Overview of biomethane markets and regulations in partner countries

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Note on legal topics

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Introduction

Biomethane is a green gas. The biogas derived from anaerobic digestion (AD) of organic sources is processed within different gas treatment and upgrading steps to remove impurities, carbon dioxide and enhance methane content. The resulting product gas is similar in composition to natural gas – with a benefit of being considered 100 % renewable.

The market for biomethane varies widely across the European countries. On one hand, there are so called forerunners like Sweden, The Netherlands, Germany, Switzerland and Austria, which have fair experience in biomethane to grid injection technology. More than 170 plants are operating in these countries that upgrade biogas to biomethane, of which a large proportion is feeding into the public natural gas grids (Table 1). In all these projects the technology providers gained valuable experience and are now poised to supply proven technology throughout Europe. Thus, technology availability is not held as a restricting factor anymore.

The second group of countries still find themselves in information phase. Countries like Italy, Hungary, Slovakia, Croatia and Poland possess excellent agro-economical conditions for biogas production, but are in the early stage of development of biogas industry.

<table>
<thead>
<tr>
<th>Country</th>
<th>Biomethane plants</th>
<th>Biomethane plants feeding the grid</th>
<th>Biogas plants total (approx.)</th>
<th>Agricultural</th>
<th>Biowaste (incl. organic MSW)</th>
<th>Sewage</th>
<th>LFG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>10</td>
<td>7</td>
<td>503</td>
<td>approx. 300</td>
<td>55</td>
<td>134</td>
<td>14</td>
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<tr>
<td>Croatia</td>
<td>-</td>
<td>-</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>France</td>
<td>3</td>
<td>4</td>
<td>89</td>
<td>40</td>
<td>98</td>
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</tr>
<tr>
<td>Germany</td>
<td>84</td>
<td>82</td>
<td>8,792</td>
<td>approx. 7,000</td>
<td>92</td>
<td>1,700</td>
<td></td>
</tr>
<tr>
<td>Hungary</td>
<td>1</td>
<td>1</td>
<td>58</td>
<td>36</td>
<td>14</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Italy</td>
<td>-</td>
<td>-</td>
<td>667</td>
<td>approx. 300</td>
<td>32</td>
<td>135</td>
<td>200</td>
</tr>
<tr>
<td>Netherlands</td>
<td>13</td>
<td>13</td>
<td>130</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poland</td>
<td>-</td>
<td>-</td>
<td>219</td>
<td>17</td>
<td>2</td>
<td>approx. 200</td>
<td></td>
</tr>
<tr>
<td>Slovakia</td>
<td>-</td>
<td>-</td>
<td>24</td>
<td>12</td>
<td>12</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>UK</td>
<td>2</td>
<td>2</td>
<td>360</td>
<td>60</td>
<td>100</td>
<td>&gt; 200</td>
<td></td>
</tr>
<tr>
<td>Sweden</td>
<td>47</td>
<td>8</td>
<td>229</td>
<td>14</td>
<td>23</td>
<td>135</td>
<td>57</td>
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<tr>
<td>Switzerland</td>
<td>17</td>
<td>15</td>
<td>600</td>
<td>140</td>
<td>460</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Number of biogas and biomethane plants in several European countries

The prevailing conditions vary considerably across these nations. The support schemes for biomethane provided by individual government vary strongly - from gas feed-in tariffs in UK and France, very supportive feed-in tariffs for CHP in Germany, to mainly market driven developments e.g. in Sweden and Switzerland. Also the feedstock applied for biogas production also varies as primarily energy crops in Germany and predominantly organic in Switzerland and Sweden, while the UK is distinguished by an uptake of high ratio of AD from sewage at waste-water treatment plants. These variations occur due to different infrastructure and raw material basis and diverse political framework and goals. Sweden for example does not have an all-spanning gas grid infrastructure, but instead the country focuses on direct applications of biomethane such as biofuel. Germany, on the other hand, focuses on applications in CHP plants, while the Netherlands and UK have established a well-developed heat market for eco-friendly green gas.
Due to all these differences in prevailing conditions, it has so far not been possible to develop a common European market for biomethane. It is therefore necessary to provide transparent and comprehensive information on the respective markets, to develop joint strategies and propositions and to learn from each other through best practice exchanges.

Green Gas Grids project aims at establishing an exchange between the partner countries; in order to boost market development, enhance knowledge in a pan-European perspective. The project is funded by the Intelligent Energy for Europe (IEE) program with the aim to boost the European biomethane market. The project’s consortium consists of 13 European partners, including national energy agencies, scientific institutions as well as industry associations involved in biomethane, natural gas, and renewable energy.

As a first major output of the project work, national reports in the partner countries have been drawn up, based on information derived from a questionnaire study. This report provides an overview on the current state of the biomethane market in forerunner countries and on the biogas market in countries where biomethane production is in early phase of development. There are several prerequisites for the development of biogas injection in a market. Apart from the availability of the organic substrates for biogas production and the choice of appropriate technology, political awareness and appropriate legal framework are essential for deployment of biogas technology. Therefore, this report addresses major issues that are considered to be essential for the success of biomethane production:

- Status quo - biogas plants and biomethane plants
- Political targets for biogas and biomethane production
- Natural gas consumption, suppliers, infrastructure
- Technical standards for biomethane and natural gas
- Support schemes for biogas and biomethane
- Certification

This report reveals that each country has adopted a different approach to tackle the challenges and obstacles concerning the exploitation of the national biogas potential in a sustainable and economical way. It will provide a reliable and up to date database to enable further communication and development in each country.
National reports on biomethane markets

**Austria**

**Status quo - biogas plants and biomethane plants**

Austria has had a long tradition in biogas production from landfill, sewage sludge and industrial waste. More than 20 years ago the first agricultural biogas plants using liquid and solid animal manure emerged. Before the millennium, attempts to use energy crops and grass were made. Some provinces subsidised such agricultural and co-digestion plants by feed-in tariffs for a period of 10 to 12 years. In 2001, the Green Electricity Act introduced nation-wide feed-in tariffs for a eligibility period of 13 years. Until 2007, more than 200 biogas plants with a total capacity of 60 MW mainly fed by energy crops have been erected. Subsequent amendments of the Green Electricity Act did not lead to a comparable market activity, the biogas market slowed down and today we can count approximately 300 agricultural biogas plants, 25 industrial AD plants, 134 sewage gas plants, 30 MSW AD plants and 14 landfill gas plants in operation.

In 2005 the first biomethane project at pilot plant scale was implemented. Today there are a total of 10 plants that upgrade biogas to biomethane, out of which seven plants are injecting into the gas grid (Table 2). The main feed stock for biogas plants are energy crops, sewage sludge or biowaste. Another three biomethane plants are not connected to the grid and deliver directly to filling stations. The feed in tariffs for electricity from biomethane are considered to be less attractive, hence, the gas is most commonly used in space heating and in the transport sector. Initiatives which go for these two pathways face tough market conditions and the lack of political backing.

<table>
<thead>
<tr>
<th>Location</th>
<th>Year of commissioning</th>
<th>Upgrading technology</th>
<th>Capacity of biomethane production [Nm3 / h]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pucking*</td>
<td>2005</td>
<td>PSA</td>
<td>6</td>
</tr>
<tr>
<td>Bruck an der Leitha</td>
<td>2007</td>
<td>Membrane technology</td>
<td>100</td>
</tr>
<tr>
<td>Schwaighofen bei Euggendorf</td>
<td>2008</td>
<td>PSA</td>
<td>40</td>
</tr>
<tr>
<td>Leoben*</td>
<td>2010</td>
<td>Amine scrubber</td>
<td>125</td>
</tr>
<tr>
<td>Engerwitzdorf</td>
<td>2010</td>
<td>Amine scrubber</td>
<td>125</td>
</tr>
<tr>
<td>Asten Linz</td>
<td>2010</td>
<td>Water scrubber</td>
<td>380</td>
</tr>
<tr>
<td>Wiener Neustadt</td>
<td>2011</td>
<td>Membrane technology</td>
<td>120</td>
</tr>
<tr>
<td>Steindorf</td>
<td>2011</td>
<td>PSA</td>
<td>150</td>
</tr>
</tbody>
</table>

* out of operation

**Table 2: Austrian biomethane projects connected to the public grid**

Beside from biomethane, efforts are made to establish production and utilisation technology for wood gas. There are a few facilities in operation, e.g. in Güssing, Villach and Oberwart, and a plant is planned to be constructed in Klagenfurt. Wood
Gas consists mainly of hydrogen and carbon dioxide and is derived from biomass such as wood chips gasified in a thermo-chemical process under oxygen-limited conditions. The resulting gas needs to be conditioned to fuel a gas engine. Besides that a few research projects are aiming at producing synthetic natural gas from biomass (BioSNG). In 2008 a pilot plant for BioSNG production has been commissioned at the European Centre for Renewable Energy in Güssing. A gas flow of about 300 m³/h wood gas is led through a methanation process and produces 120 m³/h fuel gas of a similar quality to natural gas. In the near future another BioSNG pilot plant is planned to be implemented in Villach which is part of the Polywood project supported by the funding programmes LIFE+ and the klima:aktiv initiative of the Federal Ministry of Agriculture, Forestry, Environment and Water Management.

**Political targets for biogas and biomethane production**

According to Directive 2009/28/EC [1], Austria’s target share of renewable energy in gross final consumption of energy is 34 % by 2020. In the 2005 base year this share was 24.4 % and for 2008 the figure has risen to 29.0 %. The Austrian NREAP does not set a specific target for the utilisation of biomethane by 2020.

**Natural gas consumption, suppliers, infrastructure**

Austria hosts inland gas resources and covers approximately 16 % of its gas demand with national reserves. The remaining requirement is imported from the Russian Federation (51 %), Norway (10 %) and Germany (14 %). The Austrian gas grid is a system that has evolved over time. In total the gas grid has a length of more than 38,000 kilometres and because of its geographical location it has an important function as a hub transporting natural gas imports onwards to destinations in Western Europe. An overview of the Austrian gas pipeline system is given in figure 1.

The national gas grid is mainly owned by private companies. The transportation grid is owned and operated by OMV Gas GmbH. The company is technical operator of all the trans-national high pressure grids which include in total 792 kilometers of pipeline system, they are detailed as: Hungaria-Austria-Gas-Pipeline (HAG), Süd-Ost-Gasleitung (SOL), March-Baumgarten-Gasleitung (MAB), Kittsee-Petrzalka-Gasleitung (KIP), West-Austria-Gasleitung (WAG), Penta-West-Gasleitung (PW) and Trans-Austria-Gasleitung (TAG). The distribution grid is operated by around 23 different privately owned DSOs. In some companies the Austrian state is a shareholder.

The regulator responsible for natural gas and biomethane is divided into two bodies, the Energie Control Austria and the Regulatory Commission of Energie Control. The ÖVGW (Österreichische Vereinigung für das Gas- und Wasserfach/ Austrian Gas and Water Association) is in charge of developing technical and economical methods for gas and water supply, and in this context establishes the relevant framework of technical standards.
Contributing more than 50% to the national power generation, water power takes a predominant role in Austria's energy mix. However, natural gas is of increasing significance for the country's fuel supply. In 2010 about a quarter of the gross energy consumption (23.8%) and 17.1% of the final energy consumption were derived from natural gas.

With around 6,000 CNG cars and a gas consumption of approximately 475 TJ in 2010 (less than 2% of total annual gas consumption), the transport sector is of minor significance for Austria's natural gas market. With 170 filling stations Austria has (in proportion to the country's size) one of the highest densities in terms of CNG filling stations in Europe. In a few years the gas industry wants to increase the number of public stations to 200. With the five-point action programme – which was launched in 2006 by the Federal Ministry of Agriculture, Forestry, Environment and Water Management together with the OMV – natural and biogas as road transport fuels has been encouraged. By offering a CNG fuel with 20% biomethane share, branded "Bio-CNG", the public CNG vehicle sector has been opened up for biomethane in Austria.

**Technical standards for biomethane and natural gas**
The Austrian Gas Act (GWG) regulates the general framework conditions for the integration of biogas, and grants non-discriminatory, but not priority, grid access for biogenic gases. Distribution companies are obliged to establish General Distribution System Conditions which must be approved by the E-Control Commission. In the distribution system’s condition, the quality requirements and possible integration points relevant to the introduction and transport of biogenic gases must be determined. The distribution system operator charges the plant operator those expenses incurred through the initial establishment of the connection of the biogas plant to the distribution grid in the form of a grid access fee. These costs are entirely born by the biogas suppliers. This regulation combined
with the current situation in terms of feed-in tariffs and the lack of preferential access to the grid does not provide sufficient basis for developing biomethane to grid projects.

The quality requirements specified in the General Distribution System Conditions are stated in Chapter 6 of the Technical Code of Other Market Rules. Biogas must fully respect the criteria of ÖVGW Directive G31, in order to be integrated into the grid. The quality requirements of the gas are defined in detail in ÖVGW Directive G31 that ensures safe transport within the Austrian gas network.

The quality criteria mentioned in the document focus strongly on the characteristics of imported natural gas. Additionally, the requirements of ÖVGW Directive G33 stipulating further gas quality criteria for the injection of biogas and the measures for quality control must be fulfilled.

The technical standard ÖVGW Directive G79 sets the requirements on odorization. If fed into a grid containing odorized gas, biomethane has to be odorized as well. The grid operator determines the kind of odorant and the minimum requirements for safe operation. However, landfill gas is rejected from the public grid due to concerns about harmful gas components affecting the infrastructure or gas end consumer, and due to concern about the limited availability of appropriate measurement equipment for all the impurities.

There is a uniform gas quality in the whole country (H-gas). Due to the corresponding high heating value, in some cases addition of LPG or propane may be required. Injecting upgraded gas with lower calorific value (off-spec gas) than the natural gas quality to the grid is not allowed.

Support schemes
In Austria the most important supporting schemes are the following:

- Fixed feed in tariff scheme for RES according to the Austrian Green Electricity Act (Ökostromgesetz),
- Federal grants from the Environmental Assistance in Austria and
- Tax exemption for biomethane from mineral oil tax.

The Austrian Green Electricity Act (Ökostromgesetz) prescribes the remuneration for RES. The basic tariffs for agricultural biogas plants contracted for subsidy in 2012 are between 18.5 and 13.0 öcent per electric kilowatt hour for facilities with 18.5 öcent/kWh for an electrical capacity of less than 250 kW, 16.5 öcent/kWh for those of a capacity between 250 and 500 kW, and 13 öcent/kWh for those of an electrical capacity higher than 500 kW. The tariffs are subject to minimum requirements for the use of manure (>30 percent by mass). The feed-in tariffs are granted for a period of 15 years, and the Act allows follow-up tariffs up to the 20th year of operation. In the past years, an extra support for operational costs was given up to 4 öcent per kWh, in order to compensate the higher costs when using energy crops. The new Green Electricity Act no longer provides this support.

To be eligible an annual fuel efficiency of 60 % is required. If the facility achieves even higher fuel efficiency, a CHP bonus of 2 öcent per kilowatt-hour can be granted on top of the technology and base feed-in tariff. The scheme foresees a technology bonus of 2 öcent per kilowatt-hour for green electricity generated from biomethane in a CHP. A mixed operation using both natural gas and biomethane is
possible if the share of biomethane is at least 50%. A virtual allocation of injected biomethane to a CHP is possible for the whole, or for parts of the injected biomethane quantities. The technology bonus is paid on-top to the basic feed-in tariff and doesn’t depend on capacity or type of feedstock.

As part of the "Environmental Assistance in Austria" (UFI) [2] federal grants for biogas plants, as well as cleaning, upgrading and injection installations upto a percentage of 25% of the total environmentally relevant investment costs are available. The grant doesn’t depend on the capacity of the installations, the feedstock, or the final usage of the biomethane. When fulfilling the sustainability criteria for renewable transport fuels of the RES Directive of 45% GHG reduction, a bonus of 5% can be given, adding upto 30% overall grant. A regional supply of raw materials is required with a maximum of 100 km transport distance and in line with the sustainability criteria of the RES Directive. The program has an overall budget limitation and is managed and administered by the Kommunalkredit Public Consulting GmbH (KPC).

Due to the Austrian Green Electricity Act, all nine Austrian provincial governments receive an annual budget of 7 million € in total, which they can spend on investment grants for renewable energy, energy savings and efficiency installations and measures. The subsidy provisions lie in the competence of the corresponding province. In the past also some pilot plants and demonstration projects for biogas upgrading have received such funding.

Certification

Some Austrian companies provide guarantees of origin for the biomethane share in their gas products. Salzburg AG, the operator of the two biomethane plants in "Schwaighofen bei Eugendorf" and in Steindorf, sells the produced gas as a vehicle fuel under the brand name Bio+ErdgasDrive. The biomethane fed into the gas grid is assigned to the CNG filling stations of Salzburg AG by a balancing system. The customers can purchase biogas certificates and thus generate their own biogas-natural gas fuel mix. One biomethane certificate costs 0.5 € (excl. 20% VAT) and saves one kilogram of CO₂ emissions. Even including the certificates costs, the price of biomethane currently is more favourable in terms of energy than diesel and gasoline.

Another example of biomethane certification is the energy supplier EVN Wärme GmbH. The company uses a TÜV certification to prove the delivery of biomethane to their heat customers.
**Croatia**

**Status quo- biogas plants and biomethane plants**

The biogas market in Croatia has just started taking shape. At the end of 2011 there are six operating biogas plants processing different types of biomass (Table 3).

<table>
<thead>
<tr>
<th>Location</th>
<th>Year of commissioning</th>
<th>Type of biogas</th>
<th>Electrical capacity installed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landfill Jakuševac / Zagreb</td>
<td>2003</td>
<td>LFG</td>
<td>2 MW</td>
</tr>
<tr>
<td>Waste water treatment plant close to Zagreb</td>
<td>2007</td>
<td>Sewage gas</td>
<td>2 x 1.5 MW</td>
</tr>
<tr>
<td>Ivančkovo I and II (Vukovarsko-srijemska county)</td>
<td>2009</td>
<td>Agricultural biogas (manure, maize silage etc)</td>
<td>2 x 1 MW</td>
</tr>
<tr>
<td>Tomašanci I and II, Osječko-baranjska county</td>
<td>2011</td>
<td>Agricultural biogas (manure, maize silage etc)</td>
<td>2 x 1 MW</td>
</tr>
</tbody>
</table>

Table 3: Biogas projects in Croatia

Additionally, according to EIHP there are about 30 biogas plants with applications pending for a permit to gain status of a privileged producer. All these biogas projects primarily focus on electricity generation. There are no biogas upgrading plants for biomethane production.

Even though the country holds a large biomass potential, there have been unfavorable prerequisites such as a very limited number of waste water treatment plants in operation and an agriculture characterized by small scale farms.

**Political targets for biogas and biomethane production**

Croatia’s potential for electricity generation from biogas is estimated at 90 MW$_{el}$ from agriculture and about 60 MW$_{el}$ from the food industry. As of now there are no specific targets set for 2020 by the national government, but according to the national strategic documents, there are intentions to utilise the existing biogas and biomethane potential.

**Natural gas consumption, suppliers, infrastructure**

Being one of the few European countries with its own natural gas resources, Croatia is less dependent on gas imports than other countries. The total gross inland consumption of natural gas is 102,150 TJ (2009), of which 64 % is covered from national resources. The residual amounts are imported from Russia (34 %) and a minor percentage from Italy and Slovenia (2 %).

In Croatia the natural gas pipeline system is divided into the transportation grid, operating at about 50 and to 70 bar, and the distribution grid, operating at middle and low pressure level (Figure 2). The transportation grid is operated by one TSO company, which is 100 % state-owned, while the distribution grid is operated by 39 private companies for the distribution of natural gas, town gas and LPG.
The natural gas transmission system comprises 2,034 km of pipelines, 142 exit metering-reduction stations with 210 metering lines and 19 entry metering stations. Regarding distribution, the total gas pipeline length is 15,980 km. There is a uniform gas quality. The share of methane in the Croatian natural gas grid varies between 85 and 95%, therefore biomethane production and the adjustment to natural gas quality is expected to demand less effort compared to public grids with high calorific gas. The Gas is odorized in the distribution grid. The supervising authority in charge of regulating the natural gas market is Croatian Energy Regulatory Agency (HERA).

Natural gas plays a minor role in transportation. According to the NGVA, by end of 2010 only about 200 vehicles ran on natural gas, which was about 0.01% of the total number of cars and trucks in the country. There are two filling stations offering CNG in Croatia, one located in Zagreb and the other one in Ivanic Grad.

**Technical standards for biomethane and natural gas**

The Act on Natural Gas Market (Zakon o tržištu plina) determines the rules and measures for performing energy-related activities in the natural gas sector, the rights and obligations of the gas market participants, the unbundling of activities of the system operators, third party access to the natural gas system and the natural gas market opening. According to this act, biogas, gas from biomass and other gases are permitted for injection into the natural gas grid presuming the same technical and safety standards for natural gas are fulfilled. Gas quality requirements for natural gas are laid down in the standard General condition for natural gas supply (OG 43/09). Due to the fact that the detailed standards and obligations for
the gas supplier are defined on the case-by-case basis, it can be assumed that additional requirements would be imposed on a biomethane producer. In line with the harmonisation of the national legislation with the Directive 2009/28/EC [1], it is expected that the technical standards for biomethane will also be clearly defined. Regarding the establishment of the grid connection, in the case of connecting to the electricity grid, the national grid operator is in charge of building and operating the grid connection, however the biogas plant operator bears the costs. It is expected that connections to gas grid will follow similar treatments.

Support schemes
There are no feed-in tariffs for the utilisation of biomethane, but there is a feed-in tariff scheme for electricity produced from biogas. Depending on the size of the plant these feed-in tariffs for biogas generated from agricultural substrates and biowaste range from 1.04 to 1.2 HRK per kWhel (around 14 to 16 €cent / kWhel). For landfill and sewage gas the remuneration is at a lower rate and is fixed at 0.36 HRK / kWhel (about 5 €cent / kWhel). The feed-in tariffs are adjusted annually, inline with the inflation index.

The authority responsible for the utilisation of biogas for energy production is the Ministry of Economy, Labour and Entrepreneurship. Nevertheless, depending on the feedstock used for biogas production other ministries may be involved in the regulation such as the Ministry of Environmental Protection, Physical Planning and Construction, the Ministry of Agriculture, Fisheries and Rural Development. In general, biogas is mentioned in more than 40 legal documents which provide a high declarative support for biogas benefits.

If upgraded biogas meets the technical and safety standards of natural gas, it can be injected in the natural gas grid and can be utilised in the transportation sector. Biogas is recognised as biofuel in the Law on Biofuels (2009) [3], however, unlike biodiesel and bioethanol it still does not have a supported price. When developing biogas projects, the long approval procedure presents itself as a hurdle. The absence of clear legislative guidelines for issuing permits for biogas plants leads to applications taking up to two years.

According to the national strategic documents, there are intentions for the utilisation of the biogas and biomethane, thus it is expected that the relevant legislation will be revised in the near future. Regarding the sustainability policy, there are no relevant projects for biogas and biomethane at the moment. Nevertheless sustainability is on the government’s agenda and the relevant legislative framework is in draft and planned to be implemented in 2012.
France

Status quo - biogas plants and biomethane plants
France enjoys good conditions for agriculture; nevertheless biogas activities are comparably moderate and the national biogas market is still developing. As of 2011 there are about 300 operational biogas plants in France, 71 of which are from landfill sites, 88 from industrial biowaste treatment and 74 from sewage plants. More than 40 biogas plants on farms use agricultural substrates such as manure and energy crops and 10 source MSW and biowaste as feedstock. Seven centralised plants (plants processing more than 20,000 tons per annum) use variable substrates such as sewage sludge, food-processing waste etc.

<table>
<thead>
<tr>
<th>Location</th>
<th>Year of commission</th>
<th>Upgrading technology</th>
<th>Capacity of biomethane production [Nm³ / h]</th>
</tr>
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<tbody>
<tr>
<td>Claye Souilly</td>
<td>2009</td>
<td>PSA and membrane</td>
<td>100</td>
</tr>
<tr>
<td>Lille / Sequedin</td>
<td>2007</td>
<td>Water scrubber upgrading biogas from biowaste AD</td>
<td>700</td>
</tr>
<tr>
<td>Lille / Marquette *</td>
<td>2009</td>
<td>Water scrubber</td>
<td>100</td>
</tr>
</tbody>
</table>

* (plant closed until 2014 for renovation of waste water treatment)

Table 4: Biomethane projects in France (source ADEME)

Today there are three upgrading plants (Table 4), all of which supply fuel to the transport sector. Up to now in France, there has just one biomethane plant been connected to the grid (Lille / Sequedin). Thus, biomethane to grid injection is in an experimental phase at the moment.

Political targets for biogas and biomethane production
The French NREAP of August 2010 provides the framework for political targets on renewable energy. Regarding energy derived from biogas France aims at producing more than 555 ktoe in terms of heat and install at least 625 MW of electricity by 2020 [4]. Even not specifically mentioned, biomethane is considered to be included in the goals set for biogas.

Natural gas consumption, suppliers, infrastructure
In 2010, the raw total for natural gas consumption was 565 TWh and 511 TWh for the net balance. Since France has very little domestic natural gas production (less than 2 %), it imports most of the gas requirement from Norway (about 35 %). Other major suppliers are the Netherlands (15.8 %), Russia (15 %) and Algeria (14.5 %). France has an established gas infrastructure and an extensive pipeline network with its neighbours. An overview of the French transmission pipeline system can be seen in Figure 3.
The French gas grid had been state owned until in 2002 the exploitation rights for transportation were given to two companies. Today TIGF, a 100 % subsidiary of Total Group, and GRTgaz, a subsidiary of GDF Suez, are in charge of the transportation pipeline system. GRTgaz operates the natural gas transmission grid in the northern and south-eastern part of France while TIGF is operator in the south-western and in a small part of the central region. The distribution grid is publicly owned and operated and maintained by DSOs. The main DSO is GrDF, a 100 % subsidiary of GDF SUEZ, and there are nearly 30 other local independent companies operating different distribution grids (small and medium sized cities).

The natural gas market is supervised by the Energy Regulation Commission (CRE), reporting to the French Ministry of Economy, Finance and Industry. CRE is the administrative authority, which is assigned to ensure functioning and operation of the national electricity and gas markets.

In France natural gas as vehicle fuel plays a role in public services and transportation. There are now more than 13,000 vehicles run on natural gas in France, most of them are larger vehicles such as busses and garbage trucks. There are about 140 filling stations offering natural gas, but only 32 of them are public access sites.

Technical standards for biomethane and natural gas

Biomethane is allowed to feed the gas grid if it meets the requirements of AFG specification B562-1 for the distribution grid and B562-2 for the transportation grid respectively. When injected, biomethane has priority access to the grid. Biogas from sources such as sewage sludge and industrial waste is today prevented from
being fed-in to the French gas grid. But this situation might change in following months. In 2008 biological pollution has been studied by the French agency for food, environment and occupational health and safety (ANSES, former AFSSET). In October 2008 AFSSET published the health assessment concluding that compared with the use of natural gas, the use of biomethane does not cause additional health risks. Since the study left uncertainties about the risks deriving from biogas coming from AD of industrial waste water sludge and urban sludge. According to ADEME, in France the augmentation of the heating value by adding LPG or propane has been studied and rejected due to the costs and complexity of this practice.

Support schemes
With the Décret n° 2011-1597 from 21st of November 2011 the French government established a feed-in tariff scheme for biomethane. The remuneration is linked to the upgrading capacity of the biomethane plant in terms of generated gas flow. The tariffs range from 9.5 €cent / kWh HHV for plants with a capacity of less than 50 m³ / h to 6.4 €cent / kWh HHV for plants with a gas flow more than 350 m³ / h. The Act places no restrictions on the different biomethane utilisation pathways.

Electricity from renewable energy has been supported by fixed feed-in tariffs for several years already. According to Journal officiel n° 118 of 25th of May 2011, for the electricity generated from biogas there is a basic fixed tariff depending on the capacity of the plant and on the type of feedstock. The tariffs vary between 13.37 €cent / kWh, for plants with a power less than 150 kW and using feedstock others than non-hazardous waste, and 8.121 €cent / kWh for plants of a maximum power higher than 2 MW and using feedstock declared as non-hazardous waste. A premium of maximum 4 €cent / kWh is offered for energy efficient use of biogas. Furthermore, a bonus of up to 2.6 €cent / kWh is offered for manure usage. This premium depends on the quantity of manure used for digestion. In total, the feed-in tariffs in a range from 11.19 to 19.97 €cent / kWh are offered.

Both feed-in tariffs for biomethane and biogas take into account the investment and operational costs for grid connection as well as the production and upgrading costs. Therefore, the investment for the grid connection is borne by the owner of the upgrading plant. Tariffs for electricity and biomethane are updated annually.

Besides the feed-in tariff schemes there are also direct subsidies offered e.g. by French agency for environment (ADEME), UE funds or from regional councils subsidy schemes.
Germany
Status quo- biogas plants and biomethane plants

With more than 7,000 biogas plants at the end of 2011, Germany takes the lead in biogas production in Europe. The fast and wide deployment of this green technology has been a result of a continuous and supportive policy that specifically attracted the farming community to step into biogas production.

After several years of investigation at own pilot plants and conducting study tours to Sweden and Netherlands, the first biogas upgrading facilities in Jameln, Pliening and Straelen started operation in Germany in 2006. By December 2011, 84 plants had been commissioned that upgraded biogas to biomethane and injected the gas into the natural gas grid as well as few plants sold the upgraded gas directly as vehicle fuel at fuel stops. According to market research about 75 more are expected to start operation in 2012 or due to the long project development phase of biomethane projects in the following years. There exists a considerable variation in the plants size, ranging from few large facilities with a biomethane production capacity of up to 10,000 m³ / h (e.g. Güstrow, Zörbig, Schwedt), plants of medium size (e.g. Wüsting, Aiterhofen), and rather small plants producing less than 300 m³ / h (e.g. Ronnenberg, Kißlegg-Rahmhaus, Eggertshofen), however, the average plant size is a production capacity of approximately 550 m³ / h.

![Figure 4: Biomethane production in Germany: number of plants in operation and upgrading capacity installed, status March 2012](image)

Depending on the plant size and transportation costs as well as capitalizing on financial incentives, energy crops such as maize and rye silage are the most commonly used substrates for biomethane production, while manure is mainly treated in smaller biogas plants with onsite electricity generation. The increasing amount of energy cropping, especially regarding maize silage, has been the subject of critical debate recently. Therefore, the new Renewable Energy Act, which came into force in 2012, limits the proportion of maize and cereal grains in the biogas
substrate mix. On the other hand biogas production from municipal biowaste, other biogeneous residues, and from pasture lands is being enforced. Since German incentive schemes strongly support CHP, biomethane is most commonly (around 70 %) used in gas engines with heat recovery. About 20 % of the produced quantity is sold as a vehicle fuel and a minor percentage is applied to space heating.

**Political targets for biogas and biomethane production**

By 2020, Germany aims to reduce its carbon dioxide emission by 40 %. With the decision on phasing out of nuclear energy, the climate targets are strongly dependant on a successful and fast deployment of RES. Thus, Germany plans to increase the share of RES up to 30 % in electricity, up to 14 % in heating sector, and up to 10 % share in the transport sector (biofuels). The Government’s Enactments of Meseberg, announced in August 2007, details the strategy of achieving Germany’s targets for emission reduction. The measures indicated in this document include for example Germany’s national target for biomethane feed-in of 6 billion cubic metres annually until 2020 and 10 billion cubic metres per year by 2030. Both targets are considered to be ambitious and even though Germany hosts the largest biomethane production in Europe (2011 figures), only about 5 % of the 2020 target has been reached.

**Natural gas consumption, suppliers, infrastructure**

With annual gas demand of 94 billion cubic meters, Germany is the largest gas consumer among all EU countries. The country hosts small and declining reserves of natural gas. A mere 13 % of Germany’s total gas demand is covered by national reserves. Moreover, gas is imported from The Netherlands (20 %), Norway (29 %), and Russia (32 %) as well as minor amounts from Denmark and UK. Germany has a well developed nationwide pipeline network (Figure 5) with a total length of 436,204 km. 116,927 km belongs to the high pressure grid, 177,456 km to medium pressure and 141,821 km to the low pressure grid. The most important TSOs are Eon Gastransport, Gasunie and Wingas. The largest natural gas suppliers are Eon Ruhrgas, RWE Energy, VNG, Exxon Mobil and Shell. The natural gas market is under the supervision of Federal Network Agency (Bundesnetzagentur / BNetzA). The Agency is in charge of electricity, gas and telecommunication network, for postal and railway networks and promotes the liberalisation of these markets.
Natural gas plays a small role in the transportation sector. As of today, roughly 90,000 (0.2 % of the total cars in Germany) are powered by natural gas. Although the number of CNG refuelling stations has increased to 900, the infrastructure is still considered less dense by car consumers. In contrast, service station operators complain about the poor exploitation of gas refuelling stations.

Technical standards for biomethane and natural gas
The Ordinance on Gas Network Access (Gasnetzzugangsverordnung / GasNZV) provides the framework for the access to the natural gas grid. It governs several important issues such as the following:

- Procedure regulation: how to apply for grid connection including time frames for the different steps,
- Responsibilities and cost split for grid connection,
- Maximum methane slip of 0.2 % from 30th of April 2012,
- Provision of bonus for avoided network tariffs of 0.7 €cent / kWh biomethane to reward not using the transmission pipeline system (in contrast to natural gas imports).

Figure 5: German transmission grid (source www.eon.de)

Basically, the Ordinance stipulates a cost split of 25 % / 75 % between grid connection applicant and the grid operator. If the distance between upgrading plant and the grid connection point is less than 1 km, the costs for biomethane producer will be caped at 250,000 €. If the distance between the upgrading plant and the grid connection point exceeds 10 km, biomethane producers will have to bear the
The grid operator has ownership of the grid connection station and bears the operation costs for compression, odorization, gas measurements and adjustment of the heating value. Since the grid connection represents a bottleneck for biomethane injection and is of significant importance for the profitable operation of the entire plant, a minimum availability of the grid connection station of 96% per year must be guaranteed by the grid operator. The German Association for Gas and Water (Deutscher Verein des Gas- und Wasserfaches / DVGW) is in charge of providing technical standards. The gas quality requirements are stipulated in the technical standards DVGW G260 and G262. The rules offer the possibility of feeding biomethane as an additional gas, apart from feeding biomethane as a substitute for natural gas. This implies that biomethane of different heating value (off-spec) can be fed into the grid as long as the resulting gas quality is in line with the specifications. This case can be observed in Pliening, Bavaria where off-spec biomethane is fed into a large transmission pipeline.

Support schemes
Germany creates a market demand for biomethane by introducing several incentives, such as

- Feed-in tariffs for renewable electricity,
- Renewable Heat Obligation and
- Renewable Transport Fuel Obligation.

In 2000, the Renewable Energy Act (Erneuerbare Energien Gesetz / EEG) was set into force, providing regulations for grid access and the remuneration for renewable energy. Renewable energy has priority access to electricity grid and receives technology specific feed-in tariffs. The remuneration decreases annually by a certain percentage in order to consider cost decrease due to the learning curve. Once the RES production plant begins operation, it receives the same feed-in tariff for a guaranteed period of 20 years. Germany has a large proportion of black and brown coal in electricity production, thus the country makes considerable efforts to reduce its carbon footprint in this sector. The tariff scheme focuses on green electricity production and also biomethane utilisation is eligible for feed-in tariffs only when being used for CHP. For CHP operation, 100% heat utilisation is mandatory in order to justify the energy consumption for upgrading, injecting and transport.

The Renewable Energies Heat Act (Erneuerbare Energien-Wärmegesetz / EEWärmeG) became effective in 2009. It stipulates that 14% of Germany's heat demand (in terms of final energy) is to be sourced from RES. Buildings erected after 1st of January 2009 are obliged to employ renewable energies for their heat supply. When using biogas, the obligation is generally met if 30% of the heat energy demand of the respective building is covered, provided that the biogas is used in CHP. In case the supply is from the gas grid, requirements on the sustainable production of the biomethane (state of the art technology, emission control etc.) are to be fulfilled.

The Renewable Transport Fuel Obligation (Biokraftstoffquotengesetz / BioKraftQuG), announced in 2006 and introduced in 2007, rules that all suppliers of vehicle fuel are obliged to admix a minimum percentage of biofuel to vehicle petrol and diesel fuel. Operators that fail to fulfill this quota have to pay a fine per litre of fuel for which they fall short of the quota. Thus, refuelling station operators who exceed the quota, benefit from additional revenues from trading their allowances.
The price for allowances is market driven and capped by a legal fine as a maximum. An amendment in 2009 stipulates biomethane to be eligible to fulfill the quota.

Depending on the requirements for the different support schemes, biomethane producers and users are required to provide certain proof for the origin and the sustainability of gas production. Therefore, in cooperation with numerous market participants the German Energy Agency (dena) developed the German Biogas Register [5], implemented in February 2011. The Biogas Register establishes a sector-wide standard and enables producers, traders and consumers to document the type of biomethane they are producing, trading or using. According to dena, the market has accepted the documentation system and the majority of biomethane production has been registered.
Hungary

Status quo - biogas plants and biomethane plants
The biogas market in Hungary is in a development phase. There are already 56 biogas plants in operation generating electricity from landfill gas (8), sewage gas (14) or biowaste and agricultural substrates (36). In 2010, in Zalaegerszeg, a city in the west of Hungary, the country’s first biomethane project was implemented at the municipal waste water treatment plant. Raw sewage gas is upgraded by water scrubber technology to natural gas quality and utilised as vehicular fuel. Another biomethane plant is under development in Kaposvar. Biogas is to be sourced from organic residues of the local sugar factory and upgraded by membrane technology in the future. The biomethane thus produced, is intended to feed into the low pressure grid.

Political targets for biogas and biomethane production
Hungary is subject to a binding target of 13 % of energy from RES by 2020. According to the Renewable Energy Strategy for 2007-2020, Hungary is expected to reach this target mainly by an increase of the use of renewable energy sources from 55 PJ in 2006 to 186.4 PJ by 2020.

However, in Hungary’s National Energy Efficiency Action Plan, approved in December 2010, the government set an even more ambitious target of 14.65 %. The 2010 target of 3.6 % was actually achieved in 2007, mainly due to the increase of biomass utilisation. By 2020, the potential biogas production is expected to reach 32 MW, which would equal to 5 % of the total renewable energy generated in Hungary.

Figure 6: Hungarian gas transmission grid (source www.fgsz.hu)
Hungary possesses excellent agro-ecological conditions for generating energy from biogas. According to the EU-project Redubar, Hungary has a potential to generate almost 9 billion cubic metres of biogas from agricultural residues, animal by-products, sewage sludge industrial and municipal organic waste. Currently there is no central policy or separate plan proposing measures specifically for biogas. The NREAP states that a separate biogas action plan is to be drawn up in near future, reviewing energy sector and adopting incentive measures to cover all segments of the sector in the framework of an integrated "Biogas Action Plan".

**Natural gas consumption, suppliers, infrastructure**

Natural gas is the most important source in Hungary’s primary energy mix, and ranks before oil and nuclear power. The country has inland gas resources which cover about 20 % of the gas demand, however, these resources are in decline. Hungary is still highly dependent on imports from Russia (about 80 %). The gas is fed into the Hungarian high-pressure pipeline system which is owned and operated by TSO FGSZ Ltd. The system is extensive spread out in about 5,700 km in length. More than 90 % of the settlements have access to natural gas. The grid is partly made up of steel pipelines, and the typical operating pressure is a maximum of 63 bar (in certain sections maximum 75 bar). The main international connections through gas pipeline are to the Ukraine, Austria and Serbia. The Ukrainian pipeline is the main import route while the pipeline to Austria is primarily used for balancing and peak demand. The Serbian pipeline is used for transit and is the only out-going pipeline.

In the country predominantly high caloric gas (H-gas) is distributed, but in some restricted areas there is also L-gas to be found in the network. Being a country in a landlocked position, Hungary has no LNG infrastructure. The supervising authority for the national natural gas market is the Hungarian Energy Office.

**Technical standards for biomethane and natural gas**

The Governmental Decree No 19/2009 on the provisions of the Hungarian Gas Law (Act XL 2008) assures the non-discriminatory access to the gas grid. Biomethane can be fed into the grid as long as its quality meets the requirements of the national standard MSZ 1648:2000. This standard focuses on natural gas and does not regulate the usage of different biogas feedstock or any method for adjusting the heating value. However the standard requires e. g. a strict limit for the oxygen content 0.2 % by volume and a continuous online measurement of the gas quality.

**Support schemes**

In seeking to achieve its EU target, Hungary has evolved its feed in tariff scheme, known as "KÁT". The scheme was introduced in 2003, in order to incentivise the ongoing RES development through the purchase of electricity at higher than market rates.

The government’s energy policy outlined in the National Energy Strategy 2030[6] was approved by the Parliament on October 3rd in 2011. Currently the existing scheme is under complete revision and the Ministry of National Development recently published a working paper on the planned new incentive scheme for green energy (METÁR) which is based on the German, Austrian, Dutch and Czech examples. METÁR focuses on the principles of social and economic effectiveness and sustainability. The scheme remains as a system with guaranteed feed-in tariffs as opposed to a green certificate system. The standard term for the guaranteed takeover at regulated feed-in tariffs will be 15 years under the new METÁR system.
In case a project receives a grant in form of structural or other forms, the feed-in tariff period will be shortened. The feed-in tariffs will consist of three elements: the electricity base prices (differentiated based on technology choice and quantity characteristics), the green heat incentives (for subsidizing of co-generated heat) and other incentives (enhancing, for example, innovative technologies and investments in disadvantaged territories). Biomass utilisation will be subject to sustainability criteria, which will be subsequently defined. There is no information available if biomethane will be subject to specific support.

Hungary also offers investment aids for RES plants, however, in terms of grid connection, all costs for grid connection are charged to the biomethane supplier (ministerial decree 36/2011).
Italy

Status quo - biogas plants and biomethane plants
There has been huge expansion in biogas operations in Italy in the recent past. Caused by encouraging feed-in tariffs for electricity generated from biogas many plants have been constructed and set into operation. There are more than 300 plants with agricultural background and around 200 plants operating on landfill gas. The electricity generating capacity of all these plants is roughly 480 MW. It must be stated that the development is exclusively related to electricity production and that no biomethane project has been commissioned so far.

Political targets for biogas and biomethane production
According to Directive 2009/28/EC, in 2020, 17 % of Italy’s final energy consumption must be covered by renewable sources [1]. Presuming final energy consumption slightly decreases due to energy efficiency measures, this means that in 2020 the final consumption of renewable energy must be 22.62 Mtoe. According to the Italian NREAP, energy from biogas is planned to contribute to the targets for 2015 with an installed capacity of 545 MW that is expected to generate 2,397 GWh as gross electricity production. These figures are planned to increase up to 750 MW installed capacity and 3,200 GWh by 2020. However, the plan does not mention any specific targets for biomethane production.

Natural gas consumption, suppliers, infrastructure
With its annual gas consumption of close to 80 billion cubic metres, Italy represents one the world’s biggest market for natural gas. Natural gas is essential to satisfy Italy’s national energy demand and today more than one third of the electricity production is generated from natural gas. Since national gas resources are in decline, gas imports are expected to increase significantly in the future, representing a challenge to the existing gas infrastructure, and several projects are underway in order to expand gas import capacity.

For Italy the most important natural gas suppliers are Russia and Algeria which together provide more than 50 % of the imported natural gas. Residual gas comes from inland resources (10 %) and gas imports from Libya (12 %), Norway (5 %) and the Netherlands (5 %). The transport system constitutes pipeline systems and the two LNG terminals Panigaglia and Porto Viro.
The national gas grid is well established and widespread. Historically, both the supply and transportation has been dominated by Snam, a subsidiary of ENI. The Italian gas market has been controlled for a long time by the ENI group, however, eight years on from gas market liberalisation, a number of companies have emerged in competition with ENI in the import and supply of gas to large customers and distribution companies, including Edison, Enel, Plurigas, Energia Gas, Dalmine Energia, and Gaz de France. According to the national regulatory authority AEEG (Autorità per L'energia elettrica e il gas), the main operator, Snam Rete Gas, owns 31,680 km of the 33,768 km of Italy's gas transport system. The second largest operator is the Edison Group, which runs a total of 1,414 km of pipeline, of which 374 on the national network. Edison operates both the network owned by Società Gasdotti Italia (1,331 km), and the connector to the Rovigo LNG terminal, through its Edison Stoccaggio subsidiary (83 km). Completing the transport network are seven smaller operators which own small sections of the regional system. The distribution pipeline network comprises almost 250,000 km of pipeline. The ownership of natural gas distribution facilities remains fragmented, with about 250 companies operating in the sector (this compares, however, with over 430 in 2005). The principal operator is still ENI, which controls 22.9% of the market (in terms of distributed volumes).

With more than 760,000 cars and trucks running on CNG, Italy takes the lead among other European countries regarding the number of natural gas vehicles. According to NGVA, roughly 850 filling stations, most of them public, offer natural gas as a vehicle fuel.

**Technical standards for biomethane and natural gas**

In March 2011, Italy introduced Decree No 28/2011 which allows biomethane injection into the gas grid. This law stipulates that the development of natural gas infrastructures is a national priority and the codification of biomethane to natural gas grid injection is also a priority of the Italian Authorities for Energy. The Decree allows biomethane to enter the grid, if it meets the necessary requirements. A related quality standard hasn’t been established so far, but is expected in near future.

Italy implemented the Directive 98/30/EC with the Legislative Decree No 164/2000 which provides that grid access to the existing pipeline system can not be refused for any reason for natural gas produced within Italy, in Italy waters or on the Italian continental shelf. Moreover, the act stipulates that in case of lack of connection capacity, the access can not be refused. Moreover, with Resolution No. 108/06, the Authority for Electricity and Gas has approved its network code, the CRDG (Codice di Rete per il servizio di distribuzione gas). This particular act regulated the relationship between the companies that manage the natural gas distribution and the sales companies. Adoption of this instrument obliged the distribution companies to offer neutrally and non-discriminatory distribution services to companies and sales to wholesalers.

The grid operator is obliged to ensure grid connection verifying the economic feasibility and conformance to the technical standards. The investment costs for grid connection are fully to be borne by the grid connection applicant as the Italian regulations don’t specify any cost split.

**Support schemes**

Since 2009, when Italy introduced new feed-in tariffs for renewable energies, the country experienced accelerated development of the biogas market. The tariffs are guaranteed for 15 years, stipulating electricity prices of up to 28 €cent / kWh for
plants with a maximum capacity of 1 MW, the Italian tariff scheme is among the most supportive policies for biogas to electricity projects in Europe. However, since the remuneration policy focuses on electricity production only, there hasn’t been a gas feed-in tariff for biomethane established so far. At the moment there are no technical rules on connection or specific connection tariffs for biogas.

Apart from the feed-in tariff scheme, Italy also obliges its electricity producers (over 100 GWh threshold) to source a share of the produced electricity from Renewables. This obligatory quota is linked to the Green Certificates mechanism. Producers and importers which are subject to the obligation can fulfill it by feeding electricity produced from renewable sources into the grid or by buying green certificates (certificati verdi) from other producers which verifying to GSE (Gestore Servizi Elettrici) that the equivalent quota has been produced. According to Law No 244/2007 the quota increased by 0.75 percentage points annually, for the period 2007-2012, and to 7.55 % in 2012.

The Italian RES support measures are currently under review. A mechanism has been expected since September 2011, however no follow-up regulation has been approved so far. According to the ministerial decree 18/12/08, the former support schemes is valid for plants commissioned before 1st of January 2013. To boost investments into biomethane infrastructures, the new scheme should include financial incentives specifically for biomethane.
**The Netherlands**

**Status quo - biogas plants and biomethane plants**

With about 130 biogas plants and 13 biomethane plants in operation (Table 5), the Netherlands are one of the forerunner countries in the market of biogas and biomethane. There has been considerable experience gained with biogas upgrading from different sources such as landfill gas (4 projects), sewage gas (2 projects), gas derived from biowaste and industrial waste (7 projects) and from agricultural biomass. All these biomethane plants are injecting into the natural gas grid. During the last decades Dutch companies have made their contribution to improving upgrading technologies and today are important players and technology suppliers throughout the European biomethane market.

<table>
<thead>
<tr>
<th>Location</th>
<th>Year of commission</th>
<th>Type of biogas</th>
<th>Capacity of biomethane production [Nm³ / h]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tilburg</td>
<td>1987</td>
<td>LFG</td>
<td>300</td>
</tr>
<tr>
<td>Wijster</td>
<td>1989</td>
<td>LFG</td>
<td>500</td>
</tr>
<tr>
<td>Collendoorn</td>
<td>1990</td>
<td>LFG</td>
<td>25</td>
</tr>
<tr>
<td>Nuenen</td>
<td>1990</td>
<td>LFG</td>
<td>750</td>
</tr>
<tr>
<td>Beverwijk</td>
<td>2006</td>
<td>sewage gas</td>
<td>80</td>
</tr>
<tr>
<td>Mijdrecht</td>
<td>2009</td>
<td>sewage gas</td>
<td>40</td>
</tr>
<tr>
<td>Groningen</td>
<td>2010</td>
<td>biowaste</td>
<td>700</td>
</tr>
<tr>
<td>Zwolle</td>
<td>2010</td>
<td>biowaste</td>
<td>420</td>
</tr>
<tr>
<td>Witteveen</td>
<td>2010</td>
<td>agricultural biogas/co-fermentation</td>
<td>200</td>
</tr>
<tr>
<td>Bunschoten-Spakenburg</td>
<td>2010</td>
<td>industrial waste</td>
<td>690</td>
</tr>
<tr>
<td>Well</td>
<td>2011</td>
<td>industrial waste</td>
<td>300</td>
</tr>
<tr>
<td>Dinteloord</td>
<td>2011</td>
<td>organic waste</td>
<td>1100</td>
</tr>
<tr>
<td>Meerlanden</td>
<td>2011</td>
<td>biowaste</td>
<td>400</td>
</tr>
</tbody>
</table>

*Table 5: Biomethane projects in the Netherlands (source Agenschap NL)*

**Political targets for biogas and biomethane production**

The main driver for the development of renewable energy and therefore also for biogas and biomethane is the NREAP. For 2020 there is a target set to produce 24 PJ from biomethane.

**Natural gas consumption, suppliers, gas infrastructure**
Natural gas plays a major role in the Netherlands. About 46% of the national energy demand is met by the utilisation of natural gas. Among all EU countries the Netherlands have the largest natural gas resources. The country is a net exporter to customers such as Germany, Belgium, France and Italy. The exported gas amounts are about the same as the inland consumption. These inland resources cover a part of the country’s gas demand, the remaining is imported from Denmark, Norway, UK, Russia. Furthermore there are LNG imports from Qatar. Natural gas is mainly used for heat and electricity generation, holding lesser importance in transportation sector with around 4,300 natural gas vehicles on the streets, 85 public and 65 private filling stations. It can be reasoned that the fuel market is less developed at the moment and doesn't offer much potential for biomethane in the fuel sector on a short term view.

The infrastructure for natural gas is well established and the grid is wide spread. The national transportation grid operates at pressure levels between 40 for regional transportation grid and 67 bar at the main gas transportation network. It is owned by the private owned company Gasunie and operated by Gas Transport Services. Nine DSO are active at the level of distribution grid, which operates at pressure level lower than 8 bar. There are two major gas qualities in the Netherland’s grid. Besides the most common gas with low caloric value there is also a pipeline system with high caloric gas.

**Technical standards for biomethane and natural gas**

Upgraded biogas derived from all feedstocks is allowed to enter the grid. According to Agentschap NL, to ensure the injected gas is free of pathogenes a HEPA filter needs to be installed and related gas measurements are carried out twice a year. Due to the lower heating value in the major part of the grid there is less effort required for upgrading, to adjust biogas' quality to match the natural gas requirements, reduced energy and operating costs for CO2 removal as well as reduced costs for augmentation of heating value by adding LPG or propane. Gas quality requirements are currently under discussion. The Netherlands grid (mainly constructed by using steel pipes) is considered to be more sensitive towards corrosion compared to grids made from other materials, leading to discussion regarding biomethane quality parameters such as oxygen content.

**Support schemes**

Biomethane injection is supported by the stimulereng duurzame energie (SDE+) scheme, the most important measure promoting renewable energy in the Netherlands. The SDE + scheme, replacing the former SDE scheme, provides a feed-in subsidy covering the difference between production costs and energy price. In 2012 for biomethane there are five categories related to project costs, ranging from 0.483 € / Nm³ to 1.035 € / Nm³. The scheme is budgeted and operates on first come first served basis within each categories eligibility criteria’s whereby projects applying for support in low cost category will be served first. The tariffs are guaranteed for 12 years, however, the tariffs are subject to an annual adjustment according to the market price development of fossil natural gas. The resulting costs of the SDE+ scheme are borne by the Dutch state. After 2012 the costs shall be allocated to the public revenues from electricity and gas price.

Moreover, there are national targets set on the share of biofuels in transport sector. The obligatory quota for biofuels increases continuously up to 10% in the year 2020. Biomethane is eligible to fulfill the obligatory quota for biofuels and generate biotickets which are tradeable at the biofuel market. As one of the first European...
countries the Netherlands formulated sustainability criteria. Up to now a sustainability scheme for biofuels has already been implemented. Currently there is no legal framework in place yet for solid biomass used for heat and electricity production, but requirements are expected to be established in the near future.

Certification
There have been efforts to develop a certification scheme for biomethane in the Netherlands already by Vertogas BV, a subsidiary of Gasunie. The system was implemented on 1st of July 2009 and tracks the injected gas and ensures the balance between biomethane input and output as well as the feedstock utilised for gas production. The data for the biomethane plants is validated regularly by conducting annual audits.
**Poland**

**Status quo - biogas plants and biomethane plants**

Poland's biogas market has had a slow start. By 2010 more than 200 biogas fuelled power plants have been realised, most of them landfill or sewage gas facilities with only 19 plants running on agricultural biomass or bio wastes (Table 6). These plants convert biogas directly to electricity; upgrading plants that produce biomethane have not been in operation or under construction.

<table>
<thead>
<tr>
<th>Location</th>
<th>Year of commissioning</th>
<th>Installed electrical capacity [MW]</th>
<th>Feedstock</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pawlówko</td>
<td>2005</td>
<td>0.95</td>
<td>Organic mix</td>
</tr>
<tr>
<td>Plaszczycya</td>
<td>2008</td>
<td>0.63</td>
<td>Pig manure, silage, oil-derived wastes</td>
</tr>
<tr>
<td>Kujanki</td>
<td>2008</td>
<td>n.a.</td>
<td>Pig manure</td>
</tr>
<tr>
<td>Koczala</td>
<td>2009</td>
<td>2.13</td>
<td>Pig manure, silage, food industry derived wastes</td>
</tr>
<tr>
<td>Liszkowo</td>
<td>2009</td>
<td>2.13</td>
<td>Food industry derived wastes</td>
</tr>
<tr>
<td>Niedoradz</td>
<td>2009</td>
<td>0.25</td>
<td>Pig manure, chicken wastes</td>
</tr>
<tr>
<td>Studzionka</td>
<td>2009</td>
<td>0.03</td>
<td>Pig manure, chicken wastes</td>
</tr>
<tr>
<td>Naclaw</td>
<td>2010</td>
<td>0.63</td>
<td>Pig manure with supplementary components: corn silage, glycerine and products and semi-products of crop and feed production.</td>
</tr>
<tr>
<td>Swielino</td>
<td>2010</td>
<td>0.63</td>
<td>Manure, maize silage</td>
</tr>
<tr>
<td>Kałsk</td>
<td>2010</td>
<td>1.0</td>
<td>Maize silage, sorgo, manure</td>
</tr>
<tr>
<td>Kostkowice</td>
<td>2010</td>
<td>0.6</td>
<td>Manure, organic wastes</td>
</tr>
<tr>
<td>Giżyń</td>
<td>2011</td>
<td>1.063</td>
<td>Pig Manure with supplementary components: corn silage, glycerine and products and semi-products of crop and feed production.</td>
</tr>
<tr>
<td>Uhnin</td>
<td>2011</td>
<td>1.27</td>
<td>Maize: silage, rye and grass, organic wastes</td>
</tr>
<tr>
<td>Uniechówek</td>
<td>2011</td>
<td>1.063</td>
<td>Pig Manure with supplementary components: corn silage, glycerine and products and semi-products of crop and feed production.</td>
</tr>
<tr>
<td>Świdnica</td>
<td>2011</td>
<td>0.9</td>
<td>Silage and grass maize</td>
</tr>
<tr>
<td>Skrzatusz</td>
<td>2011</td>
<td>0.5</td>
<td>waste processing industry: distillers’ grains, potato pulp, waste from carrots</td>
</tr>
<tr>
<td>Łany Wielkie</td>
<td>2011</td>
<td>0.5</td>
<td>Manure, distillers’Grains</td>
</tr>
<tr>
<td>Piaski</td>
<td>2011</td>
<td>0.99</td>
<td>Liquid wastes from diary</td>
</tr>
<tr>
<td>Grzmiąca</td>
<td>2011</td>
<td>1.6</td>
<td>Maize silage</td>
</tr>
</tbody>
</table>

**Table 6: Polish biogas projects in operation (agricultural biomass and biowaste only) (source KAPE, Budzianowski)**
Poland has extensive agricultural land and numerous livestock farms. Compared to the large potential the country offers, its current deployment of biogas technology is considered to be underdeveloped. The main reasons behind the fact are the low financial incentives paid for renewable electricity from biogas and the absence of a supportive legal framework in a longer time perspective. At present, the interest towards biogas technology has increased and the legal framework is under revision.

**Political targets for biogas and biomethane production**

Poland’s primary energy consumption is based on hard and brown coal leading to a large carbon footprint of electricity production system. Biomass accounts for 6.4% of primary energy consumption, a share mostly derived from solid biomass often co-fired in coal power plants. Therefore, with the NREAP 2010 the country set ambitious targets and aims at almost doubling its share in renewable energy production up to 15% in 2020 and several adequate measures have been determined. Regarding the demand for gross final energy in electricity sourced from biogas is planned to increase to 344 ktoe (4 TWh) in 2020 and to 592 ktoe (6.9 TWh) in 2030. In terms of heat, the Polish Energy Policy aims at 503 ktoe (5.8 TWh) in 2020 and 800 ktoe (9.3 TWh) in 2030. Starting from approximately 74 MW generation capacity of gross electricity on biogas CHP 2010, this figure is planned to rise up to 802 MW by 2020 and 1,379 MW by 2030, a market share of biogas CHP of 2.7% of in 2030.

**Natural gas consumption, suppliers, infrastructure**

The share of natural gas in primary energy consumption stood at 12.7% in 2009. The national gas demand steadily increased from 13.3 billion m³ in 2000 to 15.8 billion m³ in 2009, with an annual average growth rate of some 2%. Poland produced some 4.3 billion m³ of natural gas in 2010, which accounted for approximately 30% of the country’s demand. Gas import around 10 billion m³ satisfied the residual national gas demand. About 63.17% of the total demand for gas is imported from Russia. Minor quantities are provided by Germany (7.34%) and Ukraine (0.04%). The gas is transported via the transmission network, whereby the grid is owned to 99.6% by GAZ –SYSTEM, 0.4% are owned by the Polish Oil and Gas Company (PGNiG).
The sole TSO is GAZ-SYSTEM which is fully state-owned. Its key task is the transport of natural gas via the 9,768 km expanding transmission network throughout the country to supply the distribution networks and end consumers connected to the transmission system.

The distribution system comprises 116,325 km pipeline system in length. Six regional gas companies of PGNiG handle the local distribution areas and supply gas to households, industrial customers and wholesalers (Mazovian Gas Company, Greater Poland Gas Company, Lower Silesian Gas Company, Upper Silesian Gas Company, Carpathian Gas Company, Pomeranian Gas Company). Moreover, a few other companies buy gas from PGNiG and sell to end users through their own local distribution system. The Energy Regulatory Authority governs the gas market in Poland.

The transport sector for LPG cars is well developed and with some 6,000 LPG refuelling stops, the infrastructure is well equipped. In contrast, the utilisation of CNG as a vehicle fuel is still in the early stages. Approximately 2,000 cars run on CNG at the streets being served by about 30 filling stations.

**Technical standards for biomethane and natural gas**
The Act of 8\textsuperscript{th} of January 2010 amends the Energy Act and also other acts (Journal of Laws No 21 item 104) making important provisions for biogas. The law defines non-discriminatory access to the grid. The operator of the gas distribution system is obliged to accept agricultural biogas when conforming with the gas quality.
parameters. The law is limited to biogas from agricultural sources, wastes from food industry and from forest biomass as substrates. Landfill gas and sewage gas are restricted from the grid. By all means, the biomethane producer is obliged to prove the hygienic harmlessness of the injected biomethane before the delivery of biomethane to the distribution network, and again when changing the applied technology.

The requirements for gas quality in the grid are laid down in Polish Standards PN-C-04752:2011 and PN-C-04753:2011. There are two gas qualities in Poland, high-methane gas - with a minimal required calorific value of 34.0 MJ/m³ and nitrogen-rich gas with a minimal required calorific value 18.0 MJ/m³.

**Support schemes**
The Polish governmental supports renewable energies through the following measures:

- Tradable Certificates of Origin introduced by April 2005 with the amended Law on Energy,
- Obligation for Power Purchase from Renewable Sources (2000, amended in 2003),
- Levy exemption from consumption tax for electricity introduced in 2002.

Suppliers of electricity are required to source a certain percentage of renewable energy. This percentage is fixed to 8.76% for the year 2012 and shall increase to 15% in 2020. Trading green certificates derived from the generation of renewable electricity can fulfill the obligation. The scheme is administered by Energy Regulatory Office and does not include a technology specific rating, all types of RES are traded at the same certificate price, which is an advantage for established technologies with low electricity production costs.

Moreover, energy companies producing biomethane from agricultural substrates are eligible to obtain certificates of origin for this agricultural gas, so called "brown certificates". A register for producers of agricultural biogas governed by the Agricultural Market Agency has been already established.

The revenues of a biogas project result from the electricity and heat sale plus a green certificate bonus. Assuming the relevant conditions are fulfilled, a yellow certificate bonus (CHP with less than 1 MW\textsubscript{el} installed, based on gas including biogas) or a red certificate bonus (high efficiency CHP with 1 MW\textsubscript{el} installed) can be obtained. The certificates’ prices and therefore the project revenues strongly depend on supply and demand situation. With a shortage of certificates the prices are close to the level of relevant compensation fees which e.g. in 2011 for green certificates was about 66 € per MWh.

Major financial resources for supporting investments in renewable energy are guaranteed within EU funds, in particular within the Operational Programme Infrastructure and Environment (OPI&E) implemented with the participation of the Ministry of Economy, regional operational programmes (ROP) managed by local governments of voivodships as well as the National Fund for Environmental Protection and Water Management (NEPWM) and Voivodship Fund for Environmental Protection and Water Management. The Green Investment Scheme (GIS) Program Part 2 Agricultural Biogasworks by NEPWM aims at expanding the existing biogas electricity generating plants up to an electrical power of 40 MW.
**Slovakia**

**Status quo - biogas plants and biomethane plants**

In Slovakia the annual electricity production from biogas stands around 69 GWh. Biogas is derived from sewage sludge (about 12 plants), and a smaller quantity from agricultural biogas plants processing energy crops and manure (about 12 plants). At all these plants electricity generation has been installed. Biogas upgrading is not considered to be an economically feasible alternative due to the lack of financial incentives and hence no project has been developed till date. Even though only a few biogas plants are operating, the market has the potential to develop much further in the coming years. The Slovak Republic is aware of the emission reduction potential of biogas technology and the substantial contribution biogas can give in order to meet the Slovak targets. The legal framework for grid connection and gas injection has been thoroughly worked out and technical rules exist on the level of the distribution network, however, an adjustment of the financial incentives will be essential in order to boost biogas production and to achieve the declared objectives.

**Political targets for biogas and biomethane production**

Under the Directive 2009/28/EC the Slovak Republic is obliged to increase the share of energy from renewables to 14% of its total energy consumption by 2020 [1]. Therefore one of the priorities of the Slovak Energy Policy is to increase the use of renewable energy sources in electricity and heat production. The national strategy for achieving this goal with particular concern regarding bioenergy is set out in the following:

- NREAP (2010),
- Strategy for higher utilisation of Renewable Energy Sources (2007),
- Conception of using agricultural and forest biomass for energy purposes (2004) and

According to the NREAP, it is envisaged biogas in electricity production will increase from 70 GWh in 2010 up to 624 GWh by 2015 and 860 GWh by 2020. Starting from the year 2016 biogas is considered with a minor role as a renewable vehicle fuel in the transport sector. Even though specific targets for biomethane are not listed out, the Slovak NREAP specifically states biomethane should enjoy preferential access to the distribution network. The use of biomethane in generating electricity from CHP receives support. Moreover, the document states that biomethane producers need to be guarantees for the purchase of their biomethane, provided that they meet the gas requirements, by means of legislative amendments.

**Natural gas consumption, suppliers, infrastructure**

The Slovak Republic holds very small indigenous gas reserves. In 2009 the total reserves were estimates to be 14 billion m³. Almost the entire is met by the gas imported from Russia. In terms of natural gas transportation it is an important transit country, with a widespread distribution network. Hence, about 77% of the Slovak municipalities, meaning 94% of the total population, have access to natural gas.
The transmission grid is operated by eustream a.s. which is a 100 % subsidiary of Slovenský plynárenský priemysel a.s., a joint venture between the Slovak state as a majority shareholder and Eon Ruhrgas and Gaz de France. Eustream is responsible for transport of natural gas in Slovakia and furthermore through Slovakia to the European markets.

SPP distribúcia a.s. as DSO is the owner and operator of a gas distribution network, which accounts for approximately 98 % of the gas volumes distributed in the territory of the Slovak Republic. The company is a 100 % subsidiary of Slovenský plynárenský priemysel too with the same shareholders as eustream. SPP distribúcia is responsible for the reliable, safe and efficient distribution of natural gas from transmission networks through gas distribution systems to end consumers. It is also responsible for securing connection to the distribution network and for meter-readings of consumed natural gas.

The Regulatory Office for Network Industries is the supervising authority in charge of regulating the natural gas market. The scope of its competence is defined in the Act No. 276/2001.

Natural gas is mainly used for electricity and heating. About 21.5 % of the total electricity is produced from natural gas (2009 figures). The utilisation in the transportation sector is of minor relevance. Today around 900 cars run on CNG and 13 filling stations offer natural gas. These numbers might increase in the near future since a new program aims to encourage people to purchase CNG cars. The project is under Slovenský plynárenský priemysel and the foundation EkoFond and provides grants of up to 2,000 € per new CNG vehicle.

**Technical standards for biomethane and natural gas**
The regulation of the Ministry of Economy of the Slovak Republic No. 337/2005 Coll. sets out the details of the technical conditions for access and connection to the
electricity and gas system and the rules for operating them. Biomethane can enter
the distribution grid if it meets the technical requirements. There are no restrictions
on the feedstock the biomethane is derived from, but the producer is obliged to
prove that the gas does not cause any hygienic risks for the distribution network.
Augmentation with LPG or propane as well as the injection of upgraded biogas not
fully in line with the specifications is allowed in principle as long as the resulting
quality of the gas flow conforms to the requirements.

Even though no biomethane plant currently feeds the grid, the Slovak DSO
SPP - distribúcia a.s. is prepared for biomethane injection. The relevant regulations
have been implemented and the technical standards are in place. The requirements
and conditions for connection of biomethane facilities are published in Slovak and
English on the company's webpage.

Support schemes
To comply with the ambitious targets on renewable energy, and to manage duties
under the respective Directives of the European Parliament and Council, the Slovak
Parliament adopted the Act No. 309/2009 Coll. on the Promotion of Renewable
Energy Sources and High Efficiency Cogeneration Production ("RES Promotion Act"),
which came into effect as from 1st of September 2009. In 2010 and 2011 the RES
Promotion Act was amended, the rules that support electricity production were
revised, and new rules supporting the high-efficiency cogeneration of electricity
were introduced. The act now regulates the methods and requirements of the
promotion of electricity from renewable energy sources, in particular

- Priority connection of such energy facilities to the regional distribution system,
- Priority access to the grid, transmission, distribution and supply of electricity;
- Off-take of electricity at the price for electricity to cover grid losses,
- Feed-in tariffs and
- Transfer of the liability for deviations (i.e. the difference between the production of electricity and demand) to the regional distribution system operator.

The amended Act also redefines rights and obligation for biomethane producers and
distribution system operators, such as priority access for the grid connection,
release of certificate for biomethane etc.

The operator of a biogas fueled CHP is entitled to receive feed-in tariffs of 9.308 to
13.633 Ccent / kWh depending on the source of biogas (2012 figures). Even though
the Slovak NREAP announces legislative measures for a compulsory purchase of
biomethane for the case that biomethane integration needs to be strengthened, a
gas feed in tariff has not prevailed so far. Thus, the biogas to electricity feed-in
tariffs are valid for biomethane fueled CHP as well. In order to implement the
objectives of the RES Promotion Act effectively, the Slovak Government set
requirements on efficient use of renewable energy sources. High efficiency
cogeneration resulting in primary energy savings compared to separate heat and
electricity production is encouraged, while cogeneration with a low heat utilisation
rate results in reduction of feed-in tariffs.

Besides the feed-in tariff scheme, direct financial support for investment is also
offered, e.g. investment subsidy through the Structural Funds from Operational
Programme Competitiveness and Economic Growth. The subsidy margins are regulated by the Structural Fund rules as well as by state aid scheme. It has to be noted that investment aids such as governmental grants may result in a reduction of feed-in tariffs.

Support is also provided to the development by a beneficial tax policy. Renewable energies are subject to several tax reductions and exemption respectively, e.g.

- Tax exemption for biogenic substances used as fuel such as biogas and biomethane
- Tax exemption for electricity produced from renewable energies when delivered directly to the final consumer, or consumed by legal entity or natural person, who produced the electricity sourced from biomass

In accordance with Act No. 309/2009 Coll. the investment costs for grid connection are subject to a cost split between the parties, the biomethane producer and the grid operator. For grid connection of distances of less than four kilometres between plant and grid connection point, a share of 25% of these costs is borne by the biomethane plant owner while 75% are borne by the grid operator. For distances longer than four kilometres the biomethane producer takes all costs. This regulation is similar to German treatment and intends to increase planning and investment reliability for the biomethane plant owner, by at the same time encouraging project developers to choose a suitable place of location close to the existing gas infrastructure.

**Certification**

In Slovakia there is a certification system for biomethane in place, but it has not yet been implemented. The certificates of origins and quantity attestations are the basis for biomethane clients for claiming the feed-in tariffs according to the Act 309/2009 and the relevant amendments. The certificates of origin are issued by Regulatory Office of Network Industries (RONI) and contain information concerning the biomethane producer, location of the biomethane facility, the point of connection of the facility to the distribution system and the types and quantity of biomass used for biogas production as well as information about of the specific production costs.
Sweden

Status quo- biogas plants and biomethane plants
Sweden started biogas production as early as 1960s at waste water treatment plants, mainly to reduce sludge quantity. Later, during the energy crises, the focus shifted towards energy production and several additional organic substrates started being used for biogas production.

Sweden has always been active in developing renewable fuels and has pioneered work in the deployment of biogas upgrading technologies during the last two decades. According to the Swedish Gas Centre, in 2010 there were 47 plants in operation that upgraded biogas to biomethane, seven of which are connected to the public grid. The most common utilisation pathway for biomethane is the use in the transport sector. In 2010, 608 GWh of biomethane was produced, of which 572 GWh (94 %) was sold as vehicle fuel. The Swedish example is the most successful in regard to the integration of biogas in the transport sector. Figure 10 shows that the share of biomethane in CNG vehicle fuel already exceeds 60 %.

Figure 10: Share of biomethane in Swedish supply for vehicle fuel in GWh (source SGC)

About the half of the upgrading facilities are installed at waste water treatment plants. However, gas sourced from municipal solid waste, from agricultural biomass, and from industrial biowaste is also upgraded to biomethane. The technology most commonly used for CO₂ removal is water scrubbing, but also PSA and chemical adsorption technology are applied as well.

Sweden has enormous biomass potential in terms of BioSNG (renewable gas sourced from forest residuals), and thus the national government supports research and development initiatives in this sector. An example for R&D activities is the Gothenburg Biomass Gasification Project (GoBiGas project), run by Göteborg Energi. At the end of the project a gas production at commercial scale is envisaged with a capacity of 80 MW biomethane. The second large player, E.ON, is planning on erecting its own gasifier in either Malmö or Landskrona. All Swedish players interested in thermal gasification are cooperating on research and development under the auspices of the Swedish Gas Centre.

Political targets for biogas and biomethane production
By 2020, the Swedish Parliament decided the proportion of renewable energy should be at least 50 % of the total energy usage. The share of renewable energy in the transport sector must rise to at least 10 %. The government’s vision is that
by 2030 Sweden will have a vehicle fleet that is independent of fossil fuels. For 2050, Sweden even aims at an energy supply with zero carbon emission.

Sweden is a country in which renewable energy already plays a significant part in the national energy system. The proportion of renewable energy is the highest of all countries in the EU since RES contribute to around 45 % of the country’s final energy consumption. The country’s RES production has been at a high level for a long time, due to an enormous potential of water power and biomass. The current support mechanisms focus on the development of Sweden’s wind potential. Furthermore, a significant share of nuclear energy underpins the country’s low carbon emission.

Natural gas consumption, suppliers, infrastructure
Sweden sources 100 % of its natural gas from its sole supplier Denmark. The natural gas grid is established in the Southwest of the country. The transmission grid is 620 km long, with 40 regulation stations. The high pressure (70 bar) grid consists of 540 km of pipeline. Operational pressure in the remainder is designed for 30, 24 or 16 bar. The distribution grid, inclusive of service lines to households, has operational pressures of 0.1 - 4 bar, and is 2,600 km long. The company in charge of natural gas transport is Swedegas.

In Nynäshamn, South of Stockholm, Sweden’s first LNG terminal was inaugurated in May 2011. According to the industrial gases and engineering company Linde, LNG is considered to be a bridge between natural gas and biogas since it provides the opportunity to also supply liquefied biogas (LBG), which together with the LNG can be used as a backup when there is a shortage of locally produced and distributed biogas. The Energy Markets Inspectorate, an agency subordinate to the Ministry of Enterprise, Energy and Communications, is the regulatory authority for the electricity, natural gas and district-heating markets.

Sweden has made and is making great efforts to establish CNG in the transport sector. Today, there are around 40,000 vehicles in Sweden running on natural gas, of which about 37,700 are light duty vehicles, and the country now has more than 133 public and 47 private CNG refuelling stations (figures by end of 2011). Sweden started using biomethane as a vehicle fuel since 1996. While the market share of CNG vehicles has been increasing continuously over the years, the consumption of biogas has steadily increased in parallel. Several local fleets e.g. in Linköping, in Uppsala and Kristianstad have switched to biogas, however, not only in public transport does renewable fuel receive support. Several benefits for biogas vehicles in Swedish cities, addressed to taxis and also private car drivers, have created a

Figure 11: Swedish transmission gas grid (source www.swedegas.se)
positive climate for the deployment of biogas. Such measures include exemption from city gate tolls for biogas vehicles, special lanes for biogas taxis, and (in the past) there in some cities free parking. Major public transport companies have very ambitious environmental goals, e.g. Skånetrafiken set its target to 100% renewable energy by 2020 which includes paratransports. Already today more than 15% of all buses in Sweden are biomethane powered, with a third of all new buses during 2010 being biomethane powered.

**Technical standards for biomethane and natural gas**
The Swedish Natural Gas Act (naturgasläg) provides the legal framework for grid injection and includes regulations for natural gas pipelines and natural gas storage facilities and, in certain cases, for trading in natural gas. According to the Act, tariffs, inter alia, for the transfer and storage of natural gas must be reasonable, objective and non-discriminatory. This also refers to biogas and gases from biomass in accordance with Chapter 1 Section 2 of the Natural Gas Act.

Sweden is one of the few countries in the world with a national standard for biogas as vehicle fuel. The standard Swedish Standard (SS) 155438 "Motor Fuels – Biogas as fuel for high-speed Otto engines" was established in 1999, and is used ad hoc for grid injection cases. SS155438 states that the methane content must be higher than 95% and also sets limits for dew point, sulphur content and some other minor constituents. Gas quality requirements for grid injection are under discussion at the moment on European level. It is likely that in the future more attention will be drawn to impurities of trace compounds such as heavy metals, siloxanes etc. and biomethane producers will face more strict requirements when feeding in to the public grid. Simultaneously, on national level, a revision of SS155438 is on-going, aiming to launch a quality standard for all types of "fordonsgas" (i.e. vehicle gas), a generic term for biomethane and natural gas when it is used as a road transport fuel.

When biomethane is injected into the Swedish gas grid, the addition of propane is allowed and even essential in order to reach the high calorific value of Danish gas. 7% to 9% of propane is often necessary for augmentation with significant costs for the biomethane producer.

Methane emissions from the biomethane production are the major source for reduction of climate benefits from such projects. Even though there are no requirements set in law in Sweden, measures to control or reduce methane slip become an issue during the environmental part of the licensing procedure of biomethane production. The local authority includes these requirements. The Swedish Waste Association have also organised a voluntary methane emission control programme.

**Support schemes**
Sweden uses several tools to maintain and increase its RES share in energy consumption and to achieve its goals in reducing carbon emission. In 2003, the Swedish electricity certificate scheme was introduced. Facilities that produce renewable electricity and which were commissioned after May 2003 are entitled to an electricity certificate for fifteen years limited by a maximum period till the end of 2035. The amount of electricity certificates that electricity suppliers must purchase increases annually thus increasing demand. The certificate price is market-based and determined by the demand for certificates in the market. Starting from 2012, Norway will join Sweden's certificate system, creating a harmonised market between the two countries for electricity certificates. The revenues derived from the
Certificate scheme are considered to be less attractive for biogas and biomethane producers.

Biogas and biomethane producers also benefit from measures such as
- Exemption from energy and carbon dioxide tax for CO2-neutral fuels and for vegetable and animal oils and fats and biogas as a heating fuel implemented in 1991, up to the end of 2013,
- Government directives on procurement of environmentally friendly cars, implemented in 2005
- Requirement of retailers to sell at least one renewable motor fuel implemented in 2006,
- 5 years exemption from vehicle tax for environmental cars (meaning vehicles emitting below 120 g CO2), implemented in 2010,
- 40% reduction in the amount of fringe benefit in the income tax for environmental friendly cars using electricity or gas as fuel, implemented in 2010 and finishing in the end of 2012.

Several investment programs, e.g. the Local Investment Programmes (LIP) (1998-2002), the Climate Investment Programme (KLIMP) (2003-2008), and the Grant Programme for sustainable urban development (2009-2010) enabled municipalities and other local actors to receive grants for long-term investments that reduce greenhouse gas emissions.

There have been investment programmes for biogas production plants (2009-2011) which supported the generation, distribution and use of biogas and other renewable gases for the purpose of new technology development. Aid for farm-based biogas production from manure is included within the framework of Landbygdsprogrammet (Rural Development Programme). Between 2009 and 2013 SEK 200 million has been allocated for investments linked to this type of biogas generation. However, since these programmes will expire in the coming years, from the perspective of future project development, a political sign is required to encourage investments in biogas projects.

Certification
The Swedish company FordonsGas Sverige sells vehicle gas and guarantees at least 50 % biomethane. Gas is certified by the Nordic Eco-labelling "the Swan". The label sets requirements e.g. for maximum carbon emissions, sustainable production of raw materials, and the quality of the produced fuel. There is no other third party certification scheme in Sweden. To uphold the EU sustainability directive, the new accounting system for reimbursement of the excise tax of biofuels will in a way represent a certification of the biomethane sold in Sweden. All distribution companies have guarantees to the effect stating minimum 50 % of the publically sold vehicle gas should be renewable.
**Switzerland**

Status quo - biogas plants and biomethane plants

Switzerland introduced a subsidy scheme for renewables in 2009 and thus started actively supporting bioenergy. Prior to that, the number of biogas plants had fallen from 102 in 1990 down to 76 in 2008, but encouraged by the electricity feed-in tariff scheme biogas production went up with some 140 plants processing agricultural biomass and biowaste today. Additionally there are approximately 460 sewage gas facilities on waste water treatment plants, so in total 860 GWh of energy were derived from biogas in 2010. The preferred substrates are agricultural residues such as manure, animal waste and biowaste. However the Swiss company Kompogas pioneered the technological development of biowaste digestion and the name Kompogas has become a synonym for biogas derived from biowaste.

Even though the national policy does not offer specific financial support for biogas upgrading, there are 17 biomethane plants in operation, 15 of which inject into the gas grid, most of them feeding into the distribution network. The Swiss Gas Industry plays a key role in promoting biogas grid injection. According to the Swiss Federal Office of Energy 58 GWh biomethane were injected to the public grid in 2010. The principle pathway for biomethane utilisation as vehicle fuel, and under the brand names "Naturgas" or "Kompogas" a mixture of natural gas and biomethane is sold at Swiss filling stops. Moreover, many local gas distribution companies offer biogas to household clients for heating appliances throughout Switzerland.

Political targets for biogas and biomethane production

The Swiss Energy Act sets the framework for RES production. The Act stipulates an increase of RES in electricity of 5,400 GWh by the year 2030. Several measures,
e.g. primarily the KEV scheme, were put in place. However, if it appears that this goal cannot be met, the Energy Act provides an option to introduce a renewable obligation by the year 2016.

In autumn 2011 the Parliament decided to step out of nuclear energy and not replacing existing nuclear power plants until 2030. The result of this decision will see some change in policies. The Swiss Gas Industry considers biogas as an essential element of the Swiss energy supply and supports biomethane with a biogas fund to increase biomethane production by a factor of six within the coming six years.

**Natural gas consumption, suppliers, infrastructure**

After the decision to exit nuclear power, Switzerland may increase natural gas consumption. At present 12 % of the Swiss final energy consumption is based on natural gas but compared to other European countries the gas utilisation is rather underdeveloped. Only 0.7 % of the European natural gas consumed accounts for Switzerland. This is the result of little inland resources and the dependence on gas imports. Switzerland receives 41 % of its natural gas from the European Union. Moreover, Norway (23 %) and Russia (24 %) are major suppliers. Liquid natural gas is not significant since country’s geographical position provides limited access to LNG.

The Swiss grid has a total length of 17,500 km thereof about 2,150 km belonging to the transmission network (> 5 bar) and 15,800 km to the distribution network (< 5 bar). The grid is well established in the North, whereas in the mountainous areas the expansion of the network is very limited. In the southern part of the country the gas grid has started developing.

Historically, the Swiss gas industry is organised locally and federally with four regional gas suppliers (Erdgas Ostschweiz, Gasverbund Mittelland, Gaznat und Erdgas Zentralschweiz) and more than 100 local gas suppliers serving the Swiss consumers. Most of the needed gas is procured by Swissgas AG as commissioned by the regional gas suppliers. Minor gas quantities are bought from foreign gas suppliers. Swissgas is fully owned by its shareholders who are the four regional gas suppliers and the Association of the Swiss Gas Industry and sells at cost price.

Switzerland has one of the most developed infrastructures for gas vehicles and takes a leading position in the CNG utilisation within the transport sector. According to gasmobil AG there are 130 public filling stations and about 10,000 CNG cars such as passenger cars, commercial and light duty vehicles. The Swiss government is aware of the environmental benefits of gas as a vehicle fuel and supports both CNG and LPG by a beneficial tax policy. The Federal Office of Import and Trade is in charge of supervising the natural gas market. In terms of technical supervision the SVGW (Schweizer Verein für Gas und Wasser / Swiss Gas and Water Association) is in the authority to provide technical rules and advice.

**Technical standards for biomethane and natural gas**

The Swiss Gas Industry grants a non-discriminatory but not priority grid access for biogenic gases. There are no restrictions regarding the sources of biogenic gases apart from ecological points. The SVGW standard G13-09 determines the gas quality requirements in order to protect the pipeline system, the measuring devices and the gas customers from inappropriate gases entering the public grid. Moreover, the technical standards SVGW G11 on odorization and SVGW G209 on the technical
realisation of the grid connection are of particular relevance for gas injection. In the Swiss public grid propane or LPG can be used to augment the heating value of injected biomethane. In principal blending of biomethane containing a high CO₂ levels is possible as long as the resulting gas stream meets the quality requirements.

**Support schemes**

In 2009 Switzerland introduced the KEV scheme (Kostendeckende Einspeisevergütung / Equivalent Cost Covering) setting feed-in tariffs for RES. Having been implemented, the scheme was met with great interest and the limited budget was spent within the first months. Therefore the financial resources have been increased and account today to 247 million SFR per annum. According to the Energy Ordinance, the operators of biogas plants commissioned after 1st of January 2006 enjoy basic tariffs depending on plant size of 0.175 to 0.28 SFR (about 14.6 €cent to 23.3 €cent) per electrical kilowatt hour. The scheme sets minimum requirements for efficiency, but also rewards bonuses for facilities with a high degree of heat utilisation, defined by an annual degree of heat and electricity utilisation (Figure 13). Plants using agricultural residues and less than 20 % co-substrates such as energy crops or biowaste are eligible to receive an additional bonus of 0.45 SFR per electrical kilowatt hour for plants of less than 5 MW installed to 0.18 SFR per kWh for plants with less than 50 kW. The Swiss policy refrains from rewarding additional incentives for biogas upgrading. Biogenic gases that feed the grid and used for electricity production receive the same remuneration as sewage gas facilities. The KEV remuneration for biomass plants is granted for 20 years. In contrast to other RES technologies producing electricity, the tariffs for biomass projects are not subject to an annual reduction since the cost decrease resulting from technology development is cancelled out by the price escalation of the substrates.

![Figure 13: Minimum requirements of annual energy utilisation according to Swiss KEV scheme (electricity utilisation degree vs heat utilisation degree)](image)

If biomethane is used as a vehicle fuel, no feed-in tariff will be applied, however the gas is exempt of mineral oil tax. This tax exemption is linked to a life cycle
assessment considering ecological and social impacts. This evidence is required by the mineral oil tax ordinance and has to be provided to the Directorate General of Customs (Oberzolldirektion). It contains data about the kind and source of the substrates, applied technology and relevant emissions. The use of energy crops is regarded critically. Furthermore, to prevent GHG emissions from methane losses, the accepted methane slip in the off gas is limited to 5%.

There are no federal subsidy schemes for investment aids for biogas plants, however, in three cantons small subsidies are provided for agricultural plants.

Certification
Certified by the label "naturemade", biomethane is sold as a substitute for natural gas to household customers.
United Kingdom

Status quo - biogas plants and biomethane plants

The UK offers supportive policies for biomethane plants, and provides financial incentives such as the Renewable Heat Incentive (RHI) for biomethane injected into the national gas grid. Despite the few hurdles that surround wide scale biomethane injection (i.e. grid connection and gas quality requirements), the UK is committed in bringing biogas utilisation forward, and solutions to these issues are currently being discussed.

The country shows a steady growth in AD plants. In total there are about 360 AD plants generating biogas, mostly they are at sewage plants. Whilst there are only 60 AD plants based on agricultural biomass or biowaste there is now significant growth. The national policy focuses on expanding the utilisation of the biogas potential from biowaste, with reduced focus on use of energy crops. Two biomethane projects have been commissioned so far, a water scrubber on sewage gas in Didcot and a cryogenic gas treatment at a brewery in Adnams (Table 7). Both plants are connected to the grid and feed into the low pressure (2 bar) pipelines within the national gas network.

<table>
<thead>
<tr>
<th>Location</th>
<th>Year of commissioning</th>
<th>Upgrading technology</th>
<th>Capacity of biomethane production [Nm³ / h]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Didcot</td>
<td>2010</td>
<td>Water scrubber</td>
<td>Approx. 60</td>
</tr>
<tr>
<td>Adnams</td>
<td>2010</td>
<td>Cryogenic</td>
<td>Approx. 60</td>
</tr>
</tbody>
</table>

Table 7: UK biomethane projects injecting to the grid

Political targets for biogas and biomethane production

The UK aims to replace 15 % of fossil fuel with renewable energy by 2020. Biogas and specifically biomethane injection, is seen as a technology that has significant potential in contributing to this target. The UK Government has proposed 7 TWh of biomethane injection by 2015 as a possible scenario, but no specific target has been set.

Natural gas consumption, suppliers, infrastructure

UK gas imports have increased during the recent years due to the decline in gas production from the UK Continental Shelf (UKCS). Gas is imported from Norway (25 %), from the Netherlands (5 %) and as LNG from Qatar (20 %), with around 50 % from the UKCS. There are some LNG imports from Algeria, Nigeria, Egypt and Trinidad.

The UK gas grid is extensive, being more than 280,000 kilometres in length, and providing gas to roughly 20 million consumers. An overview of the UK gas pipeline system is given in figure 16. The high pressure grid (operating at 70 – 85 bar) is called the National Transmission System. It is owned by National Grid, the sole TSO in the UK. Gas flows from the National Transmission System into the distribution level where odorant is added. There are eight Gas Distribution Networks, which are owned by four different DSOs: National Grid, Scotia Gas Networks, CKI of Hong Kong and Macquarie.
The distribution grid is split into twelve Local Distribution Zones and each has a daily flow weighted average calorific value (FWACV) regime. The aim is to ensure that every gas consumer receives gas at an equal calorific value subject to a maximum error of 1 MJ / m³.

In 2010 the gas demand of the UK increased to 1,093 TWh. Most of the gas was used for generation of electricity in combined cycle gas turbines (34 %) and for domestic heating (35.7 %).

There is negligible natural gas used in the UK transportation sector, where there are less than 250 vehicles on CNG and LNG, mostly dual fuel trucks. There are only five CNG filing stations in UK and it is believed less than five CNG cars.

The natural gas market is under the supervision of the Office of the Gas and Electricity Markets (OFGEM). OFGEM promotes competitive gas and electricity markets and is in charge of regulating the markets to ensure that there is adequate investment in the networks. The authority also aims to contribute towards curbing climate change and other work aimed at sustainable development.

**Technical standards for biomethane and natural gas**

The UK grants a non-discriminatory but not priority grid access for biogenic gases. There are no restrictions regarding the sources of biogenic gases meaning that biomethane derived from landfill or sewage gas is also allowed to be injected into the national grid. In the UK the typical gross calorific value is 39.0–39.5 MJ / m³ while the heating value of 100 % biomethane is about 37.7 MJ / m³. Due to the high heating value requirements, significant amounts of propane or LPG are needed to adjust the heating value of the injected biomethane.

For historic reasons (related to the fact that UKCS gas has no oxygen) an arbitrary 0.2 % specification for oxygen is in place. Work is underway to change this to 1 % and it is expected that this will be changed in the second half of 2012 to 1 %.

**Support schemes**

The UK implemented several measures in order to increase renewables deployment. Attractive financial incentives are provided for biogas production through the following schemes:

- Renewable Heat Incentive
- Renewables Obligation
Feed-in tariffs
Renewable Transport Fuel Obligation
Levy Exemption from Climate Change Levy

The support schemes differ slightly between England and Wales, Scotland and Northern Ireland.

The Renewable Heat Incentive (RHI) was introduced in 2011 with a total budget of 860 million GBP in order to promote the delivery of renewable heat at all scales and to stimulate this new market. Biogenic gases from AD, sewage (but not from landfill) and gasification (BioSNG) are supported under the RHI regime with biomethane facilities commissioned on or after 15th of April 2009 enjoying a premium of about 6.8 pence per injected kilowatt hour which is paid on top of the gas price. The tariffs are fixed for a total of 20 years and increase with inflation.

The Renewable Obligation (RO) requires UK electricity suppliers to source a specified percentage of renewable electricity which increases year by year. The scheme is administered by OFGEM and is based on tradable certificates called Renewable Obligation Certificates (ROCs). Depending on the source of the renewable energy a defined number of ROCs is awarded per generated MWh. This scheme is the main financial support for larger scale renewable energy projects (> 5 MW).

Since April 2010 feed-in tariffs (FITs) have provided financial support for small-scale low carbon electricity installations of up to 5 MW. FITs for electricity generated from biogas receive from 9.4 to 14 pence per kilowatt-hour (depending on plant size) and are paid over the wholesale electricity price, as a premium. The tariffs are grandfathered for 20 years and increase with inflation. As both are support mechanisms for electricity generation, FIT and ROCs cannot be combined. However, the RHI is compatible with either the FIT or the ROC as it is a support mechanism for renewable heat. FIT and RHI cannot be used if capital grants are obtained.

The Renewable Transport Fuel Obligation (RTFO) places an obligation on suppliers of fossil fuels to ensure that a specified percentage of the road fuels they supply in the UK is made up of renewable fuels. Biomethane is eligible for Renewable Transport Fuel Certificates provided that it is produced wholly from biomass. The RTFO scheme is not as attractive as RHI.

CHP generation from eligible renewable resources such as biogas or biomethane are exempt from the Climate Change Levy and can generate CHP Levy Exemption Certificates (LECs) which have some value.

Sustainability criteria for biogas to electricity are expected for 2014. The criteria will be subject to financial support and require minimum CO₂ savings of 60%.
## Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AD</td>
<td>Anaerobic Digestion</td>
</tr>
<tr>
<td>ADEME</td>
<td>Agence de l'Environnement et de la Maîtrise de l'Energie / French Environment and Energy Management Agency</td>
</tr>
<tr>
<td>AEEG</td>
<td>Autorità per l'energia elettrica e il gas / Regulatory Authority for Electricity and Gas</td>
</tr>
<tr>
<td>ANSES</td>
<td>Agence française de sécurité sanitaire de l'environnement et du travail / French Agency for Food, Environmental and Occupational Health &amp; Safety</td>
</tr>
<tr>
<td>BioKraftQuG</td>
<td>Biokraftstoffquotengesetz / Renewable Transport Fuel Obligation</td>
</tr>
<tr>
<td>BioSNG</td>
<td>Bio Synthetic Natural Gas</td>
</tr>
<tr>
<td>BNetzA</td>
<td>Bundesnetzagentur / Federal Network Agency</td>
</tr>
<tr>
<td>CHP</td>
<td>Combined Heat and Power</td>
</tr>
<tr>
<td>CNG</td>
<td>Compressed Natural Gas</td>
</tr>
<tr>
<td>CRDG</td>
<td>Codice di Rete per il servizio di distribuzione gas / Network code of Italy</td>
</tr>
<tr>
<td>CRE</td>
<td>Energy Regulation Commission</td>
</tr>
<tr>
<td>Dena</td>
<td>Deutsche Energie-Agentur GmbH / German Energy Agency</td>
</tr>
<tr>
<td>DSO</td>
<td>Distribution network operator</td>
</tr>
<tr>
<td>DVGW</td>
<td>Deutscher Verband für Gas und Wasser / German Association for Gas and Water</td>
</tr>
<tr>
<td>GasNZV</td>
<td>Gasnetzzugangsverordnung / Gas Network Access Ordinance</td>
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<tr>
<td>GoBiGas project</td>
<td>Gothenburg Biomass Gasification Project</td>
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<tr>
<td>GSE</td>
<td>Gestore Servizi Elettrici</td>
</tr>
<tr>
<td>GWG</td>
<td>Austrian Gas Act</td>
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<tr>
<td>GWh</td>
<td>Gigawatt hour</td>
</tr>
<tr>
<td>EEA</td>
<td>European Environment Agency</td>
</tr>
<tr>
<td>EEG</td>
<td>Erneuerbare Energien Gesetz / Renewable Energy Act</td>
</tr>
<tr>
<td>EEWärmeG</td>
<td>Erneuerbare Energien-Wärmegesetz / Renewable Energies Heat Act</td>
</tr>
<tr>
<td>FIT</td>
<td>Feed-in Tariff</td>
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<tr>
<td>FWACV</td>
<td>Flow weighted average calorific value</td>
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<td>GHG</td>
<td>Greenhouse gas</td>
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<tr>
<td>GIS</td>
<td>Green Investment Scheme</td>
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<tr>
<td>HAG</td>
<td>Hungaria-Austria-Gas-Pipeline</td>
</tr>
<tr>
<td>HERA</td>
<td>Croatian Energy Regulatory Agency</td>
</tr>
<tr>
<td>HEPA filter</td>
<td>High efficiency particulate airfilter</td>
</tr>
<tr>
<td>HHV</td>
<td>High heating value</td>
</tr>
<tr>
<td>KEV</td>
<td>Kostendeckende Einspeisevergütung / Equivalent Cost Covering</td>
</tr>
<tr>
<td>KIP</td>
<td>Kittsee-Petrzalka-Gasleitung</td>
</tr>
<tr>
<td>Ktoe</td>
<td>Thousand tons of oil equivalent, 1 toe = 11630.0 kWh electrical</td>
</tr>
<tr>
<td>LBG</td>
<td>Liquefied biogas</td>
</tr>
<tr>
<td>Acronym</td>
<td>Description</td>
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<td>---------</td>
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<tr>
<td>LEC</td>
<td>Levy Exemption Certificates</td>
</tr>
<tr>
<td>LIP</td>
<td>Local Investment Programme</td>
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<tr>
<td>LPG</td>
<td>Liquefied petroleum gas</td>
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<td>MAB</td>
<td>March-Baumgarten-Gasleitung</td>
</tr>
<tr>
<td>MSW</td>
<td>Municipal solid waste</td>
</tr>
<tr>
<td>Mtoe</td>
<td>Million tons of oil equivalent</td>
</tr>
<tr>
<td>MW</td>
<td>Megawatt</td>
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<tr>
<td>MWel</td>
<td>Megawatt electrical</td>
</tr>
<tr>
<td>MWh</td>
<td>Megawatt per hour</td>
</tr>
<tr>
<td>NEPWM</td>
<td>National Fund for Environmental Protection and Water Management</td>
</tr>
<tr>
<td>NGVA</td>
<td>Natural Gas Vehicle Association</td>
</tr>
<tr>
<td>NREAP</td>
<td>National Renewable Energy Action Plan</td>
</tr>
<tr>
<td>OFGEM</td>
<td>Office of the Gas and Electricity Markets</td>
</tr>
<tr>
<td>OPI&amp;E</td>
<td>Operational Programme Infrastructure and Environment</td>
</tr>
<tr>
<td>ÖVGW</td>
<td>Österreichische Vereinigung für das Gas- und Wasserfach / Austrian Gas and Water Association</td>
</tr>
<tr>
<td>PGNiG</td>
<td>Polskie Górnictwo Naftowe i Gazownictwo / Polish Oil and Gas Company</td>
</tr>
<tr>
<td>PJ</td>
<td>Petajoule</td>
</tr>
<tr>
<td>PSA</td>
<td>Pressure swing adsorption</td>
</tr>
<tr>
<td>PW</td>
<td>Penta-West-Gasleitung</td>
</tr>
<tr>
<td>RES</td>
<td>Renewable Energy Sources</td>
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<tr>
<td>RHI</td>
<td>Renewable Heat Incentive</td>
</tr>
<tr>
<td>RO</td>
<td>Renewable Obligation</td>
</tr>
<tr>
<td>ROC</td>
<td>Renewable Obligation Certificate</td>
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<tr>
<td>ROP</td>
<td>Regional operational programme</td>
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<tr>
<td>RTFO</td>
<td>Renewable Transport Fuel Obligation</td>
</tr>
<tr>
<td>Snam</td>
<td>Società Nazionale Metanodotti</td>
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<tr>
<td>SDE+</td>
<td>Stimulering duurzame energie</td>
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<tr>
<td>SOL</td>
<td>Süd-Ost-Gasleitung</td>
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<tr>
<td>SS</td>
<td>Swedish Standard</td>
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<tr>
<td>SVGW</td>
<td>Schweizer Verein für Gas und Wasser / Swiss Gas and Water Association</td>
</tr>
<tr>
<td>TAG</td>
<td>Trans-Austria-Gasleitung</td>
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<tr>
<td>TSO</td>
<td>Transmission system operator</td>
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<tr>
<td>TÜV</td>
<td>Technischer Überwachungs-Verein / Technical Inspection Association</td>
</tr>
<tr>
<td>TWh</td>
<td>Terawatt hour</td>
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<tr>
<td>UKCS</td>
<td>UK Continental Shelf</td>
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<td>WAG</td>
<td>West-Austria-Gasleitung</td>
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Literature


