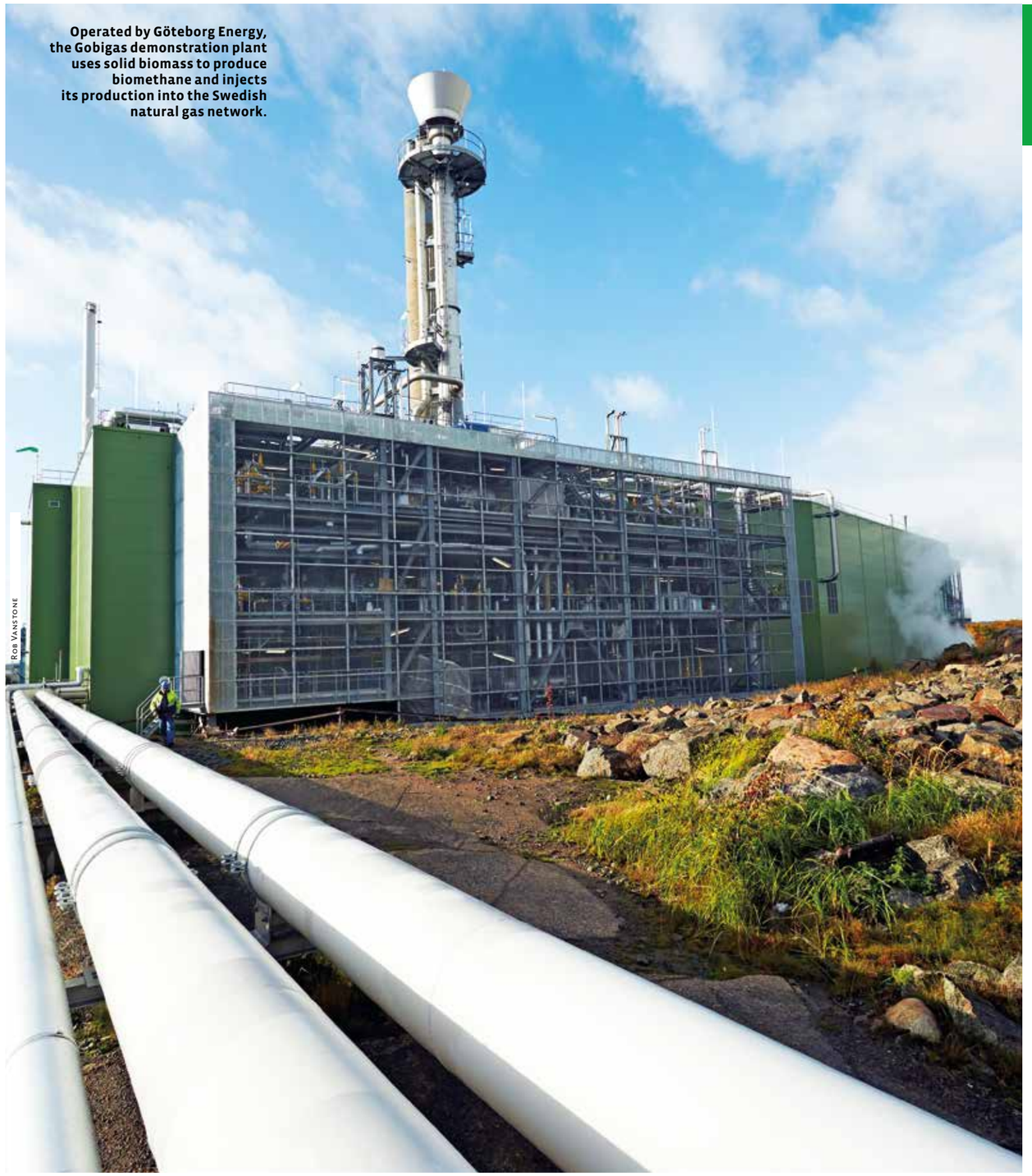

Operated by Göteborg Energy, the Gobigas demonstration plant uses solid biomass to produce biomethane and injects its production into the Swedish natural gas network.

+ 3.0 %

Biogas primary energy production growth in 2016.

BIOGAS BAROMETER

A study carried out by EurObserv'ER.

EurObserv'ER

Biogas has crossed a new threshold in the European Union, as EurObserv'ER puts primary energy output in 2016 at more than 16 million tonnes of oil equivalent. Methanization plants purpose-designed for energy recovery, such as farm biogas, co-digestion biogas and industrial biogas now produce almost three-quarters of the total biogas output leaving landfill sites and wastewater sludge treatment plants far behind.

16.1 Mtoe

of biogas primary energy produced in 2016 in the European Union.

62.5 TWh

of biogas electricity produced in 2016 in the European Union

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Injection biomethane station in the gas network in Morsbach in Moselle (France).

Most of current biogas production across the European Union comes from methanization plants purpose-designed for energy recovery grouped under the term "Other biogas from anaerobic fermentation" (see box). These plants vary in type and capacity and include small farm methanization plants, higher-capacity plants such as co-digestion (or multi-product) sites, large industrial food-processing plants (mainly single feedstock), and some household waste methanization plants. They use different types of feedstocks (raw materials) such as manure, farm crop waste, green waste, food-processing industry waste and household waste, and may also use intermediate crops (crucifers, grasses, etc.) and energy crops (corn, etc.). Energy crops are not universally used, as some Member States have adopted domestic legislation to regulate their use by setting a maximum input level for facilities seeking payment for producing biogas. For example the maximum threshold is 60 % in Germany, Austria also applies a 60 % limit (soon to fall to 30 %, see below) while it is 15 % in France (excluding intermediate crops). Energy crops are added to optimise the methanization reaction by contributing carbon. This facilitates the methanogenic production of the digestate and is primarily used in biomethane plants (purified biogas).

16.1 MTOE PRODUCED IN THE EUROPEAN UNION

In 2016, European Union primary energy production from biogas continued its upward trend (growing by 3 % to 16.1 Mtoe) although the pace has been on a steady decline **(table 1) s**ince 2011 (22.4 %, 17 %, 14.3 %, 7.3 %, 4.2 % and 3 %). The main reasons for this decline are regulations hostile **(graphique 1)** to the use of energy crops that initially boosted output in those countries that decided to develop farm biogas (primarily Germany, Italy and the UK) and the setting of less attractive biogas electricity payment terms.

Every EU country has a biogas energy recovery sector, but about 77 % of the output is concentrated in three countries, namely Germany (8 Mtoe), the UK (2.4 Mtoe) and Italy (2 Mtoe). They are followed by the Czech Republic and France running neck and neck with about 0.6 Mtoe each.

For several years the "other biogas" category has dominated the spread of biogas primary energy production in the European Union. In 2016, it held a 74.1 % share (73.2 % in 2015) and for many years has accounted for almost all the increase in total biogas output. Accordingly, the landfill biogas (17.2 % in 2016) and wastewater treatment plant shares (8.7 % in 2016) have been falling steadily. For the time being, only negligible output of synthetic biogas (by thermal processes) has been identified. The individual member states have their own spreads not necessarily dominated by the "other biogas" category. The latter is particularly prevalent where an industrial methanization sector has been developed along the lines of farm biogas and co-digestion in larger units. This is primarily true of Germany, Italy, Austria, the Netherlands, Belgium and the Czech Republic. Landfill biogas holds the upper hand where farm and industrial methanization are more recent developments, such as in the UK, France, Spain, Portugal, Finland, Greece, Ireland and Estonia. Electricity production is the main recovery method and may or may not be produced in cogeneration plants. In 2016, it accounted for 62.5 TWh of output, which represents 2.5 % growth on the previous year. Heat sales to district heating networks rose by 3.9 % in 2016 to 643.3 ktoe **(table 2)**. Final energy consumption has to be added to this (that does not go through the processing sector) **(table 3)** which is put at about 2 919 ktoe in 2016 (10.7 % more than in 2015). Biogas can be fully utilised for

Biogas in its various guises

Methanization is a natural biological process in which many micro-organisms (bacteria) break down organic matter in an oxygen-free environment. This may occur naturally in certain environments such as marshes. It may also be deliberately engineered for energy production and/or waste treatment purposes in anaerobic (in the absence of oxygen) fermentation plants using industrial equipment called "methanizers or digesters" or alternatively may occur naturally in non-hazardous waste storage centres (engineered landfills).

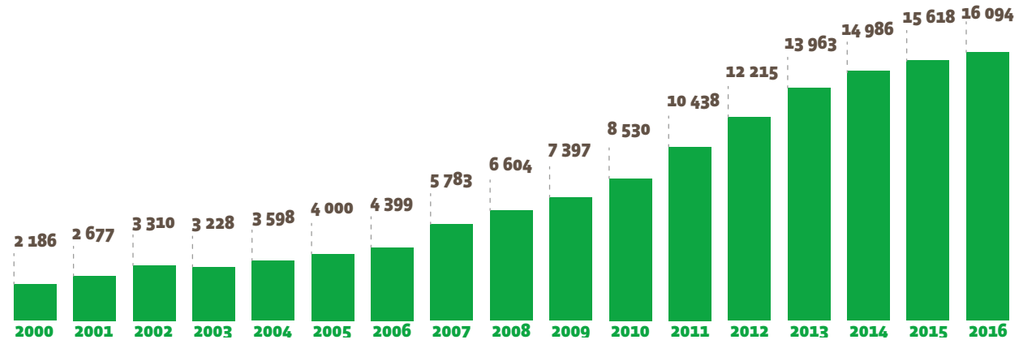
The international nomenclature used by Eurostat and the International Energy Agency, divides biogas (from anaerobic fermentation) into three sub-sectors, segmented by waste origin and treatment. The official names are given in inverted commas:

- ***Methanization of wastewater treatment plant sludge*** *("sewage sludge gas").*
- ***Non-hazardous waste storage facility biogas*** *("landfill gas").*
- ***Methanization of non-hazardous waste or raw plant matter*** *("other biogas" produced by anaerobic fermentation)*

These international institutions also monitor a fourth segment, *whose biogas is* ***the product of a heat treatment process*** *("biogas from thermal processes") by pyrolysis or gasification of solid biomass (wood, forest residue, solid and fermentable household waste). These processes produce hydrogen (H_2) and carbon monoxide (CO), which when combined can be transformed into synthetic biogas to substitute natural gas (CH_4). These processes have been identified in Finland, Sweden and Italy, and new projects are underway, as in the Netherlands (see below). For the sake of convenience and in view of their insignificant output level,* ***EurObserv'ER has included this output in the "other biogas" category.***

Graph. n° 1

Evolution of primary biogas energy production in European union (EU 28) since 2000 (in ktoe)



Source: EurObserv'ER 2017

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producing heat with maximum energy efficiency if there are outlets near the methanization plant. It can also be purified for conversion into biomethane, in which case it is recovered in the same way as say natural gas, in the form of electricity in cogeneration plants, and also stored for natural gas vehicles (NGV) or even injected into the natural gas grid. In recent years, biomethane injection has become a flourishing biogas market trend.

According to the EBA (European Biogas Association), there were at least 17 376 b iogas plants in Europe at the end of 2015 (2016 figure unavailable) which is a 3 % year-on-year increase (16 834). The electricity produced by these plants is enough to cover the consumption needs of more than 14 million European households.

Tabl. n° 1

Primary production of biogas in the European Union in 2015 and 2016 (in ktoe)*

	2015				2016*			
Country	Landfill biogas	Sewage sludge biogas[1]	Others biogas from anaerobic fermentation[2]	Total	Landfill biogas	Sewage sludge biogas[1]	Others biogas from anaerobic fermentation[2]	Total
Germany	94.0	451.7	7 306.6	7 852.4	84.6	461.5	7 410.2	7 956.3
United Kingdom	1 450.8	327.8	473.8	2 252.4	1 400.4	345.6	660.9	2 406.9
Italy[3]	369.0	53.5	1 448.9	1 871.5	400.1	58.0	1 570.8	2 028.9
Czech Republic	27.1	40.0	546.2	613.4	25.4	41.5	534.0	601.0
France	355.0	31.7	152.3	539.0	350.0	35.0	194.6	579.6
Netherlands	19.5	55.3	252.2	327.0	16.4	57.5	250.5	324.4
Austria	4.4	11.3	284.3	300.1	3.1	11.7	294.0	308.9
Poland	50.8	96.6	81.5	228.8	51.0	100.0	121.8	272.8
Belgium	25.7	24.1	176.9	226.7	26.8	25.2	184.6	236.6
Spain	140.6	70.4	50.6	261.6	124.1	62.1	44.6	230.8
Sweden[3]	16.1	59.9	90.7	166.7	15.0	61.0	97.6	173.5
Slovakia	3.4	14.8	130.5	148.6	3.4	14.7	130.0	148.1
Denmark	4.2	21.8	125.6	151.6	3.4	17.7	101.8	122.9
Finland[3]	27.9	15.5	59.9	103.2	28.0	15.0	64.5	107.5
Greece	69.9	15.9	5.6	91.4	72.5	16.6	12.6	101.7
Latvia	8.4	2.0	77.4	87.8	7.8	2.6	79.5	89.9
Hungary	13.9	20.3	45.5	79.7	13.9	20.4	46.2	80.5
Portugal	71.2	2.6	8.8	82.6	68.2	3.0	9.2	80.3
Ireland	41.0	8.0	5.6	54.6	40.3	8.5	7.5	56.3
Croatia	5.1	3.4	27.5	36.0	6.0	4.1	32.8	43.0
Slovenia	5.0	2.4	22.2	29.7	3.7	2.2	24.3	30.2
Bulgaria	5.0	14.0	0.0	19.0	9.0	19.0	0.0	28.0
Lithuania	8.5	7.5	16.0	32.0	8.2	7.0	8.2	23.4
Luxembourg	0.0	1.6	16.1	17.7	0.0	2.3	17.6	19.9
Romania	1.0	0.1	17.0	18.1	1.0	0.1	17.0	18.1
Cyprus	0.0	0.0	11.5	11.5	0.0	0.0	11.7	11.7
Estonia	11.6	1.5	0.0	13.1	10.7	0.0	0.0	10.7
Malta	0.1	1.0	0.5	1.6	0.0	1.2	0.5	1.8
EU 28	2 829.1	1 354.8	11 433.8	15 617.8	2 773.0	1 393.5	11 927.1	16 093.6

*1) Urban and industrial. 2) Decentralised agricultural plant. municipal solid waste methanisation plant. industrial methanisation plant. centralised co-digestion plant. 3) A biomethane production by thermal processes has been included in the "other biogas (biomethane)" catégory in Italy. Finland and Sweden. * Estimate. Note: When the information was not yet available. the breakdown between the different types of biogas was estimated by EurObserv'ER for the year 2016 according to the breakdown of the year 2015.* ***Source: EurObserv'ER 2017***

GERMANY, THE COUNTRY WITH 10 000 METHANIZERS

Germany is the undisputed No. 1 biogas producer country. Preliminary data released by AGEE Stat puts primary energy output close to the 8 Mtoe threshold (7 956 ktoe in 2016), i.e. 1.3% more than in 2015. Electricity production rose to 33.7 TWh (73% of which was generated in CHP plants), which equates to a 2% increase over its 2015 performance. Farm biogas, which was vigorously developed until 2011, explains its 93.1% share of the "other biogas" segment. However, the number of newly commissioned plants in the segment has dwindled since 2011 because of the change to the EEG 2012 law, which capped the use of corn as a feedstock at 60%. With the enactment of the EEG 2014 law, the downward trend was aggravated by the introduction of even more restrictive measures on the use of energy crops for new facilities and compounded by the implementation of new, less lucrative Feed-in Tariffs, the discontinuation of premiums for producing electricity via biomethane and using energy crops (Nawaro Bonus).

At the end of 2016, the Fachverband Biogas Association, counted as many as 9 346 methanization plants equating to 4 497 MW of electrical capacity. The number of new plants has risen slightly in the last two years – by 195 in 2016 (150 in 2015) but the increase is a far cry from the golden age of German biogas, when the annual plant installation rate stood at more than 1 000 (1 314 in 2009, 1 107 in 2010, 1526 in 2011). The association predicts a further fall in the number of new plants for 2017 to 137. The EBA, which factors in all biogas plants, says that the symbolic 10 000 mark was passed at the end of 2015 with 10 846 plants (2016 figures unavailable).

The German government's biomethane injection policy instituted in 2006 was highly ambitious. It initially set a target of 6 billion normal m³ (Nm³) of injected biomethane by 2020 and 10 billion Nm³ by 2030. However the last government sought to disassociate itself from these aims. The biomethane barometer published by Dena (the German environmental agency) puts the number of biomethane plants at the end of November 2016 at 194, which equates to a little less than 1 billion Nm³ of gas. At the end of November 2017, only seven plants, which would add 380 GWh of additional annual injection capacity, were under construction. According to Dena, the energy value of the injected biomethane was about 9.4 TWh in 2016 compared to 8.5 TWh in 2015, achieved mainly through improved capacity utilization in the existing plants.

The German government's priority has changed from encouraging the development of biomethane injection to improving its integration into the country's energy system (electricity, heat or fuel). Dena claims that biogas fuel contributes 1.1% of the renewable energy share for transport and 20% of the consumption of vehicles running on gas. Another advantage noted is that biomethane output can be stored for several months to meet higher demand for heat in the

Biomethane injection – a growth vector

By the end of 2016, according to the France Biomethane think tank and the Sia Partners consultancy which run a European biomethane observatory, the sector had some 480 plants injecting biomethane into Europe's natural gas grids, in the 9 countries being monitored. The number of plants rose by 13% in 2016 (and by 20% in 2015). Each of the countries under study has at least one of the four aid mechanisms specific to biomethane injection: feed-in tariffs dedicated to biomethane injection (implemented in France, the UK, the Netherlands, Denmark and Austria), grid injection priority, grants for creating installations and guarantees of origin or renewable gas quotas. These mechanisms are geared to achieving the European or national RES targets.

Several countries have banned the use of energy crops (particularly in Scandinavia). They are the most commonly used substrate by number of plants and volume of processed biogas. This is primarily due to their very widespread use in Germany and the UK. Another important trend is that co-digestion plants are developing quickly and could soon overtake the other types of production, as they enable different feedstock streams to be pooled, thereby boosting facilities' capacities and profitability. Waste storage (landfill) and wastewater treatment plants (WWTPS) are seldom found and could offer the sector with major development potential.

The nine countries covered by the study are: Germany (201 plants, 9.4 TWh injected in 2016), the United Kingdom (81 plants, 3.6 TWh in 2016), France (29 plants, 215 GWh in 2016), Switzerland (35 plants, 308 GWh in 2016), Austria (16 plants, 250 GWh in 2016), Sweden (62 plants, 470 GWh in 2015), Netherlands (27 plants, 900 GWh in 2015), Denmark (19 plants, 380 GWh in 2016), Finland (13 plants, 80 GWh in 2016).

Germany dominates the European market with 201 plants in 2016 and its output is more than 50% of the combined output of the nine. The UK has posted impressive growth, overtaking Sweden, the sector's historical pioneer, in less than six months. Sweden's sector is currently stagnating slightly along with that of the Netherlands. France has recorded a sharp rise in the number of plants but lags a long way behind the European leaders. Lastly, Denmark has the distinction of operating Europe's largest plants. Biomethane-dedicated Feed-in Tariffs have been the growth drivers in Germany and are the reason why the sector is growing fast in France, Denmark and the United Kingdom.

winter. This flexibility means that it can benefit from higher electricity prices on the market.
Nonetheless, Germany's biomethane industry is disappointed by the situation as the government has reduced the tenders to 150 MW of capacity for all biomass sectors from 2017 to 2019, rising to 200 MW from 2020 to 2022, with a maximum offer of 14.88 euro cents per kWh for new biomethane plants. Plants already in service are better off as their operators enjoy higher tariffs with increasingly optimized production levels. It should be pointed out that corn and energy crops still make up a major proportion of the feedstock used in German biomethane production plants. In 2015, corn alone accounted for 60% of the energy content (53% of the mass), with 27% from other energy crops (24% of the mass), 8% from organic waste (10% of the mass) and 5% from manure (12% of the mass).

POLITICAL UNCERTAINTY IN THE UNITED KINGDOM

Biogas enjoyed positive momentum until 2016 in the UK, mainly driven by its conversion into electricity. The BEIS (Department for Business, Energy & Industrial Strategy) reports that biogas electricity production from anaerobic digestion increased to 2.1 TWh or by 40% between 2015 and 2016. At the same time the capacity of these plants increased by 30% to 0.4 GW with an associated load factor of 62.8%. Landfill biogas is on a downhill slide for the fifth year running, brought about by the reduction in deposits of organic waste in landfills in favour of using more efficient recovery modes (for example anaerobic digestion). Electricity production from landfill peaked at 5.3 TWh in 2011, but in 2016 only amounted to 4.7 TWh, which is a 12% decline (it dropped by 3.5% between 2015 and 2016), for 8.4 GW of installed capacity (0.8% added between 2011 and 2015). If we add wastewater plant biogas output (950 GWh in 2016 as against 894 GWh in 2015), biogas electricity volumes rose by 6.5% to 7.7 TWh. As for total biogas primary energy output, the BEIS has so far only released data as gross calorific value (GCV) rather than net calorific value, (NCV), which is the unit used for international comparison purposes. On the basis of this data, EurObserv'ER puts output at 2.4 Mtoe in 2016 (NCV) – a 6.9% rise.
The British Anaerobic Digestion and Bioresources Association (ABDA) has reservations about the stability of the anaerobic digestion (AD) sector's development. In its July 2017 report, it blames delays in adopting the Renewable Heat Incentive (RHI) legislation, which provided for a remuneration rate of 5.35 p per kWh. The delays have postponed the construction of 13 AD plants. Meanwhile, electricity production at AD plants receives scant government support, with the Feed-in Tariff for >500-kW plants at just over 2 p per kWh (€ 0.023 per kWh). In 2016, 50–80 new AD plants were commissioned, but because of political uncertainty, the number is likely to fall to 19–67 in 2017.
Incidentally, since 2017, the UK has exported part of its biomethane output to the Netherlands; to boost the latter's renewable energy targets. Barrow Green Gas produces the biomethane and sells it to Essent, the Netherlands' biggest energy company (and by the way, a subsidiary of the German uti-

Biogas fuel finding its way onto the road

Another possible solution in addition to the highly promising new mobility technologies, such as electric vehicles fitted with electrochemical batteries (lithium-ion or other) or fuel cells, is biogas fuel. Biogas has a host of real assets, as it is carbon-neutral, efficient by not polluting the air, with high, very short-term deployment potential, and what is more to the point, it uses proven motorisation. It can be used as fuel (that has been purified as biomethane) in NGV vehicles (that run on natural gas) in two forms: GNC, compressed natural gas (at 20 MPa, i.e. 200 bar) or GNL liquefied natural gas (at -163°C). NGV vehicles must not be mistaken for LPG (liquefied petroleum gas) vehicles, for this oil-based liquid product comprises butane and propane. For technical reasons, there is no way that an LPG vehicle can run on NGV, and vice versa.

Sweden leads Europe in the use of biogas fuel for vehicles. According to Energigas Sverige, 64% of total biogas output in 2016, (put at 2 TWh) was converted into biomethane, which was used almost exclusively for vehicle fuel. The country has 63 biogas enrichment plants that produced 1 234 GWh of biomethane in 2016, and 13 plants that injected it directly into the country's two natural gas grids. Sweden also has an LBG (liquefied biogas) production plant that produced 44 GWh in 2016.

Germany is one of the other main users of biogas fuel, which AGEE Stat claims contributed 1.1% of the renewable energy share for transport, and 20% for the consumption of gas-driven vehicles, i.e. 370 GWh used in 2016 (345 GWh in 2015). Moreover, two biomethane plants supply a biogas service station directly without injecting any biogas into the gas grid.

According to data published by Ari Lampinen of the University of Eastern Finland, the country had at least 24 service stations with biogas fuel pumps in 2016. A further four were commissioned in the first half of 2017. The latest additions are supplied by 11 enrichment plants producing biogas fuel, whose output was 21.4 GWh in 2016.

In France, biogas fuel consumption is also rising and is being championed by economic players. In conjunction with Engie, the Carrefour hypermarket chain has just opened its first biomethane service station in the Paris region (Servon), for its own use. The chain intends to deploy 200 biomethane-driven trucks by the end of 2017, to reduce the environmental impact of its deliveries. By the same deadline, nine Bio-NGV service stations will be opened to fuel the biomethane-driven trucks and offer clean and silent delivery to 250 of its urban stores.

Tabl. n° 2

Gross electricity production from biogas in the European Union in 2015 and 2016 (in GWh)*

	2015			2016*		
Country	Electricity only plants	CHP plants	Total electricity	Electricity only plants	CHP plants	Total electricity
Germany	8 844.0	24 220.0	33 064.0	9 088.0	24 625.0	33 713.0
Italy	3 139.0	5 072.9	8 211.9	3 073.2	5 185.5	8 258.7
United Kingdom	6 513.3	723.7	7 237.0	6 934.5	770.5	7705.0
Czech Republic	51.0	2 560.0	2 611.0	49.0	2 540.0	2 589.0
France	713.0	1 070.0	1 783.0	786.0	1 179.5	1 965.5
Poland	0.0	906.0	906.0	0.0	1 049.0	1 049.0
Netherlands	42.9	993.0	1035.9	36.0	970.0	1 006.0
Belgium	87.5	867.0	954.5	85.5	847.5	933.0
Spain	743.0	239.0	982.0	893.0	0.0	893.0
Austria	579.0	44.0	623.0	584.0	55.0	639.0
Slovakia	117.0	424.0	541.0	107.7	390.3	498.0
Denmark	1.0	472.0	473.0	1.0	475.0	476.0
Latvia	0.0	392.0	392.0	0.0	397.0	397.0
Hungary	222.0	94.0	316.0	258.0	117.0	375.0
Finland	203.3	153.8	357.1	204.9	155.1	360.0
Portugal	278.9	16.0	294.9	267.7	17.8	285.5
Greece	33.6	196.7	230.3	32.8	216.7	249.5
Ireland	171.9	29.6	201.5	168.0	44.0	212.0
Croatia	24.7	151.4	176.1	28.0	172.0	200.0
Bulgaria	34.0	86.0	120.0	42.5	107.5	150.0
Slovenia	4.0	128.0	132.0	4.3	137.7	142.0
Lithuania	0.0	78.0	78.0	0.0	123.0	123.0
Luxembourg	0.0	61.6	61.6	0.0	72.6	72.6
Romania	29.0	32.0	61.0	29.0	32.0	61.0
Cyprus	0.0	51.0	51.0	0.0	52.0	52.0
Estonia	0.0	50.0	50.0	0.0	45.0	45.0
Sweden	0.0	11.0	11.0	0.0	9.0	9.0
Malta	0.0	2.6	2.6	0.0	2.9	2.9
EU 28	21 832.0	39 125.4	60 957.4	22 673.1	39 788.6	62 461.7

Estimate.* ***Source: EurObserv'ER 2017*

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lity company RWE) via a pipeline that connects the UK with Europe. Trading covers the delivery of 20 million Nm³ of biomethane per annum.

THE GREEN LIGHT FOR INJECTION IN FRANCE

After protracted hesitation, France implemented a proactive policy on biogas production and biomethane injection in 2014. Its Monitoring and Statistics Directorate (SDES) reports that the amount of biomethane injected into the country's natural gas grids increased sharply in 2016, even though volumes are still low. The amount rose from 82 GWh GCV (gross calorific value) in 2015 to 215 GWh GCV in 2016. Given the production capacities, this figure is set to rise significantly in the next few years. The SDES trend chart shows that at the end of June 2017, France had 35 plants injecting biomethane into the natural gas grids. Their combined annual capacity is 533 GWh, which is a 30% increase over the end of 2016. Additional annual capacity of 123 GWh was installed in the first half of 2017, which is twice as much as in the same period in 2016. On 30 June 2017 there were 297 projects in the pipeline for 6 501 GWh of annual production capacity – a 28% rise over six months. The declared multi-annual energy plan biomethane injection targets are now 1.7 TWh for 2018 and 9 TWh in 2023 and electrical capacity of 137 MW and 237–300 MW for 2023.

France now has extremely advanced legislation on biogas. The environment code limits the use of food or energy crops grown as a main crop in non-hazardous waste or raw plant matter methanization plants to no more than 15% of the gross feedstock tonnage per calendar year, to provide a framework for development. In 2014, the Environment Minister issued a call for projects, with a closing date of September 2017, aimed to develop 1 500 methanization installations over three years spread across rural areas.

France has several support mechanisms for methanization projects. The first is the waste fund that finances digestate treatment equipment and methanization projects involving biogas recovery produced in CHP plants. The second, the heat fund, finances methanization projects with direct heat recovery in heating networks as well as biomethane gas grid injection projects. There is also a CHP electricity purchase obligation. Tenders support 500 kW methanizers, while sites with capacities below this threshold are supported by a guaranteed Feed-in Tariff over 20 years. A tender was put out on 8 February 2017, for <5 MW methanizers, covering an annual volume of 10 MW over 3 years.

A point to bear in mind is that >500 kW installations that opt to inject biogas rather than recover it directly as electricity or heat, are not subject to tendering. This is behind the strong interest in the injection market shown by project developers. To encourage the development of injection, the government has also introduced a purchase obligation for injected biomethane.

Biomethane producers intending to inject their output into the gas transmission and distribution grids can apply for purchase obligations all year round. The injected biomethane is purchased by a natural gas supplier at a pre-set FiT for 15 years. The rate for non-hazardous waste storage facilities is € 0.045 and € 0.095 per kWh depending on the size of the facility. In the case of the other methanization plants, the injected biomethane Feed-in Tariffs (excluding the annual indexation coefficient) comprise a basic tariff of € 0.064–0.095 per kWh depending on the size of the plant, plus a premium calculated on the basis of the substrate ("feedstocks") treated by methanization. This premium is set at € 0.02–0.03 per kWh if the feedstock exclusively comprises waste or products sourced from farming or food processing. It is € 0.05 per kWh if the feedstock is exclusively household waste and varies between € 0.01 and € 0.039 per kWh for sewage sludge feedstock. When the feedstock is "blended" (codigestion), the premium is weighted prorata to the quantities of feedstocks used by the facility. As a safeguard, a tendering procedure is used to keep the development trajectory of biomethane production capacity in check.

The government announced new measures to promote renewable energies on 25 September 2017 to assist the implementation of new projects. Small and medium renewable electricity production facilities will be eligible for a rate discount on the grid connection costs of up to 40%. This discount will also be offered on the gas grid connection costs of biogas production facilities, As the Minister pointed out, up to that point, they "were entirely borne by the producers, which could make biogas production projects in rural areas impossible when the distance separating the methanizable resource from the gas grid was too great".


ECN

The project demonstrator Milena in Alkmaar in the Netherlands converts waste or biomass in biogas (biomethane quality) by pyrolysis.

AUSTRIA INTENDS TO REDUCE THE USE OF ENERGY CROPS

Biogas output in Austria is much lower than that of its neighbour, Germany. According to data released by Statistic Austria, it produced 308.9 ktoe in 2016, which is 2.9% more than in 2015 and its biogas electricity output was 639 GWh in 2016 (2.6% more than in 2015). At the end of June 2017, the country amended its renewable energy law, "Ökostromgesetz". From the beginning of 2018, methanization plants will only be eligible for remuneration for their output provided they limit their use of corn and other cereals as raw material to a maximum of 30%. There are two options open to them –<150 kWel plants with efficiency in excess of 67.5% may convert their output directly as electricity. Plants with capacities of >150 kWel will have to choose between injecting the biogas (once purified) directly into the natural gas grid or

Tableau n° 3

Gross heat production from biogas in the European Union in 2015 and in 2016 (in ktoe) in the transformation sector***

	2015			2016*		
Country	Heat only plant	CHP plant	Total	Heat only plant	CHP plant	Total
Italy	0.3	205.2	205.5	0.3	223.6	223.8
Germany	66.9	150.0	216.9	67.8	153.8	221.6
Denmark	7.3	32.1	39.4	2.7	33.1	35.8
France	2.7	31.6	34.3	2.7	31.6	34.3
Latvia	0.0	21.3	21.3	0.0	22.7	22.7
Finland	6.8	11.4	18.2	6.9	11.7	18.6
Czech Republic	0.0	14.9	14.9	0.0	14.3	14.3
Poland	0.3	10.1	10.4	0.3	13.1	13.4
Slovakia	0.0	11.3	11.3	0.0	10.3	10.3
Belgium	0.0	9.3	9.3	0.0	9.3	9.3
Sweden	3.0	3.6	6.5	3.1	3.7	6.8
Slovenia	0.0	7.3	7.3	0.0	6.6	6.6
Croatia	0.0	5.2	5.2	0.0	6.0	6.0
Austria	1.6	1.8	3.5	1.6	3.7	5.4
Romania	0.1	3.7	3.8	0.1	3.7	3.8
Hungary	1.3	1.8	3.1	1.3	2.0	3.3
Lithuania	0.0	2.2	2.2	0.0	2.2	2.2
Estonia	0.0	2.7	2.7	0.0	1.3	1.3
Cyprus	0.0	1.2	1.2	0.0	1.2	1.2
Netherlands	0.0	1.1	1.1	0.0	1.1	1.1
Bulgaria	0.0	0.6	0.6	0.0	0.6	0.6
Luxembourg	0.0	0.5	0.5	0.0	0.6	0.6
Malta	0.0	0.1	0.1	0.0	0.2	0.2
EU 28	90.3	529.0	619.3	86.9	556.4	643.3

*Estimate ** Heat sold to the district heating network or to the industrial units. **Source: EurObserv'ER 2017**

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convert it through cogeneration. The funding envelope allocated to support these new plants is limited to 1 million euro per annum. Provided that they use less than 60% corn as their feedstock, existing plants will still be eligible for subsidies.

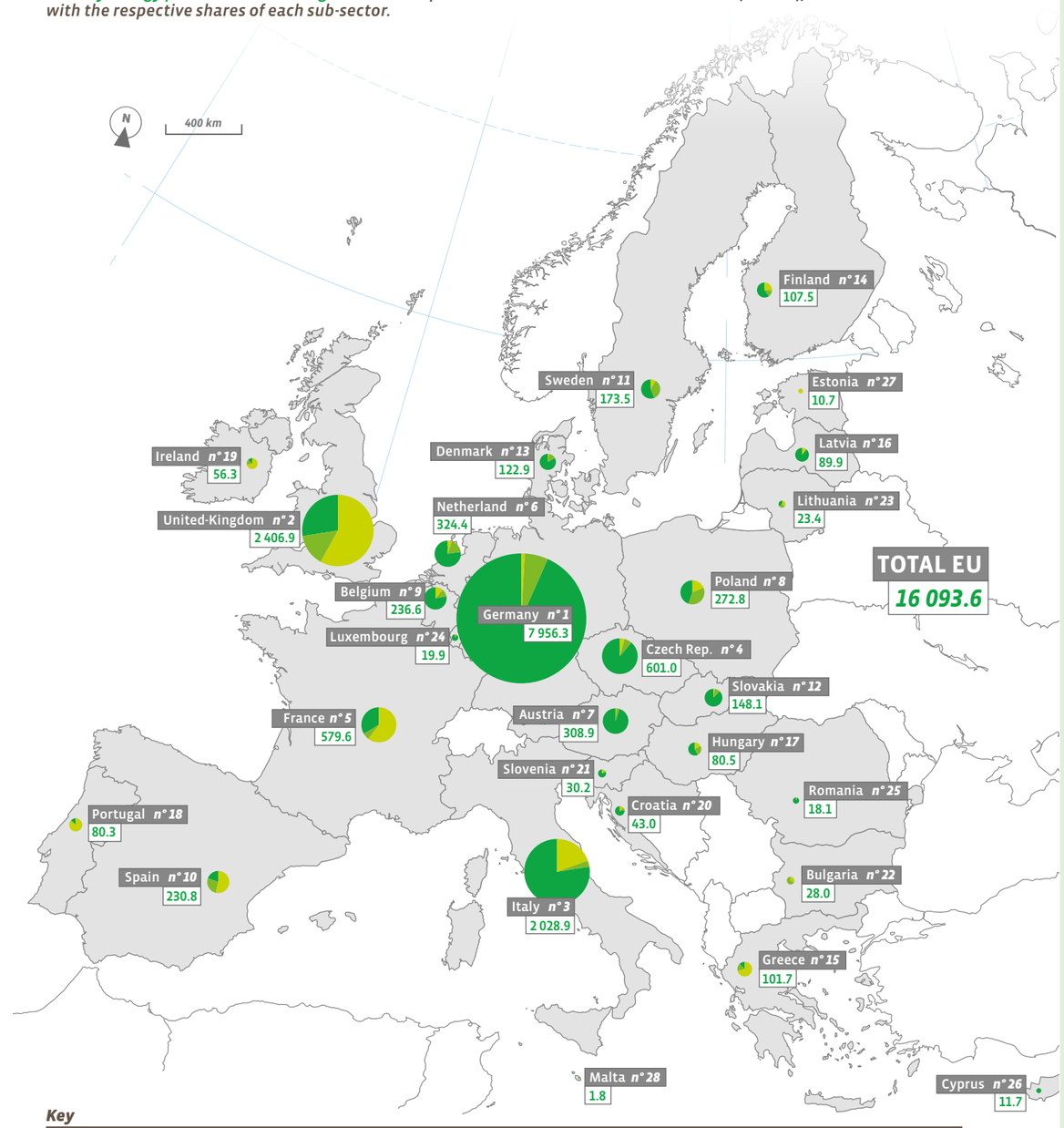
THE METHANIZATION INDUSTRY HAS NO OPTION BUT TO DIVERSIFY

The European biogas market started contracting from 2012–2013 onwards caused by the downturn in the German and Italian markets. A number of companies, such as methanizer manufacturers Biogas Nord AG and MT Energie, were unable to weather the resulting turbulence and collapsed, altering the list of representative companies **(table 4)**.
Many methanizer manufacturers began developing downstream of the value chain and started operating their own plants to diversify their income and stay in business. Also the methanization plant construction market is making the most of the growth in biomethane injection.
The value chain of a biogas project breaks down into four major stages, namely development, finance, construction and operating (see box below).
Several European concerns have focused on constructing methanization plants **(table 4)**. For example, in the middle of 2017, the German company Weltec Biopower, initially a stainless steel installation specialist, claimed it had constructed more than 300 biomethanization sites across the world. Its customers are waste management and food-processing companies, farming and water treatment companies. There is also a Danish company working in this segment, Xergie, which started work alongside NGF Nature Energy, to construct Denmark's biggest methanization facility in August 2017. It is designed to handle 600 000 tonnes of biomass from farms as well as dairy production residue, and will generate 27.5 million cubic metres of biogas. The project investment sum is 31 million euro and it should come on stream at the end of 2018.
Other constructers are looking further down the value chain by operating some of the facilities they have constructed. An example of this is the German company Envitec Biogas, which generated 62% of its 2016 income from operating sites, in contrast with construction, its core business that only generated 18.5% of its income – a 41.2% drop (primarily because of difficulties invoicing its customers). The remaining income came from a new service venture, which goes to prove the rise of the downstream segment.
In absolute figures, the company's sales of 162.9 million euro break down into € 101.7m from operating its own facilities, € 30.2m from construction and € 31m from services. In the space of twelve months, income from this new services segment has increased by 19.4%. It also enabled Envitec Biogas to hire 39 new employees in 2016. The first half-year results for 2017 show the same segment dynamics. Thus the operating line generated € 55.7m of income (15.2% more), compared to € 5.7m for construction (4.7% more) and € 17.2m for services (19.2% more). Lastly, Danish company Bigadan doubles as a biomethanization plant constructer and site operator. In 2015, the company constructed a plant 40 kilometres south of Copenhagen, in conjunction with CP Kelco, VEKKS, Chr. Hansen and Roskilde University, capable of treating 200 000 tonnes of algae per annum. Bigadan will run this site for its first five years.
At the back-end, companies offer their expertise from project development through to site construction. For instance, France's Cap Vert Energie offers turnkey installations, following a five-stage process covering advisability study, feasibility study, design, authorizations and construction (including commissioning). It concentrates on the regional methanization market with large volume co-digestion plants. Incidentally, Cap Vert Energie runs a 14 MWe methanization facility. Another French company, Fonroche, goes further still and works at all the stages of the methanization value chain, primarily through its partnership with Bigadan, which entitles it to claim the title of "No. 1 methanizer manufacturer in France".
As the growth opportunities lie in biomethane injection, companies are eager to support this new form of energy recovery. Eneria reports that when it comes to >500 kWe facilities, "8 out of every 10 biogas projects are geared to injection". Moreover this new outlet has resulted in a flurry of start-ups and launching of innovative products onto the market.
A case in point is the small French firm Waga Energy which has come up with the Wagabox after ten years of development. This innovation converts biogas from non-hazardous waste storage installations into injectable biomethane. A cryogenic distillation column separates the oxygen and nitrogen from the methane. Heat exchange between the input biogas and the liquid biomethane revapourises the latter while recovering the units of cold. The Wagabox CEO hopes to install a hundred of these Wagaboxes by 2025 in France and abroad.
Lastly, thermal biogas projects are starting to emerge in Europe. The Dutch energy research centre (ECN) and Dahlman Renewable Technology (DRT) set up a joint-venture in the second quarter of

Value chain of a biogas project

Development	Finance	Construction	Operating
Identifying sites Securing the land Feasibility studies Administrative authorizations Energy sales contracts	IFinancial engineering Fund raising	Engineering Sourcing suppliers Project management Insurance	Asset management Production control Operating the installations Maintenance

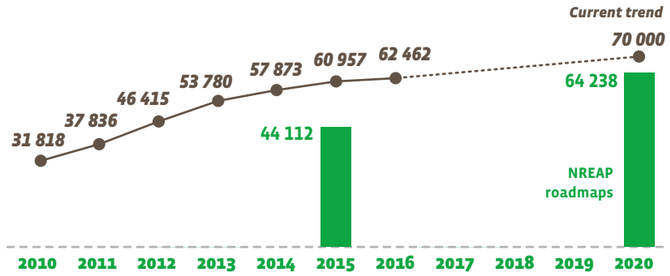
Primary energy production from biogas in the European Union countries at the end of 2016 (in ktoe), with the respective shares of each sub-sector.*



** Estimations. Note: Whenever the information was not available, the breakdown between the different types of biogas was estimated by EurObserv'ER for the year 2016 on the basis of the breakdown observed in 2015. A biomethane production by thermal processes has been included in the "other biogas" category in Italy, Finland and Sweden.* ***Source: EurObserv'ER 2017***

Graph. n° 2

Comparison of the current trend ofelectricity biogas generation against the NREAP (National Renewable Energy Action Plans) roadmap (in GWh)



Source: EurObserv'ER 2017

2017, called Milena Olga Joint Innovation (MOJI) to market a gasification process based on the Milena technology developed by ECN. Milena converts waste or biomass into biogas by pyrolysis. A demonstrator has been built in the Dutch city of Alkmaar. Similar projects are springing up elsewhere. For example, Göteborg Energi has already constructed a demonstrator in Sweden, called Gobigas. The installation now injects its output into the Swedish gas grid. Note that the project is coupled with a methanation process that increases biomethane output.

PRODUCTION COULD BE DOUBLED BY 2030

The decision of the main European biogas producer countries to reduce dependence on energy crops has hit growth scenarios hard. Growth now tends to be linked to optimized use of waste rather than increased use of energy crops or the development of gasification biogas. In February 2017, the European Commission published a study entitled "Optimal use of biogas from waste streams. An assessment of the potential of biogas from digestion in the EU beyond 2020."

The paper is original in that it concentrates on the production of biogas only from the digestion of local waste streams such as sewage sludge, landfill gas and organic farming waste, the food industry and households. Biomass gasification and the production of renewable methane from energy crops were not included in the study's scenario modelling section.

Four scenarios covering different biogas development hypotheses were analysed. The first scenario, "Local use and Growth", is based on the hypothesis of local use of biogas via CHP combined with regular deployment of feedstocks, reduction in investment costs and increase in the energy yield. The second scenario, "Local use & accelerated growth", is based on the hypothesis of local use of biogas using CHP, and accelerated deployment of raw materials, reduction in investment costs and an increase in the innovation rates. The third scenario, "To gas grid & growth", is based on purifying the biogas injected into the grid, used in the transport sector or to heat buildings, with regular deployment of the feedstocks, reduction in investment costs and conversion efficiency. The last scenario, "To gas grid and accelerated", is based on biogas conversion into injected biomethane combined with accelerated deployment of raw materials, reduction in investment costs and increased conversion efficiency.

On the basis of these potentials, the assessment demonstrates that biogas production in the European Union could increase from 14.9 Mtoe in 2014 to 28.8 (scenarios 1 and 3) or 40.2 Mtoe (scenarios 2 and 4) in 2030, depending on the quantity of useable raw material and the learning curve effects taken into account. This represents 1.8 fold and 2.5 fold increases respectively of the primary energy produced compared to 2016 (16 Mtoe). These scenarios would lead to biogas and biomethane production levels in 2030 of 2.7–3.7% of the EU's energy consumption in 2030.

The EBA feels the biomethane share of total gas consumption will increase significantly in the next few years, no matter whether it is produced by methanization or biomass gasification (thermal process). The association reckons that potential biomethane production (recovering biogas from anaerobic digestion and biomass gasification) could reach 48 billion Nm³ by 2030 (equating to 40.6 Mtoe). The sector could produce the equivalent of 10% of the European Union's current natural gas consumption if this potential were to be realized backed by suitable policies. Thus, as tends to be the case in the renewable energy sphere, the issue of the biogas sector's future development is basically down to politics.

If commitment to the renewable energy target of 27% currently proposed in the next climate energy package were stronger this would be the most easily achievable scenario. The European Biogas Association (EBA) hopes for a more ambitious target of at least 35%. It believes this commitment is quite viable given the rapid drop in renewable energy costs and could give Europe a much more realistic chance of decarbonising its energy by 2050. The EBA is also against abolishing binding national targets likely to create new divisions within the single market between the leading countries and the laggards. The introduction of a flexible governance system that helps countries make up shortfalls in renewable energy production should not compromise the binding national renewable energy targets. Consequently the EBA supports a new governance system provided that it is rooted in binding national targets. □

Tabl. n° 4

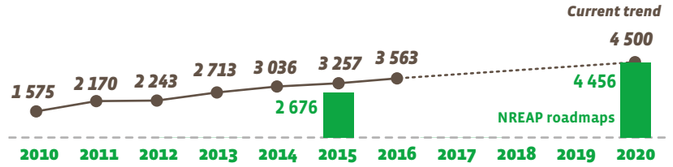
Representative firms of the methanisation sector in Europe as of 2017

Compagny	Country	Number of references	Employees
AB Energie	Italy	1 150	700
Envitec Biogas	Germany	400 MW installed	460
Bwe Energiesysteme GmbH & Co. KG	Germany	n.c.	100
PlanET Biogastechnik	Germany	400	> 200
Schmack Biogas (Viessmann Group)	Germany	450	250
Weltec Biopower GmBH	Germany	250	80
UTS Biogastechnik (Anaergia Group)	Germany	170	50
Bioconstruct	Germany	218	80
BTS Biogas	Italy	180	n.c.
Xergi	Denmark	60	n.c

Sources : Eurobserv'ER 2017 *based on companies communication*

Graph. n° 3

Comparison of the current trend of biogas heat consumption against the NREAP (National Renewable Energy Action Plans) roadmap (in ktoe)



Source: EurObserv'ER 2017

Sources : Statistics Austria, Ministry of Industry and Trade (Czech Rep.), Statistics Estonia, AGEE-Stat (Germany), DENA (Germany), CRES (Greece), University de Miskolc (Hungary), SEAI (Ireland Rep.), CSB (Latvia), Statistics Lithuania, STATEC (Luxembourg), NSO (Malta), Statistics Netherlands, DGGE (Portugal), Statistical office URAD (Slovenia), IDAE (Spain), Swedish energy Agency, BEIS (United Kingdom), SDES (France), Renewable Information 2017, (IEA), EurObserv'ER.

The bext barometer will cover Solid biomass

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