



NATURE ENERGY BIOGAS

+ 1.3 %

Biogas primary energy production growth in the EU 27 between 2021 and 2022

BIOGAS BAROMETER

A study carried out by EurObserv'ER.  EurObserv'ER



NATURE ENERGY BIOGAS

The Korskro plant, outside Esbjerg, Denmark, has been designed to treat over 700 000 tonnes of biomass per annum.

The initial EurObserv'ER estimates put the European Union's primary biogas energy output for 2022 at over 15.8 million tonnes of oil equivalent (Mtoe), which amounts to modest annual growth of 1.3% (196 410 tonnes of oil equivalent). Biomethane injection into the natural gas grid has dominated this increase, driven by the proactive policies of a few Member States, primarily France and Denmark. Injected biomethane already amounts to more than a quarter of gas consumption in the latter country.

15.8 Mtoe

of biogas primary energy produced in 2022 in the EU 27

58.7 TWh

of biogas electricity produced in 2022 in the EU 27





The semi-industrial Gaya pilot R&D platform, at Saint Fons (Rhône), has been producing biomethane by pyrogasification since 2019. A large-scale plant based on this project, dubbed "Salamandre" will be built at Le Havre and is set to be generating an annual 150 GWh of renewable gas by 2026.

ENGIE / SCOPE PRODUCTION / MEYSSONNIER ANTOINE

The Russian-Ukrainian conflict has intensified the urgency of accelerating the European Union's transition to energy self-sufficiency and given the European biogas sector a vital strategic role. Europe's biogas producers are making headway but explain that it will take time to increase their output significantly, obtain administrative authorisations and build production plants. As it happens, the growth in European biogas output observed between 2021 and 2022 primarily reflects the investment decisions made after the rollout of the REPowerEU plan. The plan was launched in May 2022 and aims to protect EU citizens and businesses from energy shortages, accelerate the transition to clean energy and retrench European purchases of Russian hydrocarbons.

BIOGAZ PRODUCTION IN THE EUROPEAN UNION APPROACHES 16 MTOE

Preliminary official estimates of the primary energy output produced from biogas collected by EurObserv'ER

across the European Union countries amount to almost 15.8 Mtoe, attesting to a modest increase of 1.3% between 2021 and 2022 (table 1 and graph 1). As in previous years, methanation biogas from non-hazardous waste and raw plant matter ("other biogas") is the main category responsible for the increase in Europe's increased biogas output. The production of biogas in the other biogas category rose by about 168.5 ktoe between 2021 and 2022 (by 1.3%) to 13.3 Mtoe. It amounts to about 84.3% of all the biogas categories' output in 2022, which is the same share as in 2021. Landfill biogas output rose by 47.3 ktoe over the same period (by 4.1%) to 1.2 Mtoe in 2022. Its share of the total rose from 7.4% in 2021 to 7.6% in 2022). Sludge biogas output dropped slightly (by 13.4 ktoe, or 1.2%) to 1.15 Mtoe (1.16 Mtoe in 2021). Its share of the total biogas output slipped from 7.5% in 2021 to 7.3% in 2022. Likewise, biogas from thermal processes contracted by 6 ktoe (4.4%) between 2021 and 2022 to 130 ktoe, resulting in a 0.8% share of the 2022 total (0.9% in 2021). As Spain's 2022 biogas output data for this cate-

gory was unavailable at the beginning of October 2023, this drop may turn out to be smaller. Our study finds that France and Denmark contributed the most to the 2022 increase in EU biogas output. French production rose by 222.7 ktoe to 1 626.9 ktoe and Danish production by 63.4 ktoe to 689 ktoe. German biogas output, which was subject to a statistical upward revision in 2021 (see further on) slipped very slightly between 2021 and 2022 (by 0.6%, or 52.5 ktoe), along with Italian biogas output (by 2.2%, or 45.2 ktoe). Nonetheless, Germany is still far and away the leading EU biogas producer country and accounted for 51.4% of the EU total in 2022, ahead of Italy with 12.9% and France with 10.3%. If we consider per capita biogas output, then Denmark leads the field with 117.3 /1 000 inhabitants, ahead of Germany (97.4 toe/1 000 inh.), Czechia (56.8 toe/1 000 inh.) and Italy (34.4 toe/1 000 inh.). France comes in 8th (24 toe/1 000 inh.), behind Finland, Latvia and Slovakia (graph 2).



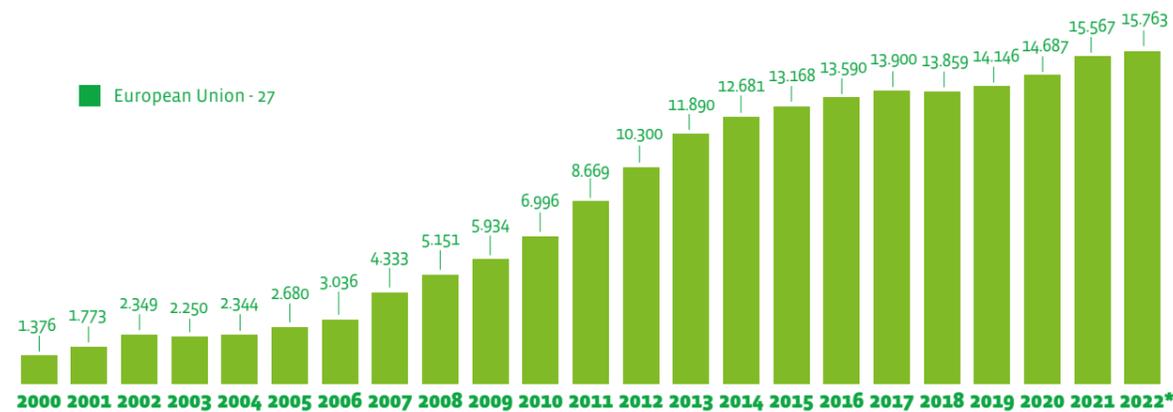
Biogas typology and usage

Methanation is a natural biological process in which many micro-organisms break down organic matter in an oxygen-free environment. Biogas produced by anaerobic fermentation breaks down into three sub-sectors that are segmented by the origin and treatment of the waste. They include biogas from non-hazardous waste storage facilities (landfill biogas), anaerobic digestion of urban or process waste water treatment plant sludge (sludge digestion gas) and the anaerobic digestion of non-hazardous waste or raw plant matter ("other biogas" category). This "other biogas" category is very broad and covers various installation types. It includes small farming anaerobic digesters that basically ferment agricultural materials from farms, and larger territorial or industrial methanation plants. These co-digestion plants can treat a mixture of different feedstocks (agricultural waste, food processing industry waste, green waste and so on). It also includes household waste and biowaste anaerobic digestion units that treat selectively collected biowaste or the organic fraction of plant-sorted household waste. Landfill biogas is naturally produced in non-hazardous waste storage facilities by decomposition. The organic fraction of this waste is recovered by capture networks. So, this is not considered as methanation biogas, because it is not produced with the aid of a digester. A fourth biogas sector is also monitored in international nomenclature and results from heat treatment ("thermal process biogas") by thermal gasification of solid biomass (wood, forest residue, solid and fermentescible household

waste) or by hydrothermal gasification of liquid biomass. These processes result in the production of a methane-rich syngas that is purified to biomethane. Biogas production by fermentation of organic matter is recognized as a relevant solution for combating climate change. The biomethane emission factor ranges from 23.4 to 44 g CO₂eq/kWh, depending on the source, which is 5 to 10 times lower than natural gas (244g CO₂eq/kWh), according to the ADEME (the French Agency for Ecological Transition) "expert file". Biogas can be used unaltered in production plants that operate using low-methane gas (50-75%, depending on the production sources) or if previously "washed" to be converted into biomethane, a gas with >97% of methane content, similar to natural fossil gas. This biogas (or biomethane) can in turn be used directly locally as electricity (in cogeneration), heat, or vehicle fuel. Alternatively, when accessibility to the natural gas grid is economically viable, biomethane can be injected into grid once it has been odourised with THT (tetrahydrothiophene). As a result, its use can be postponed and occur away from its production site. This solution offers better energy yield with 80% of the primary energy recovered compared to 40-55% for cogeneration). The biomethane will be used in the same way as grid gas, as electricity in gas-fired or CHP plants, as heat from the processing sector (e.g.: heat grid) or used directly by the final user in industry (process heat, cooling), households (heating, domestic hot water, cooking, etc.) and even as fuel for natural gas vehicles.

Graph. n° 1

Primary energy production from biogas in the European Union (27) since 2000 (in Mtoe)



Note : Methodological improvements concerning biogas production statistics in Germany have been taken into account from 2021, resulting in an increase in the level of production in this country. *Estimation. Source : Eurostat (year 2000-2020), EurObserv'ER (2021-2022)



DIFFERENT STATISTICAL PATHWAYS FOR MONITORING FINAL BIOGAS ENERGY

More widespread biomethane injection into the natural gas grid has complicated the task of accurately monitoring the biogas sector's final energy recovery. For while primary biogas energy production includes all the output, the quantity of renewable biomethane injected into

the grid (and thus blended with fossil gas) is absorbed in the statistical indicators for gas (factored into the Eurostat Natural Gas questionnaire). Hence, fossil and renewable gas are no longer distinguished once the biomethane is used in the processing sector (power, cogeneration or heat plants) or in the total final energy consumption of transport, industry and other sectors (residen-

tial, trade, public services, agriculture, fishing and other unspecified sectors). The traditional monitoring indicators for final biogas energy published by Eurostat refer exclusively to the use of "pure" biogas, which is not blended with fossil gas unless otherwise indicated by the national statistical authorities. Eurostat, through its SHARES (SHort Assessment of Renewable Energy Sources)

tool, allows the Member States to allocate the biomethane that is mixed into the grid across the various final energy recovery modes in a dedicated spreadsheet. Hence, tracking of this final "renewable" grid-injected biomethane energy is not lost, and can be included in the renewable energies target accounting of the Member States and European Union. Empirical and verifiable data, such as mass balance

certificates must be used by the Member States when tracking. This distribution allows them to estimate the corresponding electricity, heat (or cooling) yields from the processing sector (heat sold) and heat (or cooling) directly used by end-users, as well as the biomethane fuel used in transport. Member States are also obliged to distinguish the fraction of these outputs deemed to comply with the Renewable

Energy Directive specifications, which further obfuscates statistical monitoring. For the purposes of this biogas barometer, EurObserv'ER has opted to monitor the final energy of "pure" biogas used locally as well as the biomethane mixed into the natural gas grid, using the Eurostat SHARES tool methodology. However, the final energy share that complies with the requirements of the newly revamped European Renewable Energy Directive is excluded from this barometer because of the unavailability of indicators at the time of the study. While on the subject, biomethane production sustainability certification has been compulsory since 1 July 2023, according to RED 2. Now while this barometer does not monitor biogas fuel consumption, which will be a focus of the renewables energies in transport barometer, initial available data indicates very high growth of bioNGV in the 2022 transport sector.

OPPOSING TRENDS FOR ELECTRICITY AND HEAT

Renewed interest in biomethane injection into the grid and the conversion of several existing biomethane production units are partly responsible for the relative stability or slight drop in electricity and heat output from local dedicated biogas (or biomethane) recovery plants across the European Union. Based on the available initial official estimates, EurObserv'ER puts the electricity output from plants in 2022 that use pure biogas (not blended in the grid), produced and used locally at 54.3 TWh, which amounts to a 1.3% dip. This contrasts with the 5.3% increase in electricity output from biogas mixed into the grid to just under 4.5 TWh. If we add the two together, pure biogas and biogas mixed into the grid, output slipped by 0.8% from its 2021 figure (59.2 TWh) to 58.7 TWh in 2022 (table 2). The same holds true for heat output produced in the processing sector (heat grid) which corresponds to heat sales. Across the European Union, the amount of heat sold by plants that use pure, locally produced biogas, decreased by 1.3% between 2021 and 2022 to 853.6 ktoe, while the contribution of biogas mixed into the grid for the same indicator was stable at 306.3 ktoe (a 0.3% rise). If the two, pure biogas and biogas mixed into the grid, are added together, biogas heat

Tabl. n° 1

Primary production from biogas in the European Union in 2021 and 2022* (in ktoe)

	2021					2022				
	Landfill gas	Sewage sludge gas	Other biogases from anaerobic fermentation	Thermal biogas	Total	Landfill gas	Sewage sludge gas	Other biogases from anaerobic fermentation	Thermal biogas	Total
Germany	112.3	477.7	7571.4	0.0	8161.4	112.3	472.9	7523.6	0.0	8108.8
Italy	267.0	49.8	1754.0	7.3	2078.1	261.1	48.7	1715.9	7.2	2033.0
France	325.8	23.5	1054.9	0.0	1404.2	377.5	27.2	1222.2	0.0	1626.9
Denmark	3.3	25.5	596.8	0.0	625.6	3.5	26.0	659.5	0.0	689.0
Czechia	19.6	41.5	529.8	0.0	590.8	19.8	41.9	535.4	0.0	597.1
Netherlands	9.6	65.4	348.0	0.0	423.0	9.7	65.0	340.5	0.0	415.2
Spain	147.3	98.5	77.3	2.8	325.9	154.8	98.2	79.1	0.0	332.1
Poland	47.6	119.2	152.6	0.0	319.4	47.5	119.0	152.5	0.0	319.0
Belgium	16.2	28.3	200.0	1.4	245.8	16.6	29.0	205.5	1.4	252.6
Sweden	6.6	76.3	111.8	0.0	194.8	9.4	60.5	126.1	0.0	196.0
Finland	12.5	17.7	39.8	124.5	194.4	10.9	16.9	41.6	121.4	190.7
Austria	1.0	35.2	123.4	0.0	159.7	1.1	39.1	137.0	0.0	177.2
Greece	47.0	20.4	59.8	0.0	127.2	45.2	18.3	81.8	0.0	145.3
Slovakia	6.9	6.9	116.9	0.0	130.7	6.9	7.0	117.5	0.0	131.4
Hungary	7.7	30.2	46.1	0.0	84.0	9.0	35.0	53.6	0.0	97.6
Croatia	7.1	3.5	88.6	0.0	99.2	6.5	3.3	81.3	0.0	91.0
Portugal	69.0	7.4	10.8	0.0	87.2	62.5	8.2	4.1	0.0	74.8
Latvia	7.9	1.9	56.2	0.0	66.0	6.9	1.5	47.1	0.0	55.5
Ireland	29.4	7.7	15.0	0.0	52.0	30.1	7.8	15.3	0.0	53.3
Bulgaria	0.0	5.9	53.8	0.0	59.7	0.0	5.2	46.9	0.0	52.1
Lithuania	5.5	8.1	26.5	0.0	40.2	5.5	8.2	28.1	0.0	41.8
Slovenia	1.3	1.2	22.4	0.0	24.9	1.3	1.2	21.7	0.0	24.2
Romania	0.0	0.0	23.2	0.0	23.2	0.0	0.0	23.2	0.0	23.2
Estonia	1.0	6.6	10.6	0.0	18.2	0.9	5.5	8.9	0.0	15.3
Luxembourg	0.0	0.9	15.5	0.0	16.5	0.0	0.7	12.3	0.0	13.1
Cyprus	0.1	0.8	12.4	0.0	13.4	0.0	0.3	5.2	0.0	5.5
Malta	0.0	0.0	1.3	0.0	1.3	0.0	0.0	1.7	0.0	1.7
Total EU 27	1 151.6	1 160.2	13 119.0	136.0	15 566.9	1 198.9	1 146.8	13 287.5	130.0	15 763.3

*Estimation. Source: EurObserv'ER 2023



output (from the processing sector) stood at 1 159.8 ktoe in 2022, a slight 0.9% drop from its 2021 figure (1 170.1 ktoe) (table 3). The trend is much more positive for the direct use of biogas energy for heat (and cooling) production. In the case of “pure” biogas, it increased by 1.8% to 2.5 Mtoe in 2022 and the indicator for biogas mixed into the grid rose by a sharp 22.5% to 1.5 Mtoe. If the two, pure biogas and biogas mixed into the grid are added together, final energy consumption directly used by end-users (excluding the transport sector) stood at 4 Mtoe in 2022 (3.7 Mtoe in 2021) – an 8.7% increase. Incidentally, this expansion can be largely attributed to the data from France, as between 2021 and 2022 its production of biomethane injected into the grid increased significantly.

METHANATION'S ROLE DIFFERS FROM COUNTRY TO COUNTRY

FRANCE SEEKS TO SPEARHEAD EUROPEAN BIOMETHANE PRODUCTION

France is currently investing more than any other EU country in its biogas sector and in particular, in its biomethane sector. According to the Statistical Studies

and Data Service (SDES) that reports to the Ministry for Energy Transition, France increased its primary biogas energy output by 15.9% between 2021 and 2022 to 1 626.9 ktoe, namely an increase of 222.7 ktoe in the space of twelve months. The “other biogas” methanation category accounted for over three-quarters of this increase. The ADEME expert file on methanation counted over 1 450 anaerobic digesters in service in January 2023, of which 108 were in industry and 95 at wastewater sewage plants. There were 1 238 farm-based digesters and centralized installations in service, with strong growth momentum driven by the farming sector, sometimes in co-digestion with biowaste. Most (roughly 9 out of 10) of the projects commissioned in 2022 recover biogas injecting biomethane into the grid. As of 31 December 2022, according to the SDES, 514 installations had injected biomethane, following biogas production and purification into the natural gas grid, i.e., 149 more than in 2022 (152 in 2021). Their capacity had risen to 9.0 TWh p.a. by the end of 2022, which is a 38% year-on-year rise. Over the course of the year 2022, 2 506 GWh p.a. of additional capacity was installed, which is higher than the previous year's newly installed capacity (2 359 GWh p.a.). Total injected

biomethane output stood at 7.0 TWh in 2022, which is a 61% rise over 2021. At the end of 2022, the capacity of the 876 projects on the waiting list was 15.8 TWh p.a., including six synthetic biomethane installations obtained by pyrogasification for 291 GWh p.a. of capacity. According to the Sia Partners 2023 biomethane Observatory, France has become the world's leader for the number of biomethane units in service and is on the way to becoming the European leader in terms of installed capacity, challenging Germany and its output by about 10 TWh. This success can be put down to the proclamation of the EGALIM law in 2018 which introduced the right to grid injection. Since this law came into force, Sia Partners states that the CRE (French Energy Regulatory Commission) has approved at least 1.2 billion euros' worth of connection and reinforcement), which guarantees the scheduling of gas grids for biomethane integration. Each unit must have a biomass sustainability certificate obtained by committing to a certification scheme recognized by the European Commission if it is to be eligible for certification as sustainable and counted as renewable by the RED Directive, while plants commissioned after 1 January must prove a 70% reduction in GHG compared to a reference fossil fuel.

Europe makes biomethane injection its priority

According to the EBA (European Biogas Association), Europe currently has about 20 000 biogas production plants of assorted sizes (half of them in Germany), a very high proportion of which are farm-based methanation plants. At the end of 2022, the total stood at 1 222 biomethane plants, and by April 2023, 100 new plants were up and running (a total of 1 322). Most biomethane plants are either connected to transport gas grids or distribution grids. **Transport grids** are used to import gas from overland interconnections with neighbouring countries and methane tanker terminals. **Distribution grids** convey the gas from the transport grids to the ultimate consumers. In its **EBA Statistical Report 2022**, the European Biogas Association points out that in 2021 (2022 figures unavailable) 58% of the biomethane production plants were connected to the distribution grid, 19% to the transport grid, 9% were off-grid and 14% made no disclosure. Biomethane injection has been the new production growth driver for several years, stimulated by the proactive policies of a few Member States, primarily France and Denmark. Furthermore, countries such as Italy are determined to convert part of their power plant base from cogeneration to injection into the gas grid. Germany has resolved to curb its dependence on fossil gas imports for industrial uses in particular, while Italy (adopting the same strategy as Denmark and Sweden) is focussing on using it as fuel for natural gas vehicles. This preference for injection was spurred on last year by Russia's invasion of Ukraine when in March 2022, the European Commission announced its target to produce 35 billion cubic metres of biomethane in Europe by 2030, under the framework of the REPowerEU plan. Current biomethane production must be increased (which the **EBA Statistical report 2022** put at 3.5 billion m³ at the end of 2021 in Europe), if the dual aim to both reduce EU dependence on Russian natural gas imports and contribute to its climate targets is to be accomplished. Pulling off this feat will call for investment in new biogas production plants and the conversion of some existing installations for injection wherever it is economically and technically feasible. Denmark is the most advanced country. According to Energinet, in 2022 the biomethane production is expected to make up 30 % of the total gas national consumption, and the Danish Government aims for a 100 % green gas coverage already in 2030.

If this progress were to be demonstrated, France has outstripped its biomethane injection targets. The multiannual energy programme (PPE) set a 6-TWh target for biomethane injections in 2023, compared to the 7 TWh already achieved at the end of 2022. The 2028 target comes in two options, a basic option of 14 TWh and a high option of 22 TWh. According to Sia Partners, the growth pace should

slacken in 2023, heralding a drop in the number of new units in the medium term. This contraction can be attributed to the business model which has less, because of poorer remuneration conditions. The revised and is harder to swallow Feed-in Tariff, and the current context dominated by inflation and rising energy prices have curbed sector growth, which is no longer exponential. The 13 December 2021 Order

updated the regulatory framework for the new biomethane Feed-in Tariff. The Energy Code provides for a tendering mechanism for large-scale projects over three periods between December 2022 and December 2023 covering a total capacity of 1.6 TWh HHV p.a. The digesters, water treatment plants and NHW storage facilities are eli-

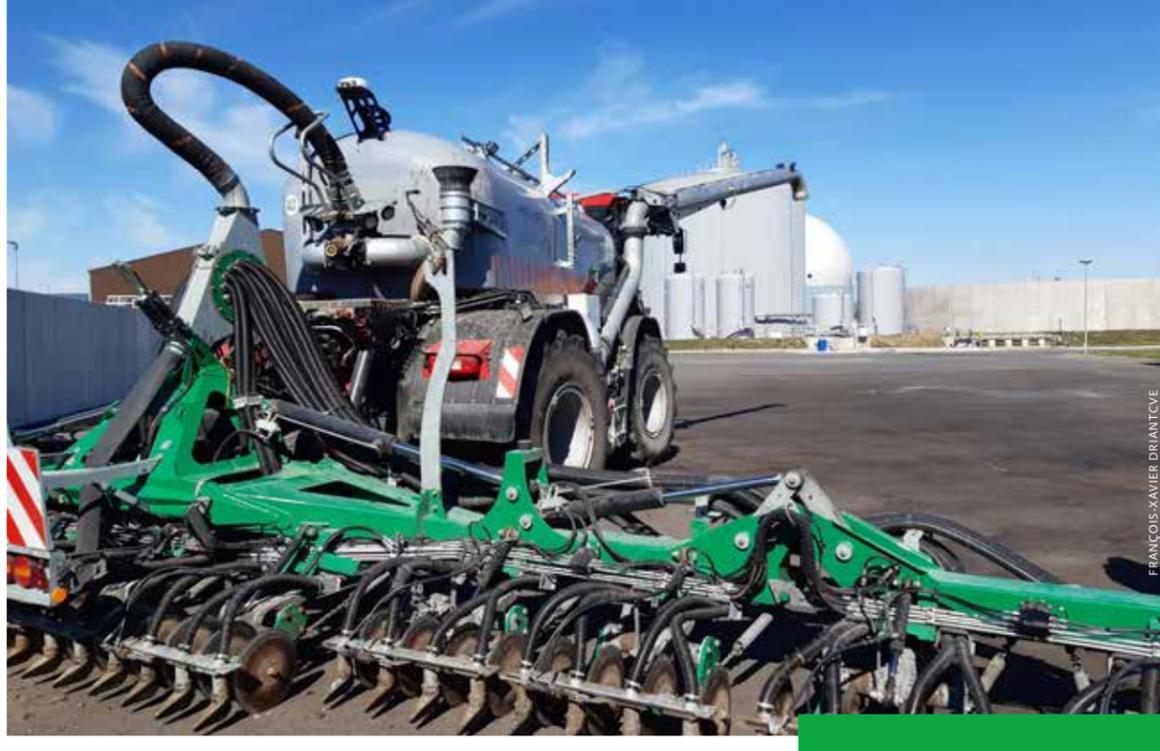
Tabl. n° 2

Gross electricity production from pure biogas and from biogas blended in the grid in the European Union in 2021 and 2022* (in GWh)

	2021				2022			
	Electricity only plant	CHP plant	Total pure biogas	Electricity from biogas blended in the grid	Electricity only plant	CHP plant	Total pure biogas	Electricity from biogas blended in the grid
Germany	8 380.0	23 980.0	32 360.0	3 280.0	8 280.0	23 950.0	32 230.0	3 100.0
Italy	2 508.6	5 615.6	8 124.2	0.0	2 403.1	5 441.0	7 844.1	0.0
France	353.4	2 800.3	3 153.7	298.5	357.8	2 836.6	3 194.4	721.2
Czechia	37.2	2 555.6	2 592.8	0.9	37.6	2 577.6	2 615.1	1.0
Poland	0.0	1 307.3	1 307.3	0.0	0.0	1 288.3	1 288.3	0.0
Netherlands	13.3	802.0	815.3	238.1	13.0	791.0	804.0	240.0
Belgium	59.2	917.1	976.3	9.9	59.3	918.9	978.2	18.0
Spain	727.0	252.0	979.0	18.9	718.0	272.0	990.0	0.0
Denmark	1.5	611.1	612.6	334.9	1.6	572.7	574.3	333.0
Austria	557.2	44.4	601.6	14.4	549.7	43.8	593.5	14.4
Greece	80.4	376.5	456.8	0.0	68.6	449.2	517.8	0.0
Slovakia	85.0	402.0	487.0	0.0	77.5	366.5	444.0	0.0
Croatia	39.0	401.2	440.2	0.0	38.2	393.0	431.2	0.0
Hungary	52.0	243.0	295.0	4.6	55.2	257.8	313.0	4.6
Portugal	246.6	19.0	265.6	2.0	225.8	21.3	247.1	3.6
Latvia	0.0	291.9	291.9	0.0	0.0	249.6	249.6	0.0
Bulgaria	52.0	164.2	216.2	0.0	45.9	144.9	190.9	0.0
Ireland	118.7	54.0	172.7	1.3	108.4	49.3	157.8	1.3
Lithuania	0.0	156.7	156.7	0.0	0.0	158.7	158.7	0.0
Finland	145.0	184.0	329.0	8.9	26.0	95.0	121.0	0.0
Slovenia	1.5	101.1	102.6	0.0	1.4	91.2	92.6	0.0
Romania	20.6	52.3	72.9	0.0	20.6	52.3	72.9	0.0
Cyprus	0.0	59.9	59.9	0.0	0.0	57.7	57.7	0.0
Luxembourg	0.0	61.0	61.0	1.1	0.0	47.7	47.7	1.1
Sweden	0.0	12.0	12.0	10.3	0.0	30.0	30.0	10.3
Estonia	0.0	16.4	16.4	0.0	0.0	10.0	10.0	0.0
Malta	0.0	7.2	7.2	0.0	0.0	7.4	7.4	0.0
Total EU 27	13 478.2	41 487.9	54 966.1	4 223.8	13 087.7	41 173.6	54 261.4	4 448.5

Note: The rank of this table is based on the cumulative biogas electricity production from biogas used pure or mixed with the natural gas network. *Estimation.
Source: EurObserv'ER 2023





FRANÇOIS-XAVIER DRIANT/CE

gible for the open window Feed-in Tariff. To revive the sector, a biomethane incorporation rate covering all natural gas sold has been set up, based on a biogas production certificates mechanism (CPB), phased in from 1 July 2023 onwards and gradually increased. Penalties will be imposed on suppliers that do not hand over enough biogas production certificates. The sharp growth in biomethane injection naturally affects the final energy statistics (electricity production, heat produced by the processing sector and heat directly used by end-users). The output of biogas plants that use their own production only increased by 1.3% between 2021 and 2022 to 3.2 TWh, whereas the electricity produced from biomethane injected into the grid, representing the share of biomethane used by conventional gas-fired power plants, increased by 141.6%, rising from 298.5 GWh to 721.2 TWh. The ADEME expert file on methanation asserts that France’s potential remains high. The ADEME scenarios for achieving carbon neutrality (Transition 2050 exercise) reckon that renewable gases could account for 90–130 TWh by the 2050 timeline, and for 82–99% of gas consumption in France, provided that a sustained energy sobriety policy halves gas consumption from its current level.

BIOGAS, AN ELEMENT OF FLEXIBILITY IN GERMANY

Yet again in 2022, over half of the European Union’s biogas output was produced in German digesters, i.e., 8.1 Mtoe of the

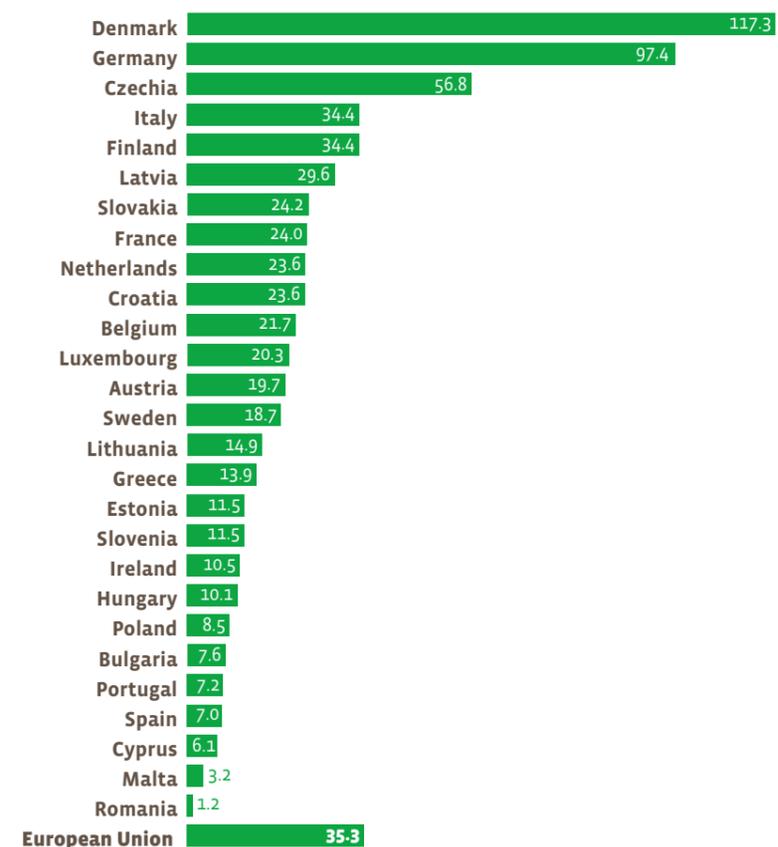
15.8 Mtoe for the whole of the EU. It should be borne in mind that Germany has almost 10 000 biogas plants, 9 876 at the end of 2022 according to Fachverband Biogas (the German biogas association), 242 of which inject biomethane into the gas grid. Now, the new installation pace is much slower than that of the end of the 2000s and the beginning of the 2010s when over a thousand biogas units were started up every year (1 314 new plants in 2009, 1 107 in 2010 and 1 526 in 2011). Since 2017, Germany’s market has revolved around a hundred or so new digesters every year, a large number of which are small slurry digesters (122 in 2017, 113 in 2018, 91 in 2019, 97 in 2020, 167 in 2021 and 77 in 2022). Since the 2014 and 2017 German renewable energies law (EEG) reforms, the government has changed tack and no longer seeks the proliferation of digesters, but instead to make the biogas electricity production of its existing units more flexible. It has changed its priority to expanding the sites in service, gaining flexibility by boosting their installed capacity so that their output coincides with peak demand periods. As a result of this policy, the electrical capacity of Germany’s biogas facilities has surged since 2016, and according to the German biogas association, capacity has risen from 4 018 MW in 2015 to 5 895 MW in 2022 although the installed capacity used has only risen from 3 723 MW in 2015 to 3 833 MW in 2022. Ofate (the Franco-German Office for Energy Transition) explains that the German government introduced a flexibility premium in 2012 for the

The Montbrison methanation plant in the Loire started up on 13 April 2023 and processes up to 23 000 tonnes p.a. of organic waste from industry (50% of the treated flow), institutions and food waste (40%), and agricultural co-products (10%) from a 60-km radius catchment area.

purpose of increasing usable electrical capacity during peaks in demand, thus distinguishing between “total capacity” and “used capacity”. Facility operators must reduce the amount of biogas that they inject the remainder of the time and must maintain the same average injected capacity level over the year as they applied before upgrade works to be able to take advantage of this additional peak capacity. This distinguishes “total peak capacity” from “usable installed capacity”. Incidentally, the 2021 output figures have been upscaled by several hundred ktoe (584.3 ktoe) from the previous Eurostat estimate. AGEE-Stat, the Working Group on Renewable Energy Statistics of the German Environment Ministry, explains that the application of methodological improvements gives a more accurate picture of the production units’ own consumption upstream of the connection point, the facilities’ electricity consumption and transformer station losses. AGEE-Stat states that the 2022 biogas primary energy output figure slipped slightly on its 2021 performance (by 0.6%). However, the working group points out that this data is preliminary and likely to be consolidated at the end of the year.

Graph. n° 2

Primary energy production from biogas by inhabitant in European Union in 2022* (toe/1000 inhab.)



*Estimation. Source: EuroObserv'ER 2023

If we focus on final energy production, electricity is the main biogas recovery mode in Germany. AGEE-Stat reports that biogas plants produced about 32.2 TWh of electricity in 2022 (32.4 TWh in 2021) to which should be added 3.1 TWh of biogas mixed into the grid used in conventional gas-fired power plants (3.3 TWh in 2021). As for heat recovery, 291.2 ktoe of biogas heat was sold via biogas (usually CHP) plants, to which should be added 199.2 ktoe of biogas mixed into heating networks supplied by the gas grid. The biogas heat directly used by end-users is put at 1 258.7 ktoe to which should be added 327.2 ktoe for the biogas mixed into the grid. If we add the two together, biogas heat consumption remained broadly stable between 2021 and 2022 (a 1.4% rise) at just over 2 Mtoe (2 076.3 ktoe in 2022).

THE GAS AND OIL COMPANIES LAUNCH AN OFFENSIVE ON BIOGAS

The European biogas industry is very diverse with myriad players operating at national, European and even international level. Europe has some forty manufacturers of anaerobic digesters of all types, adapted to the various installation types. Because of their sectors’ advanced development, the German and Danish manufacturers are in an historically strong position, including Denmark’s Nature Energy and Germany’s Envitec Biogas AG, Weltec Biopower GmbH, Planet Biogas global GmbH. There are also Italian (AB Gruppo, IEA Biogas Srl), French (Naskeo Environment, BioEnTech), and other players (table 5). While digesters are at the heart of the reactor, the sector has a fully-fledged industrial system with players specializing

in biogas and biomethane recovery (pre-treatment, biogas washing, cogeneration systems, storage tanks and CO₂ capture systems), and also firms specializing in collecting, sorting and waste packaging, sludge treatment, transport infrastructure and biomethane injection into the grid. Furthermore, there are service suppliers, such as guarantee of origin market players, consultants, financiers, biogas suppliers and buyers, laboratories, and so on. The rise in demand and European ambitions have encouraged the industrialization of new local green gas production technologies and new renewable gas production pathways, such as synthetic biomethane production, hydrothermal gasification, pyrogasification of wood waste, renewable hydrogen production or biogenic CO₂ sales or methanol production by recovering the CO₂ share of the biogas. The commissioning of large-scale industrial methanation projects for injection or transport fuels is another trend, often initiated by the major gas and oil companies, along with the refinery and oil distribution sector. These players are positioning themselves either by developing their own projects or by taking over specialized major biogas facility market leaders. The Salamandre project led by Engie is one of the most innovative projects, that aims to build a 20-MW, second-generation pyrogasification biomethane production facility, with a 150 million euro investment. The specifics of the Salamandre project are that it will supply 11 000 tonnes per annum of biomethane for the maritime carrier CMA CGM as early as 2026/2027, as the maritime sector is looking for alternatives to fossil gas. CMA CGM, which has a fleet of 30 “e-methane ready” dual fuel ships in service, currently running on NLG (Natural Liquefied Gas), but able to use BioLNG and synthetic methane, aims to be Net Carbon Zero by 2050. The number of vessels should rise to 77 by the end of 2026. This renewable low-carbon fuel will be obtained by pyrogasification by heating dry waste, in this case wood residue and solid recovered waste, to a very high temperature that currently cannot be used for conversion into gas. When the CMA CGM Group and ENGIE announced this investment in June 2022, they declared their intention to develop 200 000 tonnes of renewable gas per annum by 2028 in



Europe and elsewhere in the world to cater for the needs of CMA CGM and the shipping industry, banking on the Salamandre project. Engie already has some twenty biogas facilities through its EngieBioz subsidiary. One of the latest, located at Saint-Jean-de-Folleville, in Seine-Maritime, started up on 20 June 2023. It has 19 GWh/p.a. of biomethane production capacity. Half of the

feedstock treated (livestock manure, plant residues) will originate from about twenty farms that will recover 22 000 tonnes of digestate to spread on their crops. The other half will come from agribusiness. Early in 2023, another hydrocarbon industry player, the Swiss refinery group Varo Energy, revealed its acquisition of an 80% stake in one of Europe's biggest

biogas producers – Bio Energy Coevorden BV (BEC) in the Netherlands. VARO plans to set up Northern Europe's biggest biogas production facility through this acquisition, by more than doubling capacity at the existing BEC site, raising it from its current 300 GWh to 650 GWh by 2026. The BEC plant straddles the Dutch-German border. The company's website claims that it treats

Tabl. n° 3

Gross heat production in the transformation sector from pure biogas and from biogas blended in the grid in the European Union in 2021 and in 2022 (in ktoe)*

	2021				2022			
	Heat only plant	CHP plant	Total pure biogas	Heat from biogas blended in the grid	Heat only plant	CHP plant	Total pure biogas	Heat from biogas blended in the grid
Germany	10.7	252.5	263.2	206.6	10.7	280.4	291.2	199.2
Italy	0.1	290.8	290.9	0.0	0.1	276.0	276.1	0.0
Denmark	2.4	47.0	49.4	72.3	2.3	41.9	44.2	69.8
France	3.0	82.9	85.9	15.1	2.3	84.0	86.2	25.9
Belgium	0.0	21.4	21.4	0.2	0.0	21.5	21.5	0.2
Slovakia	0.1	17.6	17.7	0.0	0.1	20.7	20.8	0.0
Czechia	0.0	17.6	17.6	0.1	0.0	18.0	18.0	0.1
Poland	0.9	22.0	22.9	0.0	0.7	17.1	17.8	0.0
Latvia	0.2	19.3	19.6	0.0	0.2	15.2	15.4	0.0
Croatia	0.0	16.9	16.9	0.0	0.0	13.3	13.3	0.0
Netherlands	0.0	7.5	7.5	5.7	0.0	6.7	6.7	5.7
Sweden	1.5	3.8	5.3	3.3	2.3	5.9	8.2	3.3
Finland	5.8	13.4	19.2	0.4	4.8	3.5	8.3	0.4
Austria	1.2	3.6	4.8	1.1	1.1	3.2	4.3	1.1
Romania	1.8	2.9	4.6	0.0	1.8	2.9	4.6	0.0
Slovenia	0.0	3.7	3.7	0.0	0.0	4.1	4.1	0.0
Bulgaria	0.0	3.8	3.8	0.0	0.0	4.0	4.0	0.0
Hungary	0.0	2.7	2.7	0.4	0.0	3.3	3.3	0.4
Luxembourg	0.0	2.8	2.8	0.2	0.0	2.1	2.1	0.2
Lithuania	0.0	2.4	2.4	0.0	0.0	1.5	1.5	0.0
Estonia	0.3	1.3	1.6	0.0	0.2	1.0	1.3	0.0
Cyprus	0.0	0.9	0.9	0.0	0.0	0.9	0.9	0.0
Ireland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Greece	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spain	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Portugal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total EU 27	28.0	836.7	864.7	305.3	26.5	827.0	853.6	306.3

Note: The rank of this table is based on the cumulative biogas heat production in the transformation sector from biogas used pure or mixed with the natural gas network.
*Estimation. Source: Eurobserv'ER 2023



215 000 tonnes of farming and food waste every year. After its extension, the site will be one of Europe's three largest biogas facilities. This summer's declared strategy is in line with its aim to produce 1 TWh of biomethane/bioLNG by 2026, with 65 percent of the input towards this goal coming from the purchase and construction of the new biogas facility. In June 2023, the group also acquired the biogas trader, Renewable Energy Services (RES). Varo, which is part of Carlyle and energy trader Vitol, claimed that the RES acquisition would add 1 terawatt-hour of biogas trading capacity, which equates to the GHG emissions of 100 000 homes in Europe. On 12 January 2023, the oil group TotalEnergies commissioned France's biggest biogas facility at Mourenx in the Pyrénées Atlantiques, at the centre of the Lacq gas basin that is currently undergoing redevelopment. The BioBéarn project, which has garnered an investment of 38 million euros, should be capable of producing 160 GWh of biomethane within the next three years to be continuously injected

The BioBéarn plant at Mourenx in the Pyrénées Atlantiques is France's biggest methanation facility, that went on stream on 12 January 2023. It should be producing 160 GWh of biomethane p.a. within 3 years, that will be continuously injected into the Teréga distribution network.

into the Teréga grid. The biomethane is purchased directly by TotalEnergies Gas & Power, one of TotalEnergies' subsidiaries. This green gas will then be earmarked for various uses, including mobility, through the guarantees of origin mechanism. It will take three years – the time it takes for the bacteria that create the fermentation reaction to multiply – for production to be stepped up. Nonetheless, as early as 2023, the site will be able to recover 95 000 tonnes of organic matter from the local farming and agrifood industry, within a catchment area of about fifty kilometres around the facility. That will be enough to produce 69 GWh of biomethane, which equates to the consumption of 14 000 inhabitants, as well as 89 000 tonnes of digestate over

the first year in operation. Digestate is the residue produced by the organic waste methanation process. It is used as an organic soil improver, a fertilizer, to beef up the soil's organic matter content. The site will have 3 x 9 500-m3 digesters, to treat and recover biomethane from about 220 000 tonnes of farming co-product and abattoir waste. The BioBéarn methanation plant is the 18th to be operated by TotalEnergies and will raise its annual biomethane production capacity to 700 GWh, which is close to the 1-TWh annual target it has set for 2023. TotalEnergies aims to run 60 biogas facilities in France by 2030 totalling 5 TWh of capacity, and 20 TWh of worldwide capacity by the same timeline. One of the facilities, the Bionorris project in Normandy is run in partnership with the Cristal Union sugar refinery at Fontaine-Le-Dun. The digesters will be fed mainly compressed beet pulp (55%), and also agricultural waste, abattoir sub-products, agrifood industry wastewater treatment plant



sludge and other sub-products and waste. The initial phase of the project is intended to treat 110 000 tonnes of feedstock which will gradually increase to 140 000 tonnes. The project is dimensioned to produce 99 GWh of biomethane for injection into the grid from these feedstock quantities. The input will be sourced locally within a

30–35 kilometre radius.

Nature Energy, Denmark's biggest biogas producer became a wholly owned subsidiary of the Shell oil group in 2023. It should be noted that in 2018 Nature Energy acquired Xergi the Danish leader for biogas production using co-digestion. In 2023 Nature Energy operated 13 industrial-sized faci-

ties in Denmark and the Netherlands and one being completed in France. It also has a raft of projects underway in the United States and Canada. The company claims to treat 4.7 million tonnes of food residues and farming effluents currently and produces over 185 million m³ of biogas on its site, which contributes to reducing annual CO₂ emissions by 325 000 tonnes. The company has commissioned one of the world's largest biogas plants, at Korskro, not far from Esbjerg, Denmark. It can treat over 700 000 tonnes of biomass per annum. It has other similar sized plants at Holsted and Videbæk. The Korskro facility was designed to produce up to 37 million m³ of gas. This plant vies with the Tønder (Denmark) biogas plant owned by ENVO, fed by as many as 120 farms (slurry and energy crops). It produces 68.5 million m³ of biogas annually (35 million m³ of biomethane) by treating 930 000 tonnes of biomass. The plant's output is planned to increase further to 40 million m³ of biomethane. The company will also produce biogenic CO₂ with a view to producing e-methanol for maritime container transport. The facility changed ownership on 22 February 2023, when Anaergia sold it to Copenhagen Infrastructure Partners, an investment fund that develops biogas projects in Europe and North America.

BIOMETHANE OUTPUT TO BE DOUBLED BY 2030

The investments already made in European biogas production, motivated both by environmental considerations and the determination to reduce Member States' energy dependency on gas, have been given real meaning since Russia invaded Ukraine. The European Union's over-reliance on Russian gas has had dramatic consequences leading to increased energy bills for households, institutions and businesses. The European Union responded as fast as possible when it rolled out its REPowerEU plan as early as May 2022. One of the flagship measures introduced by the Commission was to introduce an action plan for biomethane that defines tools such as a new industrial partnership for biomethane and financial incentives that aim to raise output to 35 billion m³ by 2030, falling within

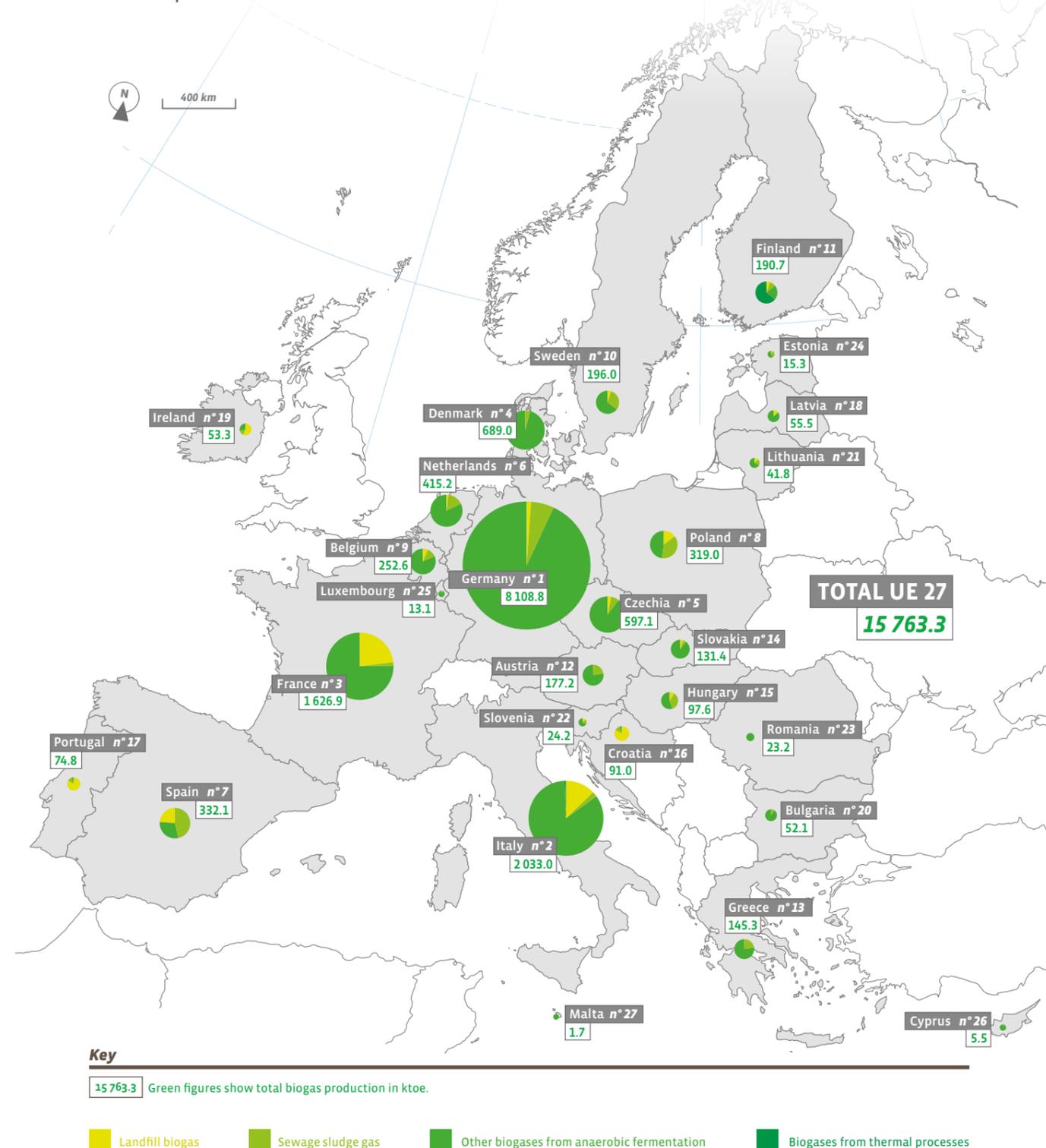
Tabl. n° 4

Final energy consumption in industry and other sectors (except transport) from pure biogas and from biogas blended in the grid in the European Union in 2021 and in 2022* (in ktoe)

	2021		2022	
	Pure biogas	Biogas blended in the grid	Pure biogas	Biogas blended in the grid
Germany	1251.6	327.2	1258.7	327.2
France	255.3	335.7	264.5	539.5
Denmark	20.8	357.1	24.9	423.3
Netherlands	132.5	167.4	130.4	171.2
Czechia	152.6	0.6	152.6	0.6
Finland	115.4	4.4	138.6	2.5
Spain	102.9	3.9	103.7	5.7
Belgium	96.8	4.4	97.9	8.0
Poland	87.7	0.0	87.7	0.0
Sweden	41.2	17.1	41.2	17.1
Italy	35.5	0.0	35.5	0.0
Greece	34.5	0.0	35.1	0.0
Austria	25.4	6.5	25.4	6.5
Slovakia	25.0	0.0	25.0	0.0
Hungary	14.0	2.9	14.0	2.9
Ireland	12.4	0.2	12.4	0.2
Lithuania	10.2	0.0	10.9	0.0
Bulgaria	10.3	0.0	10.3	0.0
Latvia	6.9	0.0	7.3	0.0
Portugal	7.2	0.0	6.0	0.0
Cyprus	5.4	0.0	5.4	0.0
Luxembourg	1.2	3.7	1.2	3.7
Slovenia	2.7	0.0	2.7	0.0
Estonia	2.7	0.0	2.7	0.0
Romania	2.6	0.0	2.6	0.0
Malta	0.5	0.0	0.5	0.0
Croatia	0.5	0.0	0.5	0.0
Total EU 27	2453.8	1231.1	2497.7	1508.5

Note: The rank of this table is based on the cumulative biogas final energy consumption (excluding the transport sector) from biogas used pure or mixed with the natural gas network.
*Estimation. Source: EurObserv'ER 2023

Primary energy production from biogas in the European Union countries at the end of 2022* (in ktoe), with the respective shares of each sub-sector.



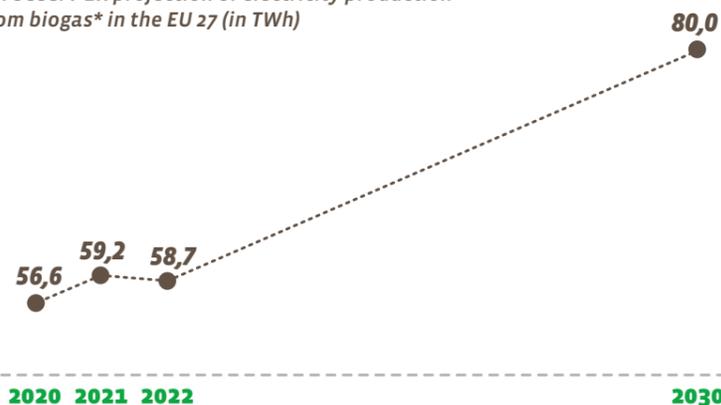
*Estimation. Note: When the information was not yet available, the distribution between the different types of biogas was estimated by EurObserv'ER for the year 2022 according to the distribution of the year 2021. Source: EurObserv'ER 2023



the auspices of the Common Agricultural Policy. A few months later, on Wednesday 29 September 2022, the European Commission and the biomethane sector leaders launched the Biomethane Industrial Partnership (BIP) that aims to turn the REPowerEU plan's aims into reality at reasonable cost. At the same time, it will make a substantial contribution to a net zero emission integrated energy system, diversify farmers' incomes and contribute to a circular approach. The financial undertakings to meet this immense challenge are becoming clearer. In June 2023, the EBA presented its first edition of the Biomethane Investment Outlook, based on a partial response by association investors and project developers. It shows that investments are on track with 18 billion euros already set aside for investment in biomethane production. Between 2023 and 2025, 4.1 billion euros should be invested, while an additional 12.4 billion euros will be released between 2026 and 2030, and a further one billion euros coming at an as yet unspecified date. The investments

Graph. n° 3

EurObserv'ER projection of electricity production from biogas* in the EU 27 (in TWh)



* Pure biogas and biogas blended in the grid compliant and not compliant according RED 2
Source: EurObserv'ER 2023

are mainly geared to projects in France (1.4 billion euros) and Italy (1.1 billion euros) because of these Member States' advantageous conditions. They are followed by the Netherlands (951 million euros), Spain (948 million euros), Germany (658 million euros), Sweden (635 million euros) and Poland (429 million euros). What is more, 5.5 billion euros of capital injection whose final destination is as yet undecided will remain in the EU and 3.3 billion euros will target third countries,

Tabl. n° 5

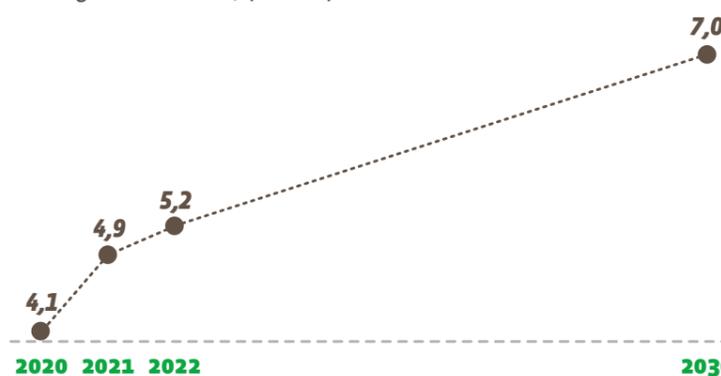
Representative firms of the methanisation sector in Europe as of 2023

Company	Activity sector	Country	Number of references
AB Group	Manufacturer	Italy	>1550 (Natural gas and biogas CHP, biomethane) 1750 MW of CHP
PlanET Biogas Global	Manufacturer and developer	Germany	>700 (World)
EnviTec Biogas	Manufacturer, developer and operator	Germany	660 references (458 MWe), operates 89 of its own plants
HZI Group	Manufacturer and Developer	Switzerland	>600 (World)
Weltec Biopower	Manufacturer	Germany	>350 (World)
Naskeo (Keon Group)	Developer and operator	France	80
Nature Energy (Shell Group)	Developer and operator	Denmark	14 (13 in Denmark, 1 in Netherlands) (185 millions m³/an)
Engie Bioz	Developer and operator	France	20 (350 GWh, Biogaz production capacity)
TotalEnergies	Developer and operator	France	18 (11 CHP plant, 7 biomethane injection) - 700 GWh of biogas production capacity
Gasum	Developer and operator	Finland	17
Biokraft (former Scandinavian Biogas)	Manufacturer, developer and operator	Sweden	5 (Sweden, Norway and Korea) (455 GWh of biogas production capacity). Biogas production capacity equivalent to 600 GWh by 2024.

Sources : Eurobserv'ER 2023 based on companies' communication

Graph. n° 4

EurObserv'ER projection of heat consumption* from biogas** in the EU 27 (in Mtoe)



* Final energy consumption and gross heat production in the transformation sector. ** Pure biogas and biogas blended in the grid compliant and not compliant according RED2. Source: EurObserv'ER 2023

primarily the UK and Ukraine. However, these investment volumes fall short of the figure needed to meet the 35 billion m3 biomethane production target. Early in July 2022, Anders Mathiasson the EBA President, put an 83 billion euro figure on the amount of capital needed to meet the target, namely, 48 billion euros to build 4 000 medium-sized plants and 35 billion euros to construct 1 000 large-scale plants in eight years. Ole Hvelplund, CEO of Denmark's biomethane producer NatureEnergy, has appealed for the introduction of a floor price for gas, which is a prerequisite for paving the way for many investments in Europe.

As for the European Union's potential, a new study was published in July 2022 by the Gas for Climate consortium comprising 11 gas transport companies (including GRTgaz, Enagás, Energinet, Teréga, etc.) and three renewable gas industry associations (EBA, the German Biogas Association and Consorzio Italiano Biogas). The study shows that 41 billion m3 of biomethane could be available in 2030 and 151 billion m3 in 2050. In detail, a potential 38 billion m3 in 2030 (91 billion m3 in 2050) could be obtained by anaerobic digestion and 3 billion m3 through thermal gasification (rising to 60 billion m3 in 2050). These figures should be com-

pared with natural gas consumption in 2020 of about 400 billion m3 including 155 billion m3 of Russian gas imports. Methanation biomethane, complemented by the other renewable gas production sectors, pyrogasification, hydrothermal gasification, Power-to-gas, and coordinated with declining needs, has the potential to release the European Union from its dependency on fossil gas and enable the new revamped Renewable Energies Directive (RED 3) targets to be met whose final text was finally formally adopted on 9 October 2023 by the European Council. The new backbone of Europe's future decarbonised energy system is at last taking shape. It will be based on a hybrid infrastructure built on a reinforced construction of gas and electricity grids primarily supplied by renewable energies. □

Sources : AGEE-Stat (Germany), Terna (Italy), SDES (France), Danish Energy Agency, Statistics Netherlands, Ministry for the Ecological Transition and the Demographical Challenge (Spain), SPF Economie (Belgium), Statistics Finland, Statistic Sweden, CRES (Greece), Central Statistical Bureau of Latvia, DGEG (Portugal), Statistics Lithuania, Statistical Office of the Republic of Slovenia, Statistics Estonia, EurObserv'ER, Eurostat early estimate.

The next barometer will be about renewable energies in transport.



This barometer was prepared by Observ'ER in the scope of the EurObserv'ER project, which groups together Observ'ER (FR), TNO (NL), Renewables Academy (RENAC) AG (DE), Fraunhofer ISI (DE), VITO (Flemish Institute for Technological Research) (BE) and Statistics Netherlands (NL). This document has been prepared for the European Commission however it reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

