Task 37 Biogas Country Overview

(Country Reports)

iea Energy Technology Network

IEA Bioenergy

IEA BIOENERGY Task 37 – Energy from Biogas

IEA Bioenergy aims to accelerate the use of environmentally sustainable and cost competitive bioenergy that will contribute to future low-carbon energy demands. This report is a summary of the country reports that are presented at the annual meetings of IEA Bioenergy Task 37 regarding the development of the biogas market in the member countries.

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1 Introduction

IEA Bioenergy Task 37 is a working group which covers the biological treatment of the organic fraction of municipal solid waste (OFMSW) as well as the anaerobic treatment of energy crops, manure, sewage sludge and of organic rich industrial waste water. The main interests are the production of biogas and a digestate of a high quality. Collection, sorting, gas upgrading and gas utilization are accompanying technologies.

The main objective of the present Task 37 work programme is to address the challenges related to the economic and environmental sustainability of biogas production and utilisation. While there are many biogas plants in OECD countries, operation in the vast majority of cases can only be sustained with the help of subsidies to be able to compete with the fossil energy industrial sector. There is a clear need to enhance many of the process steps in the biogas production chain in order to reduce both investment and operating costs.

The Task 37 working group meets twice each year to discuss the progress of the work programme. At these meetings, the member countries also present the latest information from their country within the field of biogas. These presentations are available for free download at the homepage of Task 37 (http://www.iea-biogas.net/country-reports.html). This publication is the first published summary of these presentations in an attempt to increase the availability and ease of dissemination of this information.

The way information is gathered, recorded and reported varies from one member country to another so easy comparison of country data is not always possible. Easy comparison is also hampered by countries using different units to compile the available biogas statistics. The largest difference is how the biogas production is expressed. The following three types exist: i) the energy content in the produced biogas from different plant types independent of the utilisation; ii) the energy content in the produced and utilised energy (such as electricity, heat and vehicle gas); iii) installed capacity for energy production.

The biogas production is presented for the following plant types:

- Waste water treatment plants
- Biowaste – co-digestion or monodigestion of food waste and other types of biowaste
- Agriculture – digestion at farms (mainly manure and energy crops)
- Industrial – digestion of waste stream from various industries (e.g. food industries).
- Landfill – landfills with collection of the landfill gas

2 Austria

To meet the European Union 20-20-20 goals, Austria has to increase the amount of renewable energy to 34 % of total energy consumption. The Energy Strategy Austria envisages biogas to contribute to these targets by delivering electricity or biofuel. The focus lies on upgrading biogas to biomethane with two options. The first option is the addition of 20 % of biomethane to natural gas to reach 200 000 cars by 2020. The second option is increasing the amount of biogas produced to 10 % of the gas demand, which corresponds to 800 M Nm^3 biomethane annually in Austria.

The renewable energy law foresees the construction of power plants to obtain an additional 100 MW_e out of biomass by 2015. It hast to be mentioned that the energy strategy was set up in 2010. In the past few years prices for raw materials have increased tremendously and the plans to increase the amount of biogas plants have fallen behind schedule. Currently much effort is being invested to save existing biogas plants from bankruptcy.

2.1 Production of biogas

Today the main production of biogas is derived from energy crops, sewage sludge and landfills (see Table 1). The annual biogas production corresponds to 1.5–2.5 TWh. Current trends are that high prices of biogas feedstock (e.g. maize) lead to severe difficulties to operate the plants economically. This has created a large interest to investigate the possibility to use alternative substrates.

Table 1: Status of biogas production in Austria (values from 2012)

Plant type	Number of plants with electricity generation	Energy production (GWh/year)*
Waste water treatment plants and landfills	45	31
Agriculture and biowaste	291	554
Total	**336**	**585**

* = Produced energy as electricity excluding efficiency losses.
Source: Ökostrombericht 2013, Energie-Control Austria

2.2 Utilization of biogas

In Austria biogas is utilised mainly for electricity and heat production. Even though the aim is to upgrade more biogas to biomethane for use as a vehicle fuel, this change is taking place rather slowly. There are around 7700 natural gas vehicles (NGVs) and about 180 compressed natural gas (CNG) filling stations. Three of the filling stations are situated at biogas upgrading plants.

Table 2: Utilization of biogas in Austria (values from 2013)

Utilisation type	GWh
Electricity	564
Heat	640
Vehicle fuel	7 *
Flare	13 *

* = installed capacity
Source: Ökostrombericht 2013; Franz Kirchmayr (Arge Kompost & Biogas)

There exist 11 biogas upgrading units. All commercial technologies are represented (amine scrubber, water scrubber, membrane and PSA). The upgrading plants are rather small 600-800 Nm^3/h and have a combined capacity around six million Nm^3 biomethane annually.

2.3 Financial support systems

Support is provided for electricity production via the Green Electricity Law (Ökostromgesetz 2012).

Feed-in tariffs for 2013 are:
0.1950 EUR/kWh up to 250 kW_e,
0.1693 EUR/kWh from 250 - 500 kW_e
0.1334 EUR/kWh from 500 - 750 kW_e
0.1293EUR/kWh for higher than 750 kW_e
+ 0.02 EUR/kWh if biogas is upgraded
+ 0.02 EUR/kWh if heat is used efficiently

It is required that a minimum of 30% manure is used as a substrate to get the feed-in tariff. If organic wastes are used, the feed-in tariff is reduced by 20%.

Older biogas plant, where subsidies are running out, can apply for a longer period of subsidies, in total 20 years. Furthermore, a supportive measure for existing plants (built before 2009), up to 0.04 EUR/kWh_e can be granted for securing substrate provision; in 2013 it was 0.03 EUR/kWh_e

Some investment grants exist, but they are depended on local conditions.

Figure 1: Biogas plant in Strem nearby Güssing.

3 Brazil

Through Law N°. 12.187, of December 29th, 2009 the National Policy on Climate Change was established, a commitment was made to reduce emissions of greenhouse gases from 36.1 % to 38.9 % by 2020.

With this law, submitted at the international level at the Copenhagen Accord in 2009, Brazil presents a list of national mitigation actions, called NAMAs2. Brazil will implement these actions voluntarily and in accordance with the principles and provisions established by the Convention on Climate Change, through the adoption of Sectorial Action Plans. Sectoral Action Plans are divided into the following categories: Land Use Changes (greenhouse gases caused by changes in land use), Agriculture, Energy, and Other (substitution of biomass from native forests for biomass from reforestation).

To facilitate implementation of the Sectoral Action Plan related to agriculture the Low-Carbon Agriculture (ABC Plan) has been established. The plan was derived from commitments to reduce emissions of greenhouse gases set out in the National Policy on Climate Change (NPCC), Law no. 12.187/09. Its preparation was given by the Ministries of Agriculture, Livestock and Supply (MAPA) and Agrarian Development (MDA), also counting on the participation of organizations that represent the producers.

3.1 Production of biogas

Brazil has a large potential for biogas production, but today the biogas sector contributes only a very small part of the total renewable energy produced. According to Brazilian Energy Balance data in 2013, about 84.5% of electricity was produced from a renewable source. The production of electricity from biomass corresponds to 8.5% in the Brazilian electric grid from an installed capacity of 11 337 MW. A part of this, 80 MW, is from biogas power plants.

The National Agency of Electric Energy (ANEEL) has a record of biogas plants producing electricity connected to the distribution system. However, this record does not include information on other biogas plants. Despite the large size of the Brazilian territory, collection of biogas plant information from other plants not registered at ANEEL would demand a major effort.

In Brazil there are 22 biogas power plants connected to the electric grid. The majority of biogas plants are installed on agricultural properties, processing residues, and at landfills.

Table 3: Status of biogas production used for electricity production in Brazil (values from 2013)

Plant type	Number of plants	Energy production (GWh/year)*
Sewage sludge	5	42
Biowaste	1	1
Agriculture	8	10
Industrial	2	248
Landfills	6	637
Total	**22**	**697**

* = Produced energy as electricity excluding efficiency losses.

However, several more biogas projects are planned and many of these will use manure as a substrate. Given that the agricultural sector relies on imported fertilizers it is of great interest to use digestate to a larger extent in the future. Pig manure is especially interesting since it is available in large quantities since Brazil produces three point three million tons of pork meat.

In addition to pig manure, there is an increasing number of households with sanitation services which create an increased potential to produce biogas in waste water treatment plants (WWTP).

A final important source for biogas production is landfills. Brazil has a history of using waste dumps, but the number of sanitary landfills is now increasing as well as the interest in utilizing the produced landfill gas. Today, only ¼ of the municipalities have sanitary landfills and only 13% of the waste is recycled. The largest landfill in Brazil is situated in São Paulo.

3.2 Utilization of biogas

The main part of the biogas is used for electricity and heat production, while biogas use as a vehicle fuel is rare. There are still many projects where the biogas is not used, being simply burned in a flare. However, there is no registered information of how much biogas is burned directly.

Table 4: Utilization of biogas in Brazil (values from 2013)

Utilisation type	GWh
Electricity	697
Heat	17*
Vehicle fuel	n.d.
Flare	n.d.

* Data collected with the cooperatives of western of Parana

The biogas upgrading units for biomethane production and gas supply stations are available only from experimental projects.

3.3 Financial support systems

The Low Carbon Agriculture, or ABC, includes access to rural technical assistance to promote improvement of infrastructure associated with the technologies offered by agricultural research. In addition, they offer credit to producers to develop such technologies. By using pig manure as a substrate, the carbon dioxide emissions from the agricultural sector can be decreased through the support of the low carbon agriculture program (ABC).

The program is financed with funds from BNDES, Rural Savings Booklet (MCR 6-4) and Constitutional Funds, which are obtained by public resources taxes and driven by the national economy. The target group is farmers and their cooperatives, including transfer to associates, with the credit limit of U.S. one million dollars per beneficiary per crop year. This figure can be received regardless of other credits that the producer or the cooperative has a right to and is based on controlled rural credit resources. The interest rate is 5.5% a year.

Figure 2: Biogas in Brazil has been developing strongly based on the use of organic waste produced in agriculture, urban areas and industries.

4 Denmark

In March 2012, the Danish Government entered into a broad energy policy agreement for the period 2012–2020. The agreement includes several elements and calls for a significant enhancement of the share of renewables in the Danish energy supply. The main aim is to make Denmark fossil fuels free by 2050. Biogas is a key area of the 2012 energy agreement, with a tenfold increase of the 2012 production by 2020.

4.1 Production of biogas

Today around 1.2 TWh of biogas is produced in Denmark. Animal manure is the most important biogas feedstock. According to the Danish Biogas Association, roughly 7% of the animal manure is today supplied to biogas plants in Denmark, and the aim is to increase it to 50% by 2020. Along with manure, organic wastes from industry and sewage sludge also make a significant contribution to the biogas production.

Table 5: Status of biogas production in Denmark (values from 2010)

Plant type	Number of plants	Production* (GWh/year)
Sewage sludge	65	220
Biowaste	-	-
Agriculture	82	800
Industrial	5	115
Landfills	30	83
Total	**167**	**1218**

* = produced raw biogas expressed as its energy content from the different plant types
Source: Danish Energy Authority (2010)

Recent estimations (PlanEnergi, 2011) of the biogas potential in Denmark show that the agricultural sector can provide up to 22 TWh (81 PJ) biogas, compared to around 0.8 TWh nowadays. The highest potential is derived from animal manure (6 TWh) and energy crops (11 TWh). Compared to these, other sources of biogas such as sewage sludge or industrial waste, green waste etc. have much lower potentials, estimated together to be 0.5–1.5 TWh. Not all this potential is realistically exploitable. The first priority is to use the waste materials easily available, as the new "Resource strategy - Denmark without waste" adopted by the Danish Government in 2013 aims to achieve. The Danish Energy Agency has therefore estimated that the total potential of biogas production from manure, waste and residues from the food industry, sewage sludge, etc. is approx. 11 TWh. Given that only about 7 per cent of manure is currently used in biogas plants, in 2009 the Government decided that this must be increased significantly, so that half of it should be used for biogas production by 2020. It will require the building of 40-50 new large-scale biogas plants. The most important role of biogas in the future Danish energy supply will be to balance the wind dominated electricity production. Furthermore, biogas will help convert the transport sector from fossil to "green" fuels.

4.2 Utilization of biogas

Today biogas is mainly used for heat and power production. The Danish government believes that biogas will be an important vehicle fuel in the future, especially when replacing the fossil fuels for the heavy duty vehicles. At a biogas conference in Skive in January 2013, the Danish climate- and energy Minister Martin Lidegaard said: "I believe that gas is one of the main solutions for the future of transport".

Table 6: Utilization of biogas in Denmark (values from 2012)

Utilisation type	GWh	%
Electricity	808	66
Heat	242	20
Vehicle fuel	n.d.	n.d.
Flare	122	10*

Source: Energistatistik, 2012 and Danish Energy Authority, 2013 (*)

The interest for using biogas as a fuel for cars is increasing. The first Danish biogas upgrading plant is operating in Fredericia. A number of biogas upgrading projects are at various planning stages. There are four biogas filling stations and more are about to be established. Currently, 81 CNG cars are in operation in Denmark.

4.3 Financial support systems

New financial support of the biogas sector was approved by the EU at the end of 2013. The only condition is that the support cannot be overlapped (e.g. cannot be received by the same plant for both investment costs and for operation costs). The financial support system is complex but its main elements are:

- 0.056 EUR/kWh for biogas used in a CHP unit or injected into the grid (115 DKK/GJ).
- 0.037 EUR/kWh for direct usage for transport or industrial purposes (75 DKK/GJ)

These tariffs include natural gas price compensation of maximum 0.012 EUR/GJ (26 DKK/GJ) and temporary support of 0.005 EUR/GJ (10 DKK/GJ) up to 2016. It is also possibly to apply for investment grants for plants digesting mainly manure. 19 new biogas projects received governmental grants 2013 with a total value of 268 MDKK (36 MEUR).

Support for upgraded biogas supplied to the natural gas network in the calendar year 2013 is of 111.6 DKK per. GJ. The support is payable to both upgraded biogas supplied to the natural gas grid and to purified biogas entering a town gas grid. This support is provided with effect from 1 December 2013. In the energy agreement, new support frames for biogas to transport, process and other applications were also agreed. These framework conditions and the size of the support are currently about to be discussed with the EU as a separate case. The final decision on these cases are expected to be reached in 2014.

Figure 3: Lemvig Biogas Plant is the largest thermophilic agricultural biogas plant in Denmark, with a reactor capacity of 14300 m^3, producing about 10.2 M Nm^3 of biogas per year (2012). Source: Lemvig Biogas A/S

5 Finland

The government target is that about 10 % of gas used will be from biomass based gas, mainly SNG by 2025.

5.1 Production of biogas

In 2012 the total energy production from biogas was 568 GWh from 73 different biogas production sites (including landfills). In addition, about 115 GWh was flared.

Table 7: Status of biogas (heat and power) production (values from 2012)

Plant type	Number of plants	Energy production * (GWh/year)
Sewage sludge, municipal	15	135
Biowaste,codigestion	9	112
Agriculture	8	4
Industrial wastewater	2	6
Landfills	39	312
Total	**73**	**569**

* = Produced energy as electricity, heat, vehicle fuel or flared excluding efficiency losses.
Source: Huttunen and Kuittinen, 2013, Suomen biokaasulaitosrekisteri n:o 16, *University of Eastern Finland*

It has been estimated that in Finland up to 4–6 TWh/year biogas could be produced from wastes and manures. The potential biogas yield from grass could potentially be similar, depending on land availability. In 2012, the role of energy crops was insignificant. In addition, wood based bio- SNG could significantly add to the gas supply. In the beginning of 2013, about 20 co-digestion plants were under construction or in the planning phase.

5.2 Utilization of biogas

The biogas utilization was almost 83 % of total production in 2012 and the biogas was mainly used for heat and electricity.

Table 8: Utilization of biogas in Finland (values from 2012)

Utilisation type	GWh	%
Electricity	160	23
Heat	409	60
Vehicle fuel	4	1
Flare	115	17

Source: Huttunen and Kuittinen, 2013, Suomen biokaasulaitosrekisteri n:o 16, *University of Eastern Finland*

The Finnish government is committed to promote the use of biogas as a vehicle fuel. The first upgrading plant to inject methane into the grid was taken into operation during 2011 and the biomethane is distributed to existing CNG filling stations. In 2012 five upgrading plants were in planning and operation phase. Also in 2012, 16 public filling stations for biomethane/CNG and two private fuelling stations were operating mainly in the southern part of Finland. A few biogas upgrading and filling stations also exist outside the grid. The share of biomethane in methane/CNG sold for transportation was approximately 10 %. In total about 1300 gas vehicles are in operation. Biomethane costs about half of the price of petrol.

5.3 Financial support systems

The Electric Market Authority of Finland is supporting new biogas plants, which produce more than 100 kVA, with a feed-in tariff. It guarantees a minimum price of 83.50 EUR/MWh electricity, but when the combined capacity of the generators exceeds 19 MVA no subsidy is paid. If the generated heat is utilized, 50 EUR/MWh heat premium on top of basic subsidy is paid, provided that the total efficiency is at least 50% or at least 75% if nominal generator capacity exceeds 1 MVA. In the feed-in tariff system, an electricity producer whose power plant is approved in the system will receive a subsidy (feed-in tariff) for a maximum of twelve years. The subsidy varies on the basis of a three-month electricity market price or the market price of emission allowances. These supports are paid up to the amount confirmed in the acceptance decision. When the price of electricity is below 30 EUR/MWh, the subsidy to be paid amounts to the target price less 30 EUR/MWh. Subsidy is not paid per hour when the price of electricity is negative.

Investment grants are paid by the Ministry of Employment and Economy to biogas plants which do not meet the requirements of feed-in tariff and produce energy, but this kind of grant is not meant for residential buildings, farms or plants connected to the above-mentioned types. A maximum of 30 % of acceptable investment costs are supported, provided that there is still money available in the budget for the investment year.

The Ministry of Agriculture and Forestry supports biogas plants built on farms aiming at producing their own energy and heat. More than half of biomass must be from their own farm and more than 50 % of the energy produced must be used by the farm. Part of the support is money and part of it is loan.

There is no excise tax on biogas.

Figure 4 Biogas digester in Vampula, Finland, owned by Vambio Oy. The plant produces methane and various fertiliser products from industrial biowastes and manures.

6 France

The view of the French Environment and Energy Management Agency is to produce 70 TWh biogas in 2030 and that 600 biogas plants will be built every year. 50% of the produced biogas shall be injected into the grid, 30% shall be used to produce electricity and the remaining 20% shall be used to produce heat. In 2050, the aim is to produce 100 TWh.

6.1 Production of biogas

In France it exits 256 biogas plants and 245 landfills. Only 90 of the 245 landfills are valorizing the biogas (see Table 9). The number of farm AD plants is expected to double by the end of 2013.

Table 9: Status of biogas production in France (values from 2012)

Plant type	Number of plants	Electricity production (GWh/year)	Heat production (GWh/year)
Sewage sludge	60	97	540
Biowaste from MSW	11	51	15
Industrial	80	7	350
On-farm and centralized plants	105 (90+15)	260 (120+140)	390 (190+200)[1]
Landfills with biogas valorization [2]	80	858	296
Total	**336**	**1273**	**1591**

[1] heat recovery = 210 GWh/year (90 GWh/year on farm + 120 GWh/year centralized plants)

[2] source ADEME : *ITOM, les installations de traitement des ordures ménagères en France – Résultats 2010*, octobre 2012

A recent study financed by ADEME on *The estimation of feedstock for AD use* shows that the potential resources for AD will give a probable potential of 56 TWh by 2030. Based on his own calculation, an estimation of ADEME expects a theoretical production of 70 TWh by 2030.

6.2 Utilization of biogas

In France there is a strong development of on-farm and centralized biogas plants and for landfills to recover biogas in electricity production (today 90 out of 245 landfills). Around 120 on-farms AD plants are built until 2013 and near 15 centralized units. In addition, 60 WWT and 80 agrofood industries AD plants are operating right now.

In 2010, a study showed a relatively low energy recovery from biogas, around 60% of raw energy, the main part coming from landfills (*Market study on anaerobic digestion and biogas valorization in France*, Ernst & Young, May 2010).

Regarding the table 9, 44% of the energy recovery is transformed in electricity and 56% in heat.

There are only four biogas upgrading plants in operation, but more than 400 applications to inject biomethane into the natural gas grid which indicate a significant increase of the number of upgrading plants in a nearby future. Today, all the biomethane produced is commercialized under gaseous form, injected into the grid or sold as fuel for vehicles

More than 13 500 vehicles, of which 3 500 are trucks, are in circulation in France, representing a daily consumption of 265 000 Nm^3. 37 public filling stations and around 130 private filling stations are in operation (http://www.afgnv.info/Mise-a-jour-des-stations-GNV-en-France_a101.html).

6.3 Financial support systems

In France there is a feed-in-tariff system for electricity produced from biogas with the following properties (energy efficiency bonus and manure bonus included, tariffs revised yearly, values of 2013):

0.8580 to 0.14521 EUR/kWh_e for landfills
0.1182 to 0.2110 EUR/kWh_e for AD plants

It also exist upgrading tariffs with the following properties:

45 to 95 EUR/MWh for biomethane from landfills (depending of volume, values of 2011)
69 to 125 EUR/MWh for upgrading the biogas to biomethane from AD plants (depending of volume and the nature of the feedstock, values of 2011)

Some subsidies are possible and attributed by the French Agency for Environment and Energy Management through two financial funds: the Waste Fund and the Renewable Heat Fund. So the subsidies are depending of the nature of the investment, and limited in the amount or by the percentage of aid.

Other subsidies can complete them from regional (Regional Councils) or European (FEDER) funds.

Figure 5: Biogas unit in Chaumes en Brie, France, owned by Bioénergie de la Brie Co. The plant produces biomethane and various products from agro food biowastes and manures. The biomethane is injected into the natural gas grid and feed 5 cities located close to the unit.

7 Germany

With the cabinet decisions of June 6, 2011, the Federal Government of Germany has decided to redirect the energy police and considers renewable energy as a cornerstone of the future energy supply. By 2020 the share of renewable energy in terms of electricity and total energy demand should be increased to 35 % and 18% respectively. A key element of this aim is the revision of the Renewable Energy sources act (EEG) of April 1st, 2012 for implementation of the EU Directive 2009/28/EG.

7.1 Production of biogas

Within Europe most biogas plants have been built in Germany. The vast number are agricultural plants, but also biogas plants digest sewage sludge, bio-waste, industrial wastes and waste from landfills (Table 11). The main substrates used for biogas production in the agriculture sector is a mixture of energy crops, e.g. maize silage, and animal manure.

Table 11: Status of biogas production in Germany from different plants 2012, (BMU, AGEE Stat, supplemented)

Plant type	Number of plants	Energy production* (GWh/year)
Sewage sludge [1)]	1400	3100
Biowaste [2)]	95	4500
Agriculture [3)]	7800	29400
Industrial [4)]	250	3420
Landfills	400	550
Total	**9945**	**40970**

* = Produced energy as electricity, heat, vehicle fuel or flared excluding efficiency losses.
[1)] IFEU (2010) [2)] Witzenhausen Institute, 2010, [3)] German biogas association (2012) [4)] aqua-consult 2011

The technical potential for biogas production in Germany until 2020 amounts to 116 TWh/year, of which 70 TWh/year energy crops (1.6 Mio ha crop land), 29 TWh/year crop residues and animal manure, 13 TWh/year organic fraction of municipal solid waste (OFMSW) and 4 TWh/year industrial organic wastes (FNR, 2012).

7.2 Utilization of biogas

In 2012 the biogas was used for electricity (26.7 TWh), heat (14.0 TWh) and vehicle fuel (0.35 TWh).. This means that 4.4 % of electricity, 1% of heat and 0.1% of vehicle fuel total consumption is produced from biogas (Table 12).

Table 12: Utilization of biogas in Germany, data from BMU, AGEE Stat

Utilisation type	GWh	%
Electricity	26650	65
Heat	14000	34
Vehicle fuel	350	1
Flare	n.d.	n.d.

According to data of the German Energy Agency (DENA) and German Biomass research centre (DBFZ) biogas upgrading capacity is growing rapidly. At the end of 2012 about 120 bio methane feed-in plants were in operation with an installed capacity of 72 000 Nm^3/h. By 2020 it is planned to have 1000-1400 upgrading plants, most of them with capacities in the range 500-800 Nm^3/h. The share of bio methane in the natural gas fuel has increased from six to over 15 % in the past year. At the end of 2012 pure biomethane could be fuelled in 119 of the around 900 CNG filling stations by the around 100 000 of gas vehicles that are in operation (www.ngvaeurope.eu). By using biomethane as fuel instead of gasoline, around 100 000 ton of carbon dioxide

was avoided in the past year. This is equivalent to the emissions of approximately 30 000 gasoline-powered passenger cars per year. There is an action group for CNG and biomethane use as a vehicle fuel. The Action Group supports the goal of the Federal government for increased consumption of CNG and biomethane from the current 0.3% to 4% by 2020. There is political support for market development, e.g. reduced energy tax, creation of an incentive system for gas vehicles for road transport, including private and commercial vehicles.

7.3 Financial support systems

The revised financial support for renewable energy in 2012, the "*Amendment of the Renewable Energy Sources Act (EEG)*" is shown in Table 13, the feed-in tariff depends on plant size, type of substrate and the biogas upgrading.

Table 13: Amendment of the Renewable Energy Sources Act (EEG) 2012 in Germany

Plant size	Basic bonus (EUR/kWh)	Substrate category I [1] (EUR/kWh)	Substrate category II [2] (EUR/kWh)	Bonus OFMSW [4] (EUR/kWh)	Upgrading bonus (EUR/kWh)
< 75 kW_e	0.25 [3]				0.030 until 700 Nm^3/h
< 150 kW_e	0.143	0.060	0.080	0.160	
< 500 kW_e	0.123	0.060	0.080	0.160	0.020 until 1000 Nm^3/h
< 750 kW_e	0.110	0.050	0.080	0.140	
< 5 MW_e	0.110	0.040	0.080	0.140	0.010 until 1400 Nm^3/h
< 20 MW_e	0.060	0	0	0.140	

[1] Biogas crops, e.g. maize, beets, whole plant silage, > 60 wt% animal slurry
[2] Plants from landscape conservation, clover, > 60 wt% animal waste,
[3] > 80% animal slurry (wt%)
[4] Organic Fraction of Municipal Solid Waste

Figure 6: Bio-energy-village Schlöben, State of Thuringia. All inhabitants of the village, the commune and the farmer are members of a civil-action group, operation of a micro-gas grid, of 3 CHPs and a local heating system for supplying of 480 inhabitants with heat and electricity (Source: Federal Ministry of Food, Agriculture and Consumer Protection, 2012).

8 Republic of Ireland

The biogas industry has not taken off, as of yet in the Republic of Ireland. There are a number of reasons for this including the relatively low level of renewable energy feed-in tariff (REFIT) as compared to neighbouring Northern Ireland. This has led to a situation whereby biogas developments are more profitable north of the border and as such developers are more likely to situate north of the border. At present there is trade of biomass across the border, South to North.

Another reason for the relatively low level of development of biogas facilities in the Republic (South) is the ongoing discussion on the processing standards for various categories of substrates.

A Government Bioenergy Strategy is due to be released by the end of 2013. It is hoped (and expected) that this will include targets or strategies for increased biogas production, for biomethane grid injection and for use of biomethane as a transport fuel.

8.1 Production of biogas

The exact number of biogas plants in Ireland is hard to access in detail. Many waste water treatment facilities have digesters but as they are in private ownership the data is somewhat hard to obtain. There are approximately 30 renewable gas to energy facilities including landfill gas systems, wastewater sludge digesters and farm scale biogas facilities. Cre (Composting and Anaerobic Digestion Association of Ireland) and the Irish Bioenergy Association (IrBEA) provided the data presented in Table 14.

Table 14: Biogas production in the Republic of Ireland (values from 2012)

Plant type	Number of plants	Installed capacity
Sewage sludge	14	n.d.
Biowaste		
Agriculture	8	2.7 MW_e
Industrial		
Landfills	8	29 MW_e
Total	**30**	

Source: Cre and IrBEA

The facilities at present are dominated by provision of electricity and/or heat. This is reflective of the REFIT scheme. However there is a viewpoint that if the biogas industry is to take off in Ireland it is likely to require gas grid injection to facilitate better returns on the biogas produced.

A Bord Gais report with the title *The future of renewable gas in Ireland* (http://www.bordgais.ie/corporate/media/15665_BG_RenewGas_Final1.pdf) suggests that a realistic biogas industry could be based on use of 5% of cattle, pig and sheep slurry, 75% of poultry slurry, 50% of slaughter waste, 25% of food waste and grass from 100 000 ha of grass land (2.2% of agricultural land). The report suggests that biogas should be upgraded to biomethane and gas grid injected. This would require approximately 180 rural digesters, 4 slaughter waste digesters and 4 municipal digesters; all at a scale of 50 000 t/year of substrate. The investment cost was estimated at ca. 1400 MEUR. This scale of investment could facilitate substitution of 7.5% of current natural gas demand and provide for ca. 5% of energy in transport. (Singh, A., Smyth, B.M., Murphy, J.D. (2010) “A biofuel strategy for Ireland with an emphasis on production of biomethane and minimization of land take”, Renewable and Sustainable Energy Reviews, 14(1): 277–288)

There are no biogas upgrading plants in Ireland, however some companies are considering large scale investments including some for gas grid injection.

In the last two years a number of companies have invested in natural gas vehicles (NGVs). Initial trials by Bus Eireann in Cork and Celtic Linen have been very positive. This industry is expected to grow rapidly. A market for gaseous transport fuel initially based on natural gas will facilitate gas grid injection of biomethane.

8.2 Financial support systems

Support to biogas on Ireland includes for:

- A landfill levy of 75 EUR/t is in place as of July 2013. Also as of July 2013 there is a requirement to provide collection of source segregated food waste for population centres with an excess of 25 000 persons. By July 2015, this will be required for population centres of 500 persons. These regulations provide an incentive to digest the organic fraction of municipal solid waste.
- REFIT for biogas to CHP was 0.072 EUR/kWh$_e$ in 2007 and was raised to 0.12 EUR/kWh$_e$ in 2008.

As of May 2010, the tariffs are indexed and offered on a 15-year basis and include:

- AD CHP equal to or less than 500 kW: 0.15 EUR/kWh$_e$
- AD CHP greater than 500 kW: 0.13 EUR/kWh$_e$
- AD (non CHP) equal to or less than 500 kW: 0.11 EUR/kWh$_e$
- AD (non CHP) greater than 500 kW: 0.10 EUR/kWh$_e$

Figure 7: Biogas plant McDonnell Farms Limited. Primary Digester and first covered storage digester. David McDonnell milks 300 dairy cows in Limerick and also operates a free range poultry farm. In 2009/2010 he installed the most modern farm digester in Ireland which has a capacity of 250 kWe. (Source: SEAI (Sustainable Energy Authority of Ireland) Anaerobic Digestion: A case study – McDonnell Farms Biogas Limited, Shanagolden, Co. Limerick))

9 Norway

The main energy sources used in Norway are petroleum and hydropower. Close to 60% of the energy consumption in Norway is based on renewable sources, mainly hydropower and wood.

In a report to the Storting (Parliament) (St.meld. nr. 34 (2006-2007)) a national goal to increase the amount of energy from biomass has been set. Underlying this goal is the recognition that increased use of bioenergy will reduce the emissions of GHG and local pollution, and at the same time reduce the nation's dependency on petroleum and virgin sources of plant nutrients.

A national strategy on increased development of bioenergy was presented by The Ministry of Petroleum and Energy in 2008. This strategy suggests a conservative estimate of 14 TWh available bioenergy that can be realized annually by 2020. This strategy inadequately covers biogas, and Norway has not established a specific strategy on biogas. However, according to Report to the Storting No 39 (2008–2009), 30% (4–5 million ton/year) of manure is to be used for biogas production together with 600 000 ton of food waste (ie. approx .60% of available food waste) by 2020. The main incentive for this goal is to reduce emissions of GHG from agriculture by 500 000 ton of CO_2- equivalents. In 2012 another white paper was presented (Meld St 21, 2011–2012), that states that the cost of this measure was not completed. Later reports (Klimakur 2020) have documented relatively high costs, mainly due to high costs in production and distribution of biogas. Consequently, the development of biogas plants, especially those treating manure has been limited.

In the political platform for the government formed by the Conservative Party and the Progress Party (7. Oct. 2013), the government states that it will prepare a strategy for biogas fuel.

Energi21 - A collective R&D strategy for the energy sector in Norway:
The Energi21 strategy sets out the desired course for research, development and demonstration of new technologies for the 21st century. The strategy has been revised at the request of the Ministry of Petroleum and Energy as part of the effort to boost value creation, facilitate energy restructuring with the development of new technology and cultivate internationally competitive expertise. (www.energi21.no).

9.1 Production of biogas

In 2010 approx. 0.5 TWh of biogas was produced. For comparison, during the same year 118 TWh of hydropower and 1 000 TWh of natural gas (excl. LNG) was produced.

Table 15: Status of biogas production in Norway (data from 2010)

Substrate/Plant type	Number of plants	Production (GWh/year)*
Sewage sludge	25	164**
Biowaste	11	63
Agriculture	4	3
Industrial	3	n.d.
Landfills	85	270
Total	**129**	**500**

* = produced raw biogas expressed as its energy content from the different plant types
** = 2008

The realistic potential for biogas production is estimated to be 2.3 TWh in 2020: 32% from manure, 22% from industry waste, 14% biowaste from households and 7% biowaste from catering and trade, 12% landfill, 7% straw, 6% waste water sludge. (The Norwegian Environment Agency, 2013. Report TA3020)

At present only 0.5 TWh is used, and specific plans are available for another 0.3 TWh. This leaves a remaining realistic potential of 1.5TWh for biogas production in Norway by 2020.

9.2 Utilization of biogas

Approximately 60 % of the biogas is used at the production plants. The remaining 40% is delivered as electricity, heat, or it is being upgraded to fuel or simply flared. Statistical data on the use of biogas is not available. About half the collected landfill gas is being used for heat and electricity, the rest is being flared.

Table 16: Utilization of biogas in Norway (estimates, Raadal et al, 2008)

Utilisation type	GWh	%
Electricity	n.d.	18
Heat	n.d.	53
Vehicle fuel	n.d.	2
Flare	n.d.	19
Unknown	n.d.	9
Total	**500**	

Source: Raadal, H. et al. 2008. Report OR.21.08 from Østfoldforskning. ISBN 978-82-7520-595-5 / 82-7520-595-6

Norway has less than 10 upgrading plants. Today almost 1000 vehicles run on methane and 24 filling stations exist (http://www.ngvaeurope.eu/european-ngv-statistics).

9.3 Financial support systems

The two strongest incentives for increasing the available substrates are the Landfill guidelines that banned landfilling of biodegradables from 2009, and a delivery support system that gives approx. 3.5 EUR per ton of manure delivered to biogas plants

To stimulate production of biogas, different schemes for investment aid are available, depending on size of plant.

The use of biogas is stimulated by

Tax-exemption on road use

Investment aid for infrastructure related to sustainable mobility solutions

Figure 8: Romerike Biogas plant was operative by the end of 2012. The plant recovers biogas and fertilizer from source separated food waste from the households and businesses in Oslo. (Photo: Oslo Waste-to-Energy Agency).

10 Republic of Korea

Total energy production has steadily increased over recent years; renewable energy accounted for 2.75% (7.6 MTOE) in 2011 of which 963 kTOE was bioenergy (9.5% from biogas plants and 13% from landfill gas). Landfill gas utilisation has dominated bioenergy production over the last decade while biogas plants have started to make a significant contribution only since 2010. The "Bioenergy Strategy 2030" targets bioenergy production to increase by a factor of more than 10 and biogas by a factor 4.

10.1 Production of biogas

A total of 78 biogas plants are now in operation to produce 1 925 GWh per year. Landfill biogas contributes 41% (783 GWh/year), biogas from sewage sludge 34%, biowaste 25%. Biowaste mainly consists of food waste, food waste leachate and digestible co-substrates. Table 17 shows Korean biogas production from different types of plants.

Table 17: Status of biogas production in South Korea (values from 2012)

Plant type	Number of plants	Biogas production* (GWh/year)
Sewage sludge	24	661
Biowaste (co-digestion)	25	472
Agriculture	8	9
Industrial	-	-
Landfills	21	783
Total	**78**	**1,925**

* = produced raw biogas expressed as its energy content from the different plant types

The electricity generation from biogas amounted to only 45 GWh in 2011. The governmental goal is very slowly increasing; 64 GWh in 2020 and 161 GWh in 2030, respectively. There are 21 new biogas plants under construction to treat 4 748 ton of food waste and food waste leachate daily to produce 8.7 TWh by 2017.

10.2 Utilization of biogas

About 54% (960 GWh) of the biogas is utilized for heat production. This part is decreasing every year to meet the increasing demand for biogas sale. The main part (27%, 479 GWh) of the remaining biogas is used for electricity generation. Flaring biogas is still significant (13%). The utilization of biogas as vehicle fuel is only 0.7% of the total biogas production. The utilization of biogas in South Korea is summarized in Table 18.

Table 18: Utilization of biogas in South Korea (values from 2012)

Utilization type	GWh	%
Electricity	479	27
Heat	960	54
Vehicle fuel	13	1
Flare	234	13
Biogas sale	95	5
Total	**1 781**	**100**

The number of buses that used CNG as a vehicle fuel reached almost 39 000, of which 600 were running on biomethane and the number of gas filling stations reached 184 of which six are biomethane filling stations. However this number can only supply 0.2% of the total number of buses.

Biogas upgrading is carried out by water scrubbing or PSA at 4 wastewater treatment plants and one food waste leachate plant. The biomethane is used mainly in city buses and municipal vehicles. The standard for vehicle fuel and grid injection is similar to Swedish standards. There is no grid injection system operating in Korea until now.

10.3 Financial support systems

There are no tariffs or subsidies for biogas. However 10% VAT (Value Added Tax) and 2% tariffs will be charged when the mixture of CNG and biogas is sold.

The RPS (Renewable Portfolio Standard) system has been implemented since 2012. As "Mandatory Supply Quantity (MSQ)", 2% of the total power generation should be supplied using the appropriate kind of renewable energy. There is a governmental target to increase MSQ up to 10% of the total power generation in 2020, increasing by 0.5% every year. The average REC price has been around 45–50€/MWh.

Figure 9: Sudokwon Biogas Plants that is producing 4.7 GWh electricity and 300 000m^3 vehicle fuel annually. (source: Ministry of Environment, South Korea)

11 Sweden

In Sweden there is a governmental aim to produce 50 percent of the energy from renewables by 2020 (this has already been reached), but there are no specific targets for the biogas production. A committee inquiry recently reported its findings after 1.5 years of work on how fossil free transportation can be reached in 2050. The results are expected to be important for the future governmental support for biomethane production in Sweden.

11.1 Production of biogas

In Sweden the production of biogas has been fairly constant at around 1.3–1.5 TWh for several years. The main reason is the difficulties in showing a feasible profit for new investments and new biogas plants. The biogas production of new plants is balanced by the steady decline in landfill gas production. Table 19 shows the Swedish biogas production from different types of plants.

Table 19: Biogas production in Sweden from different plants (values from 2012).

Plant type	Number of plants	Biogas production* (GWh/year)
Sewage sludge	135	660
Biowaste	21	507
Agriculture	26	47
Industrial	5	121
Landfills	55	254
Sum	**242**	**1 589**

* = produced raw biogas expressed as its energy content from the different plant types
Source = Produktion och användning av biogas år 2012, Statens Energimyndighet 2013

The potential to produce biogas from anaerobic digestion and gasification until 2030 has recently been evaluated (Dahlgren S (2013) "*Realiserbar biogaspotentiali i Sverige 2030 genom rötning och förgasning*", WSP). The potential depends mainly on the development of the financial support system, the technical development and the price of fossil fuels. The investigation was made for three scenarios with good, moderate or bad development of these parameters.

The potential to produce biogas from anaerobic digestion was shown to be 1–3 TWh in scenario 3 (poor development), 58 TWh in scenario 2 (moderate development) and 5–10 TWh in scenario 1 (good development). Today, more than 50% of the produced biogas is upgraded to biomethane and this proportion is expected to increase even more until 2030.

11.2 Utilization of biogas

In Sweden, around 50% of the biogas is used as vehicle gas. This part is increasing every year to meet the increasing demand from the increasing number of gas vehicles. The main part of the remaining biogas is used for heat production. The entire utilization of biogas in Sweden is summarized in Table 20 below.

Table 20: Utilization of biogas in Sweden (values from 2012)

Utilisation type	GWh	%
Electricity	41	3%
Heat*	524	33%
Vehicle fuel	845	53%
Flare	165	10%

* = including heat losses, e.g. during electricity production, and heat used by the biogas plant.
Source = Produktion och användning av biogas år 2012, Statens Energimyndighet 2013

In Sweden, nearly all upgraded biogas is used as automotive fuel, designated “fordonsgas” (vehicle gas), which means that the annual biomethane production in Sweden is around 845 GWh, according to Table 20. The biomethane is produced in 55 biogas upgrading plants with various technologies (~70% water scrubbers and, ~15% PSA, ~15% amine scrubbers). In one plant with a capacity of 60 GWh the biomethane is liquefied and sold as LBG (LiquefiedBioGas). The automotive fuel has a biomethane share of 57% on energy basis (figure of 2012), and is used by 44 000 gas vehicles, of which 1,800 are buses and 600 are heavy duty vehicles. Around 200 filling stations exit for vehicle gas of which four also have liquid biogas.

11.3 Financial support systems

Sweden has no feed-in tariffs, but instead use other support systems, mainly focused on increasing the usage of biomethane as automotive fuel. The existing support systems are:

- No carbon dioxide or energy tax on biogas. Today this correspond to a value of 68 EUR/MWh compared to petrol and 52 EUR/MWh compared to diesel of which 26 EUR/MWh is from the carbon dioxide exemption and the remaining part is from the energy tax exemption.
- 40% reduction of the fringe benefit taxation for the use of company NGVs until 2016
- Investment grants for marketing of new technologies and new solutions for biogas during 2013–2016. Maximum 45% or 25 MSEK (~3 MEUR) of investment cost
- A joint electricity certificate market in Norway and Sweden. The producer gets one certificate for every MWh electricity produced from renewable resources and end-users are obliged to buy certificates in relation to their total use. Average 2012 price was approximately 17–22 EUR/MWh
- 0.2 SEK/kWh (~0.02 EUR/ kWh) for manure based biogas production to reduce methane emissions from manure. Total budget 240 MSEK (10 years).

Figure 10: Lidköping Biogas plant produces 60 GWh liquid biogas annually (source: Göteborg Energi).

12 Switzerland

The aim for Switzerland is to abandon nuclear energy and to replace it by efficient renewable solutions.

12.1 Production of biogas

In Switzerland there are around 600 biogas plants and six landfills, see Table 21. The total biogas production was 870 GWh annually in 2011. A number of new biogas projects are being developed, mainly farm-scale plants with capacities in the range 60–100 kW_e.

Table 21: Status of biogas production in Switzerland (values from 2012)

Plant type	Number of plants	Biogas production* (GWh/year)
Sewage sludge	463	523
Biowaste (co-digestion)	26	239
Agriculture	89	187
Industrial waste water	22	74
Total	**600**	**1023**

* = produced raw biogas expressed as its energy content from the different plant types

12.2 Utilization of biogas

The biogas is mainly used to produce electricity and heat in CHP plants, see Table 22.

Table 22: Utilization of biogas in Switzerland (values from 2012)

Utilisation type	GWh	%
Electricity	258	24
Heat	370	34
Vehicle fuel	462	42
Flare	n.d.	n.d.

There are 16 upgrading plants (mainly PSA units, amine scrubbers and organic physical scrubbers), four on agricultural sites, four on waste water plants and eight at biowaste AD sites, with total biomethane production of ~80 GWh in 2011. Biomethane injection into the natural gas grid started in 2008 and exceeds 1 MNm^3 annually (~40 GWh). The target is to reach 300 GWh by 2016. Today more than 11 000 vehicles run on methane and 138 filling stations exist (http://www.ngvaeurope.eu/european-ngv-statistics). In 2008 was 18.6% of the vehicle gas derived from biogas.

12.3 Financial support systems

In Switzerland there is a feed-in tariff for electricity according to Table 23 below.

Table 23: Feed-in tariff for electricity in Switzerland in Swiss currency (CHF).1 EUR ≈ 1.2 CHF

Power class	≤ 50 kW_e	≤ 100 kW_e	≤ 500 kW_e	≤ 5 MW_e	> 5 MW_e
Basic tariff [CHF/kWh]	0.28	0.25	0.22	0.185	0.175
Agricultural bonus [CHF/kWh]	0.18	0.16	0.13	0.045	0
Heat bonus [CHF/kWh]	0.025	0.025	0.025	0.025	0.025
Maximum [CHF/kWh]	0.485	0.435	0.375	0.255	0.20

There is also a fund for biomethane injection which is a voluntary support program by the Swiss Gas Association with the objective to inject 300 GWh biomethane annually within 6 years. Also projects reducing GHG emissions can get financial support

Figure 11: Biogas plant in Kägiswil, producing annually 1.5 GWh electricity and 1.7 GWh heat.

13 The Netherlands

To meet the European Union 20-20-20 goals, the Netherlands has to increase the amount of renewable energy to 14 %, which can be compared to 2% in 2005. The ambitions of the Netherlands to increase the amount of renewable energy are expressed in the National Renewable Energy Action Plan. There it can be seen that the expected amount of energy from the feed-in of biomethane into the natural gas grid will increase to 6.7 TWh in 2020, from around 1 TWh today, if the required share of renewable energy should be reached.

13.1 Production of biogas

In the Netherlands today there are 252 biogas plants. There are no data in the Netherland for the current biogas production. Instead the installed capacity is given for production of heat, electricity and upgraded biogas in Table 24 below to give an indication of the actual production.

Table 24: Status of biogas production in The Netherlands (values from 2013)

Plant type	Number of plants	Installed Heat capacity (MW)	Installed electricity capacity (MW)	Upgrading capacity (Nm3 biomethane /h)
Sewage sludge	82	8	46	470
Biowaste	11	11	11	3892
Agriculture	105	18	129	606
Industrial	13	0	18	5312
Landfills	41	0	15	1625
Total	**252**	**37**	**219**	**12530**

Source: http://www.b-i-o.nl/

The biomass potential for the production of bioenergy in the Netherlands was evaluated in 2010. All Dutch biomass was included and the focus was not directed on green gas production in particular. The results showed that, in 2020, approx. 13.4 to 16.4 million ton of dry biomass material would be available for the generation of energy. This can be utilised for the generation of 15 to 26 TWh of final energy (http://groengas.nl/wp-content/uploads/2011/09/Beschikbaarheid-van-Nederlandse-biomassa-voorwarmte-en-elektriciteit-in-2020.pdf).

13.2 Utilization of biogas

The main utilization of biogas in the Netherland is for electricity production, as seen in Table 24. Around 60% of the installed capacity is for electricity production, 30% for biomethane production and 10% for heat production. The gas grid in the Netherland only requires 88% methane which makes the biogas upgrading cheaper and suitable for technologies and designs adapted for producing lower biomethane qualities, such as membrane upgrading units with simple design. In 2012, the first biogas upgrading unit using cryogenic separation was taken into operation in the Netherlands. Today almost 7000 vehicles run on methane and 186 filling stations exist (http://www.ngvaeurope.eu/european-ngv-statistics).

13.3 Financial support systems

A new support scheme was launched in 2013 (SDE+) with a budget of 3 BEUR. The interesting concept of the scheme is that it forces all renewables to compete with one another. In a staged application process with closing dates set at 6 dates throughout (see Table 25) the year projects can apply when the tariff fits their business plan. Since the tariff gradually increases during the year the scheme favours large scale facilities, unless the small facilities can demonstrate that heat is utilised. In Table 25, the tariffs are guaranteed minimum income, which means that the scheme only pays out if energy prices are lower than the prices in the table.

Table 25: Tariffs for the new 2013 SDE+ support scheme in the Netherlands

Phase	Opening	Max Electricity (EUR/kWh)	Max. Heat/CHP (EUR/GJ)	Max. Gas (EUR/Nm^3)
1	4 Apr.	0.07	0.194	0.483
2	13 May	0.08	0.222	0.552
3	17 June	0.09	0.250	0.621
4	2 Sep.	0.11	0.306	0.759
5	30 Sep.	0.13	0.361	0.897
6	4 Nov.	0.15	0.417	1.035

Figure 12: De Meerlanden Rijsenhout is a waste collection and management company in the Haarlemmermeer-Bollenstreek-Aalsmeer region. It collects waste from 4 000 companies and 120 000 households, including some 50 000 ton of organic household waste on annual basis. An innovative process transforms this waste into five new products: green gas, CO_2, heat, compost and water.

14 United Kingdom

The UK government is still supporting the role out of AD in England and devolved administrations.

- In England, Defra set out in 2011a vision for AD to generate between 3-5 TWh of heat and electricity by 2020.
- Wales as part of their 'One Wales Delivery Plan' have created a capital and revenue financial support package for local authorities who wish to adopt AD technology.
- In April, Scotland will see the introduction of food waste bans to landfill. This has driven up the AD capacity and this trend is expected to continue.
- Northern Ireland with its attractive government subsides (4 ROCs) for AD has seen an increase of farm fed (grass) facilities. Number of plants is 9

14.1 Production of biogas

There are today 66 AD plants treating food waste (74 MW_e capacity) and 53 farm plants (29 MW_e capacity). The number of new plants has increased rapidly since 2005, along with gas production and is predicted to keep on rising rapidly. The electrical generation from AD in United Kingdom has increased by 52% during the period 2009–2012.

Table 26: Status of biogas production in United Kingdom (number of plants from 2013, energy generation from 2012)

Substrate/Plant type	Number of plants	Energy Generation* (GWh/year)
Sewage sludge	146	720
Biowaste (co-digestion)	66	523**
Agriculture	53	4098
Landfills	345	5154
Total	**610**	**10494**

* = Produced energy as electricity and/or heat

**= *including both Biowaste and Industrial plants*

The upward trend is expected to continue to 2030. The estimated total energy generated by AD biogas in 2030 could be around 23 to 37 TWh (Analysis of Characteristics and Growth Assumptions Regarding AD Biogas https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48166/2711-SKM-enviros-report-rhi.pdf).

14.2 Utilization of biogas

The main use for biogas in the UK today is for electricity production (103 MW_e from AD alone). There is increasing interest in upgrading biogas to biomethane and in using biomethane as a vehicle fuel . Currently less than five biogas upgrading plants are in operation, but several more are planned and some are being constructed.

Examples of upgrading biogas to vehicle fuel have been demonstrated in the UK although the market is still very much in its infancy. DECC statistics have reported that 1.1 million litres of fuel was produced from biogas in the financial year 2012–2013, but this accounts for only 0.002% of total fuel produced from renewable sources in the UK. There are currently only around 5 CNG filling stations in the UK.

Examples of biogas to vehicle fuel include the Albury landfill in Surrey which has been producing liquid biofuel since 2008. Furthermore, developments such as the first UK buses to run on biomethane gas from AD are highlighting the possibilities to local councils and business alike. WRAP has also supported Evergreen Gas (figure 13) to construct one of the first small scale biogas upgrading to vehicle fuel facilities in the UK. With an onsite filling station Evergreen are using the upgraded gas to run duel fuel vehicles from the local area.

14.3 Financial support systems

Feed-in tariffs for electricity generation from August 2011 are, 0.14 GBP/kWh (~€ 0.17) for up to 250kW, 0.13 GBP/kWh (~€ 0.16) for >251 kW up to 500kW and 0.09 GBP/kWh (~€ 0.11) for >500kW. Double Renewable Obligation Certificates (ROCS) apply to AD, although in Northern Ireland, quadruple ROCS are awarded to plants with sizes up to 500 kW and triple ROCS are awarded to plants in the range >500 kW to 5 MW.

A new renewable heat incentive operating from April 2011 provides a tariff of 0.068 GBP/kWh (~€0.08) for biomethane injected into the natural gas grid and combusted downstream. Renewable Transport Fuel Obligation Certificates were worth 0.1115 GBP/litre (~€0.13) in late2010.

WRAP recently released a new funding scheme to support small scale On-Farm AD (http://www.wrap.org.uk/content/farm-ad-fund) which provides both grant support and a follow-up loan for suitable projects. The support covers early stage costs surround the development of a business case, feasibility report and process steps such as planning permission. Where projects meet the programme criteria they will be eligible to apply for further loan funding through the scheme.

From its launch back in June 2013 the 15 MGBP RCREF (http://www.wrap.org.uk/content/rural-community-energy-fund) fund provides up to 150 000 GBP of funding for feasibility and pre-planning development work to help community renewable energy projects become investment ready. The funding comes in two stages:

- Stage 1 - provides a grant of up to approximately 20 000 GBP to pay for an initial investigation into the feasibility of a renewable energy project.
- Stage 2 - provides an unsecured loan of up to approximately 130 000 GBP to support planning applications and develop a robust business case

The project has received much attention. There are currently 15 stage 1 applications for funding, 7 of those have received stage 1 funding and 1 in stage 2 (not all AD technology).

Table 27: WRAP recently released its Annual Survey of the Organics Recycling Industry report which covers the market size in 2012. Headline figures of 7.54 million ton of organic waste input into composting and AD in 2012 with 2.51 million ton of mixed waste input to MBT facilities. The following table breaks down the headline figures by region.

	England	Northern Ireland	Scotland	Wales	UK Total
Compost (inc IVC)	5 080 000	140 000	430 000	190 000	5 850 000
AD (Commercial, R&D and on-farm)	1 280 000	10 000	120 000	10 000	1 430 000
AD (Inudstrial)	250 000	0	0	10 000	260 000

Source: http://www.wrap.org.uk/content/ad-continues-drive-organics-recycling-sector-growth

Figure 13: Evergreen Gas' small scale biogas upgrading to vehicle fuel facility, as part of WRAP's Driving Innovation in AD programme.

15 Conclusions

Biogas production in the IEA Bioenergy Task 37 member countries is clearly dominated by Germany with more than 9000 biogas plants. No other member country today has more than 1000 biogas plants and only UK has more than 500 plants except for Germany, according to the available data. Around 0.5-2 TWh of biogas is produced annually in most countries except for UK and Germany where the production is several times larger. In UK 10 TWh of energy (mainly electricity) was produced from the biogas during 2012 and in Germany the amount of energy generated was 40 TWh (mainly electricity).

The biogas produced is mainly used for generation of heat and electricity in most countries with exceptions for Sweden and Switzerland where approximately half of the produced biogas is used as vehicle fuel. Many countries, such as Denmark, Germany and South Korea, among others, show initiatives and interest in increasing the share of the biogas to be used as a vehicle fuel in the near future.

Financial support systems are very different from country to country. Various systems with feed-in tariffs, investment grants and tax exemptions exist. A clear correlation between the financial support system and the way biogas is utilised can be seen in the Task 37 member countries. In UK and Germany with feed-in tariffs for electricity have led to that most of the biogas is used to produce electricity, while the system with tax exemption in Sweden favours the utilisation of the biogas as a vehicle fuel.

Figure 14 below shows the country where facilities are located and technology used for the 276 biogas upgrading units that have been identified by IEA Bioenergy Task 37 at the time of publication of this report.

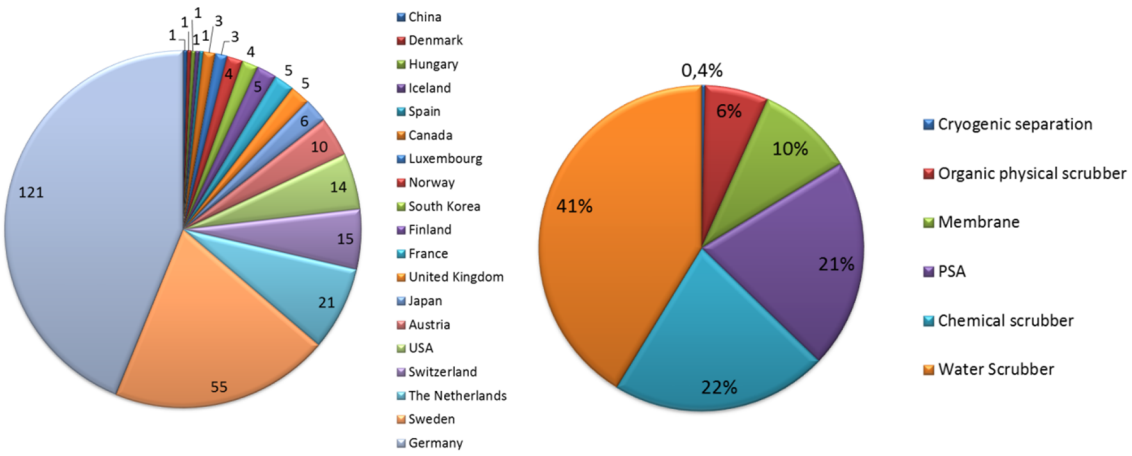

Figure 14: Country where facilities are located and technology used for the 276 biogas upgrading units that have been identified by IEA Bioenergy Task 37 at the time of publication of this report. The labels are in the order from the smallest to the largest.

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