 58 biogas plants, with a production of 298.4 GWh in 2019, while there is as yet no biomethane production. One biogas plant started producing biomethane in 2020, while several other plants plan to start biomethane production in 2023/2024.

Development of the biomethane sector

Over 2022, significant changes have taken place on the way to launching biomethane production. The parliamentary National Economy Commission accepted amendments to the Energy Law to hand over the mandate for the TSO and the responsible organisation of the GO system, to be developed by July 2023. The Technical Regulations on injecting biomethane into the pipeline have also been adopted. Work is under way on the support programme for installers of biomethane equipment.

The way ahead: goals/objectives and the future vision of the biomethane sector

To ensure a stable market in the next steps, the desired use of biomethane should be defined, taking into account criteria to ensure the socially and environmentally responsible use of biomethane. Targets for biomethane production and local consumption should also be defined. The Ministry of Economy included the goal of 10% of biomethane in its operational plans.



Lithuania – Amber Grid

The biomethane sector at a glance

In Lithuania, there are 41 biogas plants, with a heat capacity of 9.5 MW and electricity capacity of 33.4 MW. However, there is as yet no biomethane production. In 2021, EUR 15 million for eight new biomethane production plants or biogas upgrading facilities were distributed under the National Climate Change programme. For 2022-2027, the Recovery and Resilience Facility (RRF) is expected to provide investment support of EUR 22 million for biomethane plants.

Lithuania's national Climate Change Plan sets the goal for 2030 at 5.2% biomethane and green hydrogen in the final fuel mix for transport. The Ministry of Energy has set a target of 950 GWh biomethane consumption in the transport sector by 2030. The country also sees the potential of biomethane in other sectors, for example the ETS system.

Development of the biomethane sector

In Lithuania, two biomethane plants will be connected to the distribution and transmission network in 2023. It is expected that in 2025, five biomethane plants will be connected to the gas transportation system, with annual production of 682 GWh/y. Based on several studies, the total potential biomethane production in Lithuania is seen between 2.2 – 2.6 TWh/y.

The way ahead: goals/objectives and the future vision of the biomethane sector

Over the long term, the biomethane sector is seen as competitive and integrated into the renewable energy system, which ensures the sustainable implementation of the national Climate Change Plan and creates value for the country's economy. It is based on:

- the sustainable implementation of the national Climate Change Plan, with 1 TWh produced biomethane in Lithuania in 2030;
- the creation of value for the country's economy, through new jobs, capital returns, taxes paid, the export of know-how;
- the integration into the European GO exchange system.



Poland – UPEBI

The biomethane sector at a glance

At present, there are around 350 biogas plants, including 130 so-called agricultural plants, with an installed capacity of 250 Mwe. There is no biomethane production in Poland as yet. However, the country has a large raw material potential (estimated at around 1 bcm in 2030).

Development of the biomethane sector

By 2030, biomethane is expected to account for 10% of the gaseous fuels market, with 100 biomethane installations. By 2050, this could be increased to a 30% share, with 300 biomethane installations. To achieve the goals defined in the vision, all the stakeholders in the biomethane chain will need to cooperate.

The way ahead: goals/objectives and the future vision of the biomethane sector

There are no biomethane plants in Poland, mainly because work on biomethane legislation is still in progress. There are over a dozen projects ready for implementation, but investors are waiting for the legislation and support system. The development of the market will be based on:

- transparent and reliable legislation;
- reduction of administrative and bureaucratic barriers;
- close and friendly cooperation among gas network operators;
- promotion and raising awareness among decision-makers and potential investors;
- education on all levels.



Slovenia – GOSPODARSKA ZBORNICA SLOVENIJE

The biomethane sector at a glance

In 2021, there were 24 biogas plants, producing power of 87.9 GWh. There is currently no biomethane production.

Development of the biomethane sector

There are plans to produce biomethane in future (one for 1.2 million m₃ of biomethane per year). It is expected that production and injection into the natural gas network could be started by the end of 2023.

The way ahead: goals/objectives and the future vision of the biomethane sector

The Slovenian biogas sector has potential in terms of both the availability of raw materials and the demand for biogas. Well-designed and targeted policy instruments could speed up development: profitability can be improved with subsidies, and demand for end-products can be increased with various incentives. Incentive schemes should be made more predictable and long-term to encourage new investments.



Spain – NEDGIA

The biomethane sector at a glance

There are currently five biomethane plants in Spain injecting into the gas grid (covering more than 100,000 km). Spain's total biomethane production in 2021 amounted to 100 GWh.

Development of the biomethane sector

There is a strong interest in the development of the biomethane market: the industrial sector is asking the Spanish government to approve support mechanisms for renewable gas and its injection into the gas grid.

Some interesting developments:

- the last four biomethane plants were commissioned in 14 months;
- private investments in biomethane production plants focus on the EU market;
- Royal Decree 376/2022 (17 May 2022) – Guarantees of Origin for renewable gases defines the Ministry as the entity responsible for GOs in Spain. ENAGAS GTS was appointed as the responsible entity on a temporary basis. GTS assumes the development of the system and its operation. The Ministry may eventually require the transfer of the IT tool.

The way ahead: goals/objectives and the future vision of the biomethane sector

The objective of the sector is for biomethane to reach a 10% share of gas consumption by 2030 (around 30 TWh of biomethane). To do so, establishing a reasonably stable regulatory framework and long-term foresight to attract investment and foster both the supply and demand sides is key. In addition, there is an urgent need to implement a system of biomethane Guarantees of Origin, including information on compliance with sustainability criteria and the reduction of greenhouse gas emissions in the production process of biogas, where appropriate. The implementation of appropriate policies to make better use of energy potential for biomethane producers, prioritising biomethane injection into the grid, is also a key element for the development of the biomethane sector.



Ukraine - Bioenergy Association of Ukraine

The biomethane sector at a glance

By the end of 2021, there were 77 biogas plants. Around 260 million m₃ of biogas were produced in that year. While biogas production in Ukraine is still stimulated by feed-in tariffs (green tariffs) for electricity, almost all biogas is used for electricity generation. As of now, there is no biomethane production in the country.

Development of the biomethane sector

The new Law of Ukraine adopted at the end of 2021 demands that the Cabinet of Ministers of Ukraine (CMU) ensures the adoption of the procedure for the operation of the Biomethane Register within six months from the date of this law entering into force.

The CMU adopted a special Biomethane Resolution in July 2022. This document regulates the functioning of the Biomethane Register, and stated that the State Energy Efficiency Agency of Ukraine must launch the Biomethane Register within six months. Several Ukrainian biogas producers have already announced their plans to switch to biomethane production. The first operational biomethane projects are expected in 2023. According to expert estimates, Ukrainian biomethane production could reach 1.0 bcm in 2030.

The way ahead: goals/objectives and the future vision of the biomethane sector

The next steps for the development of the Ukrainian biomethane sector are as follows:

- development of the Ukrainian Biomethane Register and cooperation with similar Registries of EU countries to ensure the possibility of exporting biomethane;
- conversion of existing biogas plants to biomethane production;
- adaptation of the Ukrainian gas system for biomethane delivery using a zoning approach;
- preparation and conducting of a wide communication campaign to raise consumers' awareness of the advantages of biomethane;
- international cooperation within the Biomethane Industry Partnership.

The mid-term actions may include the target and legislative incentives to promote the use of biomethane in the transport sector, tightening the regulatory framework for nutrient recycling, developing and adapting the roadmap for bioenergy including biomethane by 2050 and the Action Plan until at least 2035, and expansion of the bio-CNG and bio-LNG distribution network, etc.

4. Advances in biomethane trading systems

4.1. General introduction to Guarantees of Origin

Tracking consignments of biomethane and other renewable gases (e.g. green hydrogen) is especially challenging when transported through the natural gas grid. After injection into the grid, the renewable gas molecules blend with those of natural gas, making it impossible to physically trace them. In addition, the definition of the origin, quality and quantity of renewable gases had not been requested by European legislation before the publication of the Renewable Energy Directive Recast (RED II), which extends the purpose of Guarantees of Origin to gaseous energy carriers such as biomethane and green hydrogen. According to this Directive, a Guarantee of Origin is defined as an electronic document which has the sole function of providing evidence to a final customer that a given share or quantity of energy was produced from renewable sources. Moreover, according to article 19, RED II, only certificates issued under the supervision of

governments or by officially designated issuing bodies can be called Guarantees of Origin (GO). In this regard, the biomethane/renewable gas certificates (GOs if compliant with article 19, RED II) contain all information concerning the injected biomethane/renewable gas volumes, including their green intrinsic characteristic. Furthermore, Article 19 RED II specifies the purpose of GOs to be purely for demonstrating to final customers the share or quantity of energy from renewable sources in an energy supplier's energy mix. GOs serve only for consumer disclosure, which means that the "green gas" attribute is separated from the gas physical volume. This model is called "book and claim" and is useful for setting the path to the European biomethane market because the GOs help document the volumes being produced, distributed and consumed.

The centrepiece of a GO is its attribute list, which provides information about the renewable gas product on three levels (installation, quantity and quality). This attribute list must clearly describe the type of gas being consumed by the end user and shall not change during the lifetime of the GO. In this regard, issuing bodies must assure, with sufficient measures in place, that they can avoid any possible risk that a market player could change the attributes of a GO being traded. Such risk can be mitigated by the establishment of an electronic registry that can store the information of the gas volumes produced, issue the respective GOs, and then offer them to be transferred among issuing bodies within the same territory or even internationally between EU member states. The transfer on the national and international levels requires the harmonisation of the attributes of the GOs. According to Article 19 RED II, such minimum attributes shall include the following:

- the energy source from which the energy was produced, and the start and end dates of production;
- the energy carrier to which it relates (in this case, gas or hydrogen);
- the identity, location, type and capacity of the installation where the energy was produced;
- whether the installation has benefited from investment support and whether the unit of energy has benefited in any other way from a national support scheme, and the type of support scheme;
- the date on which the installation became operational; and
- the date and country of issue and a unique identification number.

Renewable gas GOs may also have additional optional attributes that can provide essential insights for transparency reasons and potentially increase their monetary value. Even though these data fields are optional, they shall not be deleted during the transfer process because that would violate the immutability principle and could lead to illegal practices. Such data fields could provide information such as:

- mode of transport from the production unit;
- information on the share of each processed biomass feedstock;
- GHG emissions caused by the production of the gas volumes.

However, harmonisation is not only needed for the attributes but also for the issuance, transfer and cancellation of the GOs. In this regard, article 19 (6), RED II clearly indicates that member states and designated competent bodies shall ensure that the requirements they impose for GO issuance, transfer and cancellation comply with CEN Standard EN16325. This standard is currently being revised and its aim is to harmonise the aforementioned activities related to GOs, such that the mechanisms put in place by member states are accurate, reliable and fraud-resistant. In addition, CEN Standard EN16325 harmonises the attributes on a GO, thus facilitating its cross-border transfer.



4.2. Accelerating the set-up of electronic registries for renewable gas certificates in member states

The development of a biomethane market is complex and requires professional experts and tools in order to not only establish trust in the market, but also expand production. Some of these requirements include, but are not limited to, building further production facilities, increasing biomethane production, tracking biomethane via a renewable gas registry and bringing the product to market level. The registry has a responsibility towards market participants to be a neutral and trustworthy platform for biomethane/renewable gas certificates.

With its characteristics of being a flexible energy carrier, biomethane can be applied to a broad set of marketing paths (renewable electricity, renewable gas for heating and cooling, transport sector, etc.). Such different marketing paths require specific characteristics from the biomethane product. Not only the different end uses, but also the different types of renewable gases (biomethane, bio-syngas, green hydrogen) will be part of an integrated renewable gas market and should thus also be covered by a registry system.

Target countries constantly implemented the requirements of RED II during the REGATRACE project. A cornerstone of renewable gas documentation is the setting up of an issuing body, in accordance with article 19 of the aforementioned directive. This shall provide evidence for final consumers on the renewable gas volume. An electronic registry system is the common basis for this kind of documentation, already known from the electricity sector.

Moreover, biomethane registry systems can provide additional value to accelerate the use of renewable gases. Therefore, REGATRACE consortium members have developed practical guidelines covering the targets, functions and tasks of a national registry. Some of these include:

- providing harmonised and transparent electronic documentation of biomethane/renewable gas consignments;
- generating confirmations for the volumes of renewable gas included in the scope of their activities (e.g.: upgraded biogas, renewable gases from PtG technology, biomethane from biomass gasification, etc.). This can be done through different categories of certificates, such as Proofs of Origin (PoO), GOs, sustainable information and others;
- certificates issued by the registries, which may have different functions, value and relevance under different bodies of legislation. All of them serve as proof of a certain quality and quantity of the produced biomethane/renewable gas volume. At any point in time, a gas certificate only belongs to one owner and always has a unique ID number. Transfer of ownership (title transfer) is feasible within the registry. In the event that different biomethane volumes are requested than that represented by one specific certificate, splitting a certificate is a valuable option. The registry provides a secure platform



for market participants to transfer their certificates or split them to provide specific volumes and cancel those certificates within the registry after final consumption;

- the registry may document final consumption by providing proof of withdrawal, for example a registry extract, to the owner of the biomethane. After consumption, the certificate is cancelled within the registry to prevent multiple use of certificates;
- controlling, auditing, verification in relation to both injection and withdrawal;
- supporting national authorities, services in data management in relation to renewable energy quotas and support schemes;
- serving as a “lighthouse”, a knowledge centre for project developers, providing a platform for information exchange on topics related to renewable gases;
- providing input in addressing country-specific policy issues in relation to renewable gases (such as meeting European and national renewable energy targets);
- connecting the biomethane and natural gas industries;
- facilitating the market introduction of new products and contributing to the use of renewable gases;
- participating in the European network of national biomethane/renewable gas registries with the purpose of promoting the cross-border trade and the development of this sector in Europe.

Several member states were appointed as issuing bodies for renewable gases during the project’s lifetime. Some of those countries started quickly implementing a registry system as well. Thanks to the REGATRACE project, the professional experts of the consortium had the opportunity to provide several tools to those organisations in order to include fundamental and specific requirements of a biomethane registry system, from the high-level design to specification, tendering process, and implementation.

Energy prices in 2022 require the expansion of renewable gas production to cope with the limited supply through existing cooperation and infrastructure. Those volumes will be necessary for the decarbonisation of various end-use sectors such as heating and cooling, electricity production, the transport sector and industrial processes. Registry operators and their systems are responsible for the proper documentation of gas volumes. The international exchange of gas certificates must be considered when developing a registry system. Such international trade needs organisational, technical and legal agreements between the registries involved. European platforms have been established and will be a major driver of further integration on the European gas market. These challenges are well acknowledged by the REGATRACE consortium and have been communicated professionally with proper deliverables to countries that have not yet established a registry, are in the process of developing one or that established one during the lifetime of the REGATRACE project.

Implementation of biomethane registries in Austria

As of 2022, Austria has three biomethane registries, the AGCS biomethane registry, the renewable transport fuel registry operated by the Austrian Environmental Agency (UBA) and the issuing body for Guarantees of Origin operated by Austrian Regulator E-Control. The AGCS biomethane registry primarily issues biomethane certificates for all production volumes in Austria regardless of their final end use. Cooperation and interfaces are established for purposes other than those for which AGCS is responsible. These cooperations exclude double counting of the same renewable gas volume transported through the Austrian gas grid. Biomethane used in the transport sector is exchanged with the registry system of the Austrian Environmental Agency based on a cooperation agreement with AGCS. E-Control and AGCS are requested to cooperate in the use of Guarantees of Origin.

This set-up on the one hand fulfills all legal requirements on the documentation of different end uses of renewable gases, but on the other hand results in extensive administrative efforts to use the same renewable gas volume for different purposes. For cross-border transfers, each of the Austrian registries already offer or will do in the future interfaces to European platforms such as the Union-wide database for renewable transport fuels, ERGaR and AIB.

The REGATRACE projects provided significant insight into the development in other countries and their complexities in offering registry systems for different end use sectors, enabling secure, efficient and well-developed interfaces to form between the existing national registry systems in Austria.

Implementation of biomethane registries in Belgium

Regarding certification, in Flanders a GO system was put in place in 2020, and biomethane (with a Proof of Sustainability) can also be used in the Emissions Trading Scheme (ETS), as from the beginning of 2022. In Wallonia, the existing GO system is still only applicable for CHP while biomethane use for ETS is under development. Bio-CNG and bio-LNG, on the other hand, have been able to be registered since the beginning of 2022 in the federal government's registry. The import (or export) of GOs from neighbouring countries is still not possible, as the Flemish system is AIB-based, while the ERGaR system is used in the adjacent member states. For ETS and biofuels, the import of a PoS from adjacent member states is (under certain conditions) definitely possible. The REGATRACE project has significantly raised awareness and knowledge on certification, and has led to the development of a solution for GOs and ETS in Flanders and for bio-CNG and bio-LNG in the federal system. However, there is still a long way to go before a mature solution is reached. Mainly, in light of upcoming evolutions in the EU on certification (Union database, hydrogen, low carbon, etc.), producers and industries involved in the sector are pleading for a more efficient, centralised certification solution for Belgium. This would avoid further fragmentation and inconsistencies of certification systems, with different criteria and rules in the regions and at federal level. For now, uncertainty on the EU framework (RED III, delegated acts, UDB, etc.) has only delayed concrete initiatives from the policy makers on this matter.



Implementation of biomethane registries in the Czech Republic

The Czech Republic is one of the target countries of the project that did not have an issuing body or a registry for Guarantees of Origin of biomethane and/or other renewable gases.

Meetings were organised between REGATRACE and representatives of legislators (Ministry of Industry and Trade, Ministry of Agriculture and Ministry of Environment) and state energy organisations (OTE, the Energy Market Operator, and ERU, the Energy Regulatory Office). The project and its objectives were presented, existing and missing legislation was discussed, and a vision and steps were developed that should lead to the successful launch of a national renewable gas registry. In the autumn of 2021, an amendment to the Law on Supported Energy Sources (currently undergoing the notification procedure with the European Commission) was approved. According to the amendment, the Czech Republic should issue Guarantees of Origin for biomethane from 1 January 2023. Subsequently, OTE was appointed as the national issuing body of Guarantees of Origin for biomethane and as the national registry.

After the establishment, OTE started working on the establishment of the registry, and the supplier of the IT system has now been selected. According to the available information, the registry should be operational in May 2023, with the issuance of Guarantees of Origin for biomethane retroactive to January 2023. The system is being prepared so that, if necessary, Guarantees of Origin for hydrogen can also be issued and registered.

Implementation of biomethane registries in Estonia

Estonia has had a biomethane registry operated by Elering since 2018. Initially, the registry was an environment for the core processes of biomethane GO – issuance, transfer and cancellation. It was also an environment for the submission of biomethane production subsidy applications and for the provision of national biomethane production and consumption statistics. The market participants involved in the registry included biomethane producers and gas sellers. In Estonia, biomethane GOs contain biomethane sustainability information providing Proof of Sustainability. Since 2021, the biomethane registry has connected to the system operated by the national Environmental Board to electronically transfer biomethane transport sector consumption data based on the cancelled GOs. For this, biomethane producers submit extra information on the biomethane produced every month in the biomethane registry in the format required by the Environmental Board. This information is then attached to the respective GOs. In 2021, additional operations were introduced in the transport sector offsetting platform module of the biomethane registry, including issuance, transfer and reporting of transport sector certificates. When a biomethane GO is cancelled to provide proof of transport sector consumption, biomethane transport sector certificates are issued to the biomethane seller. Transport sector certificates of sustainable biomethane can then be reported to fulfil market participants' obligations regarding national biofuel blending and greenhouse gas emissions reductions. Since 2021, electric vehicle charging operators and liquid fuel sellers have also participated in the transport sector offsetting platform for transactions of transport sector certificates of biomethane, renewable electricity and liquid biofuels. Soon, current bilateral transfers of transport sector certificates will be replaced with futures and auctions.

Implementation of biomethane registries in Germany

According to the German Agency for Renewable Resources (Fachagentur Nachwachsende Rohstoffe e.V., FNR), Germany has a biomethane potential of 35 billion m³. Currently, the German gas grid holds a total of 91 billion m³ of gas, out of which 1 billion m³ is biomethane (FNR, 2022). The following paragraphs aim to give an overview of the status quo regarding the implementation of a gas GO registry in Germany. A distinction is made between governmental registries and market-based registries.

- **Governmental gas registry:** no entity has yet received the state mandate for gas GO issuance. In summer 2022, a draft law on the implementation of the requirements according to article 19, RED II for gas GOs, hydrogen GOs and GOs for heating and cooling was published. The legislator has left open the question of who will be the competent body for gas GO issuance. According to the draft law, 18 employees and an annual compliance cost of EUR 2.86 million will be needed to create such a gas registry. Again according to the draft law, the entity that will receive the official state mandate may outsource the operation of the GO registry to third parties.
- **Market-based gas registry for compliance with legal requirements:** The dena Biogasregister was founded in 2010 and is operated by the German Energy Agency (dena). The registry lists approximately 200 biomethane plants and three PtX plants. It manages standardised and simple documentation of evidence of gas quantities and qualities. It is aimed at producers, traders and consumers of all gaseous energy sources. The dena Biogasregister documents evidence of the use of biogas, especially for electricity and heat

production (under the German Renewable Energy Act-EEG) or pure heat production (under the Renewable Energy Heat Act - EEWärmeG). As a neutral stakeholder, dena operates the Biogasregister and provides a system under which biomethane, hydrogen and synthetic methane can be certified and tracked from production to consumption. Auditors or environmental auditors verify the data during its registration process in the Biogasregister. The verified quantities can be transferred by the users and booked out for the intended end use (e.g., electricity generation under the Renewable Energy Act).

Implementation of biomethane registries in Italy

In Italy, the GO system was introduced by the Decree of 2 March 2018 that assigned GOs only to the production of non-incentivised biomethane deriving only from certain categories of raw materials (e.g. animal manure, agro-industrial by-products). The system had to be used to prove to the customer the origin and sustainability of renewable gas used, and was considered a very important element in the effective development of the direct use of biomethane in all sectors (industrial, residential, etc.). The registry of Italian GOs, mentioned in the 2018 Decree, should have been implemented by the GSE, the Italian public body that manages the incentive mechanism aimed at promoting electricity and biomethane generated from renewable sources, but this has not been implemented as of yet. Italian Ministerial Decree no. 340 of 15 September 2022 provides for the introduction of a GO system which, according to the legislator, serves to prove to the consumer the origin of renewable gas used. In Italy, following the publication of Decree no. 340, the publication of a specific decree and technical regulations for GOs is expected.

Implementation of biomethane registries in Ireland

Renewable Gas Forum Ireland (RGFI) in conjunction with an industry-led collaboration, including Gas Networks Ireland (GNI), Deutsches Biomasseforschungszentrum (DBFZ), Deutsche Energie-Agentur GmbH (dena) - German Energy Agency and MaREI Centre, initiated the blueprint design of the green gas certification scheme in Ireland. The key objectives of this project were:

- the development of a robust methodology (which considers different feedstock/ processes and potentially end uses) for calculating and accounting for GHG emissions savings from renewable gas, and ensuring its compatibility with international best practices and EU legislation;
- the determination of the relevant specifications required to independently quantify and certify the carbon savings associated with using renewable gas by having a traceable and auditable Guarantee of Origin and validation of greenhouse gas savings;
- the description of the structure for an accreditation/certifying body that will adopt and implement robust methodologies for registering and certifying renewable gas producers and carbon credits;
- the development of a green gas registry blueprint, which can promote the development of a robust and reliable green gas market in Ireland.

During the project, RGFI and GNI collaborated and strove for stakeholder engagement and the dissemination and communication of the project results to policy makers, industry and the wider community via workshops and face-to-face discussions.

On completion of the project and identification of the next steps, the joint licensees of RGFI and GNI agreed that as the gas authority in Ireland, GNI would proceed with its application to the government of Ireland to be formally appointed as the “National Registry”. GNI initiated the process of seeking recognition as the National Registry through a Statutory Instrument, and was formally appointed in August 2022.

The government of Ireland has formally appointed GNI as the National Renewable Gas Registry under a Statutory Instrument, now in legislation since 27 July 2022. The blueprint design for the GreenGasCert in Ireland was completed in April 2018, and it was agreed with RGFI, as joint licensee, that as the gas authority in Ireland, GNI would proceed with the application to be formally appointed and recognised as the National Register and Issuing body for renewable gases.

Implementation of biomethane registries in Lithuania

In 2019, Amber Grid was officially designated as the issuing body for renewable gas GOs in Lithuania. At that time, there was no national biomethane production or interest from market participants for gas GOs. Therefore, it was decided to build a simple database to serve registry needs as an interim solution.

In March 2021, the Act on Alternative Fuels was approved by the Lithuanian parliament. This Act enabled the use of GOs together with Proof of Sustainability for national energy consumption targets in the transport sector. Together with the investment support for biomethane production plants, this was a big boost for national biomethane market uptake.

In 2019, Amber Grid prepared a detailed action plan to implement a new IT system for a national gas GO registry. According to the plan, the new IT system was expected to be operational in 2022. In 2019-2020, the purpose of the registry was defined and a concept with basic principles for upgrading the registry based on the present situation and future production technologies for renewable gases was developed. A cost and benefit analysis indicated that the best option would be to acquire an IT solution offered on the market. At the end of 2021, the tender was announced and as of today, the IT system is expected to go live very soon.

The new IT system will improve overall functionality, transparency, the experience of market participants, and enable the national registry to connect with European GO exchange hubs in the future.



Implementation of biomethane registries in Poland

Work on biomethane legislation in Poland has started, but is still in progress. The draft amendment to the RES Act introduces a Guarantee of Origin for biomethane. It states that:

- GOs for biomethane will be issued by the Energy Regulatory Office (URE);
- the register of Guarantees of Origin for biomethane will be kept by the Polish Power Exchange (TGE).

Several meetings were organised for industrial stakeholders (planning investments in biomethane) concerning GOs and registries, as well as training for TGE on the IT system. The knowledge base from the REGATRACE project concerning GOs and registries was systematically provided to the Ministry of Climate, URE and TGE.

The REGATRACE pilot IT system helped stakeholders to gain a broad knowledge of the attributes of renewable gases and to better understand the transfer processes between market participants of the system. In Poland, this was tested by many representatives of industry, business and administration. The REGATRACE working materials provided were used to provide training to stakeholders such as TGE.

The Polish registry will be launched at the earliest after 1 January 2023 (entry into force of the amendment to the RES Act). According to the draft amendment to the RES Act, TGE will retain the Guarantee of Origin register for biomethane and will be responsible for the Polish IT system.

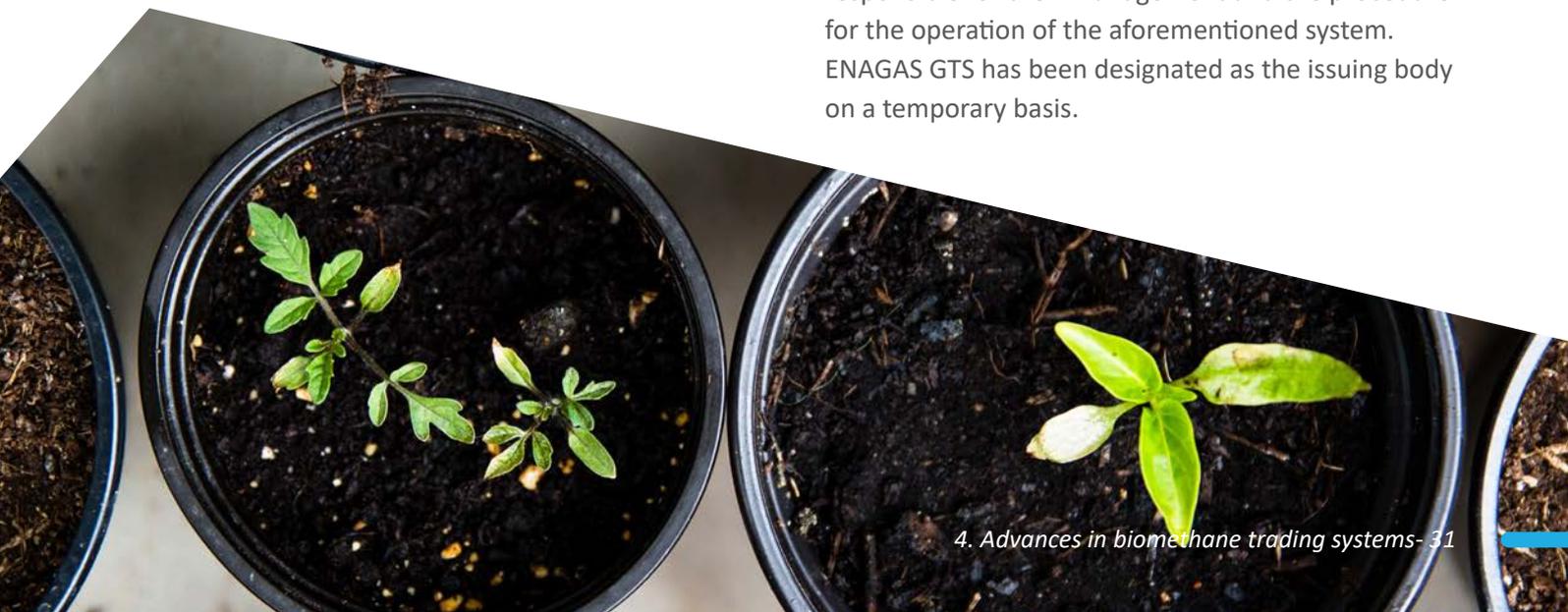
Implementation of biomethane registries in Slovakia

SPP - distribúcia (the largest gas distribution network operator in Slovakia and the only nationwide operator) will be the founder and operator of the Slovak Registry of Renewable Gases, mandated by the government via an amendment to the Slovak RES Act (implementing the RED II Directive), which should enter into force in December 2022. The process of procuring the Registry software provider was executed in 2021 in cooperation with REGATRACE, which helped define the technical tender criteria. SPP - distribúcia has held several presentations in 2022, promoting the Registry of Renewable Gases among stakeholders, including the Slovak Biogas Association, the heating & cooling sector and the industrial sector under the EU ETS as well as the Ministry of Economy and Ministry of Environment of the Slovak Republic.

Implementation of biomethane registries in Spain

In Spain, GO systems have still not been implemented. The Ministry for Ecological Transition and the Demographic Challenge published Royal Decree 376/2022 of 17 May, which regulates the criteria for sustainability and the reduction of greenhouse gas emissions from biofuels, bioliquids and biomass fuels, as well as the system renewable gas GOs.

It determines the creation of a system of GOs applicable to renewable gases, such as biogas/biomethane and green hydrogen, establishing the definition of these guarantees, their content, the conditions for issuing them, as well as the authorisation for the designation of an entity responsible for their management and the procedure for the operation of the aforementioned system. ENAGAS GTS has been designated as the issuing body on a temporary basis.



5. Documenting the cross-border transfer of renewable gas in Europe

5.1. Laying the ground for a common European biomethane/renewable gases GO system

In recent years, the demand for renewable energy has become an increasingly important aspect, not only in terms of environmental policy, but also in the field of security and foreign policy. As EU member states, and those countries neighbouring them, are becoming increasingly interconnected, so is their interest in establishing a system in which renewable energy can be traded in a transparent, reliable and efficient manner.

This is especially the case for biomethane. As a flexible energy carrier, its characteristics are multilateral, for example in renewable electricity, heating and cooling or transport. This makes its trade lucrative for various end-consumers, which in turn also requires a system in which its qualitative and quantitative, and its origin must be able to be verified and traced as a true renewable energy source. Trustworthy and transparent verification is an aspect in which European policy has become active, especially through legislation such as the Renewable Energy Directive (RED). Here, member states are required to establish issuing bodies for gas GOs and ensure that only liquid and gaseous biofuels that meet sustainability and greenhouse gas saving criteria can be counted towards the renewable

targets of the RED II. The European Union's slogan is "united in diversity", and interestingly, this also illustrates the fact that while common ground does exist in many areas of European collaboration, there are still areas in which diversity is the reality, insofar as different member states are still at different stages in their production, and also the issuance and trading of renewable gas certificates.

At the time of publication, 16 countries already had a national renewable gas registry, operating on a voluntary basis or with a government mandate (Austria, Belgium, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Ireland, Latvia, Lithuania, Netherlands, Portugal, Slovenia, Switzerland and the United Kingdom). While bilateral agreements on the mutual acceptance of renewable gas certificates have existed between different national registries previously, no Europe-wide system for cross-border transfers of renewable gas certificates was in place. For this reason, the motivation to establish a unified approach has been growing, resulting in the development of the ERGaR CoO Scheme and the extension of the EECs electricity scheme to gaseous fuels.

5.2. Facilitating the cross-border transfer of gas certificates

How ERGaR schemes facilitate the cross-border transfer of gas certificates

The European Renewable Gas Registry (ERGaR) was started by and continues to be composed of long-established registries and stakeholders of the biomethane and renewable gas industry. A growing imbalance between biomethane production and consumption in several countries necessitated cross-border transfers. Individual bilateral solutions were established, but in most cases member states refused to grant any benefits to imported biomethane. As such, it has been in its best interest to create a system in which the cross-border transfer of gas certificates could be both technically facilitated and recognised in the target country. Apart from the lack of harmonised renewable gas characteristics and data fields, an adequate and Europe-wide recognised concept for the mass balancing of grid-injected renewable gases was missing. It was for these reasons that ERGaR initiated its own European system for cross-border transfers of renewable gases. Since not all existing biomethane registries have the status of a competent issuing body under article, 19 RED II, the term Certificates of Origin (CoO) was created as an umbrella term for GOs and other types of renewable gases. A CoO holds the same kind of information as a GO according to article 19, RED II, with the difference being that a CoO can also be issued by a national registry that is not (yet) considered a competent body.

While the issuance and transfer of GOs follows the book-and-claim principle, the ERGaR CoO Scheme also facilitates the documentation of sustainability criteria and mass balance. For the latter, ERGaR is seeking recognition from the European Commission as a so-called Voluntary Scheme.

While operated by the organisation, it seeks to facilitate the cross-border transfer of CoOs between participating national biomethane registries according to a set of joint rules, harmonised attributes and common business processes with regards to the exchange of the underlying electronic documents. The transfer itself is facilitated through the ExtraVert IT-platform, to which all participating

biomethane registries are connected via an IT interface.

Launched in June 2021, the CoO Scheme now has four system participants, composed of biomethane registries and issuing bodies from AT (AGCS), DE (dena), NL (Vertogas), and the UK (REAL). Other issuing bodies have shown an interest, and are at different stages of joining the ERGaR CoO Scheme. In the first 15 months of operation, already more than one TWh of cross-border transfers were documented with the system. With the Danish issuing body (Energinet), likely to be the next system participant, the scheme represents more than 50% of biomethane production capacity connected to the European grid.

How the European Energy Certificate System facilitates the cross-border transfer of gas certificates

The Association of Issuing Bodies, abbreviated to AIB, is a non-profit, Brussels-based international association under Belgian law (ivzw) with a mission to “guarantee European Energy”. AIB gathers the issuing bodies of energy certificates and operates the European Energy Certificate System (EECS®), a voluntary standard that enables the reliable and efficient cross-border transfer of energy certificates. AIB was founded in 2002 in close dialogue with, but as a separate organisation from, the renewable energy attribute certificate traders’ association RECS International.

In October 2022, 34 issuing bodies were members of AIB, from 28 European countries. At that time, 16 AIB members had been appointed by law to issue Guarantees of Origin for gases: Austria (E-Control), Belgium Brussels (Brugel), Belgium Flanders (VREG), Belgium Wallonia (SPW), Czech Republic (OTE), Energinet (Denmark), Estonia (Elering), Finland (Gasgrid Finland), Greece (Dapeep), Italy (GSE), Latvia (Conexus Baltic Grid), Lithuania (Amber Grid), Portugal (REN), Slovenia (AGEN-RS), Spain (Enagas GTS), Switzerland (Pronovo).

AIB facilitates the operation and maintenance of EECS® for its members, including its IT support mechanisms and a discussion forum with a robust decision-making structure that enables continuous development of this voluntary standard, strengthened by a contractual framework that adequately allocates liabilities to all parties involved. AIB also facilitates quality assurance for its members by conducting three-yearly audits on its members regarding adherence to the EECS standard. This reassures importing registries of the quality of imported certificates issued in another geographical region.

The principles of EECS® were copied in the EN16325 standard for Guarantees of Origin in 2013, while EECS® harmonises more detailed protocols to ensure efficiency in cross-border transfers, while still allowing the flexibility to adapt to changing circumstances.

EECS® has set up a set of rules for a generic certificate system, setting out the basic components of certificate system management, complemented with scheme-specific rules. The EECS® Gas Scheme has been in draft status since 2008-2009, but only in 2019 was it established as a dedicated chapter of the EECS® Rules. This followed the publication of RED II in December 2018, which added GOs for gaseous energy carriers, in relation to which several AIB members are being charged with the corresponding responsibility for issuing gas GOs. The joint framework for electricity and gas certificates enables the efficient handling of Guarantees of Origin at energy conversion. The outcome of the REGATRACE D4.4 study is the reason why AIB will facilitate for all its members the import of Guarantees of Origin for all energy carriers. This will enable the efficient and reliable handling of GOs at conversion. The EECS® Gas Scheme provides for mandatory data fields and optional data fields on standardised EECS Gas Certificates, which can be transferred across registries and adequately read as long as the certificates reside in an AIB member's account.

First of its kind European Network to facilitate tracking of renewable gas certificates

In late 2021, the REGATRACE project launched a network to facilitate collaboration and boost biomethane trading across Europe. Since then, the REGATRACE Network has been sharing information on topics of common interest between organisations responsible for the documentation and tracking of renewable gas, including in particular GO issuing bodies, registries/databases on (gaseous) biofuels, renewable gas registries, especially when related to cross-border transfers. Here, the market uptake of exchanging renewable gases is based on certificates documenting the intrinsic value of renewable gases in line with existing European regulation as set in RED I and RED II, monitoring regulation and other European legislation.

Meeting every two to three months virtually, the network is composed of 16 network partners: Amber Grid (LT), AIB (EU-wide), AGCS (AT), Deutsche Energie-Agentur (dena, DE), EBA (EU-wide), Energigas (SE), Energinet (DK), ERGaR (EU-wide), Nedgia (ES), Netherlands Standardisation Institute (NEN, NL), REDCert (DE), RECS (NL), Renewable Energy Assurance Ltd (REAL, UK), SPP Distribucia (SK), Unia Producentów i Pracodawców Przemysłu Biogazowego (UPEBI, PL) and Verband der Schweizerischen Gasindustrie (VSG, CH).

The REGATRACE Network is open to any organisations, institutions or authorities involved in the verification and documentation of renewable gases, as well any associations representing producers, traders and/or consumers of renewable gas certificates. Organisations and institutions interested in joining the REGATRACE Network can contact the Network coordinators by emailing info@regatrace.eu.

6. Developments for documenting the cross-border transfer of renewable gas

6.1. Options for linking or integrating the gas certification schemes of ERGaR and AIB

The REGATRACE project outlined that a centralised IT solution can be considered as the most cost-efficient solution for issuing bodies to facilitate one-to-many connection for cross-registry transfers.⁸ One aspect of this are the options for linking or integrating the existing gas certification schemes of ERGaR and AIB with the Gas Scheme in its European Energy Certificate System (EECS standard). Such a collaboration has the potential to overcome the obstacles of bilateral and individual solutions from individual issuing bodies, which is a very short-term solution that does not facilitate automation and scaling to the levels needed for a liquid pan-European market. However, this would require changes of procedures and standards that are currently operated separately in both associations to align the quality assurance level, scope of collaboration and decision-making procedures, etc.

Regardless which IT option is envisaged, the establishment of a single transfer protocol with generic data fields and common data field specifications for all transfers of renewable gas certificates in member states would pave the way to facilitating all cross-border transfers. Since IT specifications merely reflect business needs, it is essential to set accordingly also the operational

processes and agreements in place. Given the desire to create a European solution, a collaboration between AIB and ERGaR is considered a key element in the equation.

This finding has been taken up and during the course of the REGATRACE project, the boards of AIB and ERGaR convened multiple times to discuss their cooperation, which will continue after the project closure. A straightforward merger of the associations in their current set-up was identified as not possible due to differences in the constitutional principles of the organisations. They agreed to continue exploring other options assessed within the framework of the REGATRACE project for collaborating in the field of renewable gas tracking. AIB and ERGaR acknowledge the value of their cooperation, and seek to maintain the reliability of gas tracking in Europe and to increase its efficiency.

⁸ Deliverable 2.8 “Techno-economic feasibility study on a harmonised system for cross-border title-transfer of the renewable character of gas in Europe”, www.regatrace.eu/work-packages/wp2-european-biomethane-renewable-gases-goo-system/

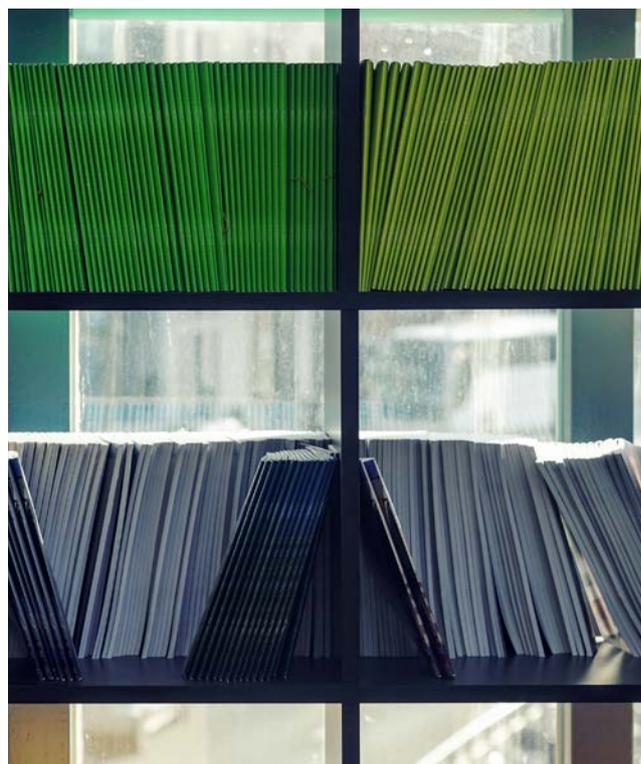
6.2. Integrating Guarantees of Origin for multiple energy carriers

Energy carriers can be converted into each other, and their origin can be proven with GOs, requiring a common approach to GO management. As gases can be converted into electricity and into other gases, project activities focused on the interaction of Guarantees of Origin for multiple energy carriers and on the integration of the systems managing these Guarantees of Origin. An analysis of GOs from different renewable gas technologies was conducted, with guidelines produced for the verification of cross-sectoral concepts. The certification schemes of ERGaR, AIB and CertifHy were also compared.⁹

Then, harmonised rules for handling Guarantees of Origin at energy carrier conversion were finalised.¹⁰ Such rules are essential for a functional market for Guarantees of Origin that facilitate cross-border transfer from nationally-governed GO systems. Harmonisation enables trust with regards to imported GOs from other countries and enhances efficiency in the management of the GO system. Finally, an investigation was conducted on how to maintain reliability and efficiency when issuing GOs after energy carrier conversion, for which the input energy was proven with cancelled GOs.¹¹

It walks through attention points for overcoming practical challenges and aims to support issuing bodies who are designing (an upgrade of) their GO system in line with the ongoing integration of the energy sector.

While a liquid GO market benefits from automated processes, it is explained why this automation is made easier if the GOs that certify the origin of the energy input into conversion, are cancelled in the same registry as where the new GOs after conversion are issued. This remains the case even if the registry is designed for issuing GOs for a different energy carrier.



⁹ Deliverable 4.2 “Technical and operational comparison of the biomethane/renewable gas GO system and the electricity GO system”, www.regatrace.eu/work-packages/wp4-integration-of-goo-from-different-renewable-gas-technologies-with-electric-and-hydrogen-goo-systems/

¹⁰ Deliverable 4.3 “Harmonised set of rules for the conversion of electricity into biomethane/renewable gas and hydrogen GOs”, www.regatrace.eu/work-packages/wp4-integration-of-goo-from-different-renewable-gas-technologies-with-electric-and-hydrogen-goo-systems/

¹¹ Deliverable D.4 Design study on a coordinated process for handling Guarantees of origin for energy conversion”, www.regatrace.eu/work-packages/wp4-integration-of-goo-from-different-renewable-gas-technologies-with-electric-and-hydrogen-goo-systems/

6.3. Guidelines on renewable gas sustainability certification

The European policy framework for bioenergy includes sustainability requirements for biofuels, bioliquids, biomass fuels and other alternative fuels. These requirements have to be fulfilled by economic operators and are the precondition for public incentives and subsidies. Compliance with the requirements can be shown with a sustainability certification process. For this purpose, the EU Commission has recognised a number of certification schemes, which are qualified to verify compliance with RED II requirements. Most of the relevant sustainability criteria included in the RED II were introduced for liquid and gaseous biofuels used in the transport sector in 2009. Consequently, existing certification schemes have developed experiences with the robust certification of market relevant biofuels.

However, due to the differences in the characteristics of the value chains, additional effort is needed to fully implement the GHG mitigation criteria for gaseous biofuels. REGATRACE summarised existing materials, tools and approaches to support the implementation into practice of RED II requirements for biobased renewable gases.¹²

Due to the potentially considerable effort for stakeholders, an important element in this regard is the GHG mitigation criteria. Thus, the report includes a specific chapter, that discusses an exemplary GHG emission calculation.

Finally, REGATRACE included a set of recommendations and conclusions from the analysis of the current status of sustainability certification for renewable gaseous energy carriers. These include aspects to reduce the level of complexity for market actors participating in the certification process, amongst others:

- additional default values for the most relevant substrates and feedstocks on a NUTS 2 level in Europe;
- tools (e.g. for the calculation of N₂O emissions)

and guidelines (e.g. for the calculation of individual credits for manure/slurry and for improved agricultural practices) to support the market stakeholders during the process of certification and increase the comparability and transparency of results;

- clarifications and support for group certifications, especially for operators with several feedstock suppliers;
- clear guidance for the implementation of the GHG calculation rules from the RED II in practice for producers of biogas, biomethane but most importantly for RFNBOs and RCFs;
- clear criteria to show the additionality of energy for renewable gas production, in order to qualify the respective renewable gas as sustainable;
- the traceability of information and general information management throughout complex and interlinked supply chains, including elements from different industry sectors.

Considering the above-mentioned aspects, general awareness from policy makers regarding the possibilities, but also the limitations of certification as a tool to proving compliance with sustainability requirements for renewable gases is very important. Thus, it is highly relevant that current and future sustainability requirements for renewable gases are defined in a way that is in general compatible with certification instruments, without creating systems that become overly complex or increase the risks for potential fraud and non-transparency.

¹² Deliverable 5.3 "Guidelines on renewable gas sustainability certification", www.regatrace.eu/work-packages/wp5-integrated-assessment-and-sustainable-feedstock-mobilisation-strategies/

7. European and national recommendations

Approach to Guarantees of Origin

1. Implement a **European harmonised certification and documentation approach** of the renewable value of renewable gases. Allow for the inclusion of sustainability information in the renewable gas certificates so that Guarantees of Origin and Proof of Sustainability can be linked or complement each other.
2. Establish **harmonised rules** for handling GOs at energy carrier conversion to prevent double counting and different valuation of GOs from different domains.
3. Given the ambitions of **linking Guarantees of Origin and Proof of Sustainability**, ensure that the methodologies for energy conversion are harmonised in both rules and standards.

Renewable gas registries

4. Enable the **set-up of the biomethane registry** by creating a domestic biomethane market and providing a timeline for the set-up of the appropriate regulatory framework.
5. Engage in an **open dialogue** with the biomethane industry to develop national biomethane registries rapidly based on the industry's initiatives and strategic advice.
6. Establish one **central registry per member state** for all national and European documentation purposes, covering all types of renewable gases with different certificate attributes.
7. Consider the **operational efficiency gains** of allocating the role of issuing body for GOs for all gases and electricity with the same organisation per geographical domain.

A European system of cross-border transfer of renewable gas certificates

8. **Allow transition** from individually acting national renewable gas registries to a common European renewable gas market with one or several European Scheme(s) of renewable gas certificates for all purposes of certification and issuance.
9. Implement a **single data format** for cross-registry transfers of Guarantees of Origin and other certificates.
10. **Collaborate** with the Association of Issuing Bodies (**AIB**) and the European Renewable Gas Registry (**ERGaR**) to establish a harmonized EU-wide system for cross-border title transfer of renewable gases.
11. Adopt a **flexible approach** to the set-up of interfaces between the Union Database of renewable fuels and national renewable gas registries.

Sustainability certification of renewable gases

12. Provide **additional default values for typical renewable gas value chains** to reduce unnecessary efforts of market actors.

Scale-up of biomethane markets

13. Establish **national biomethane strategies** and targets for 2030.
14. Give **biomethane production momentum** by setting-up investment support and simplifying permitting procedures.
15. Establish by the end of 2023 the **legislative, regulatory and technical framework** for quick and affordable network connection of biomethane plants.
16. Establish the appropriate regulatory framework and incentives to enable increased use of digestate as an alternative fertilizer.
17. Implement **demand incentives** through preferential taxation, fuel supply obligation and rewarding GHG emission reductions enabled by biomethane consumption.

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