SUSTAINABLE POTENTIAL OF GAS FOR THE ENERGY SYSTEM

CEDEC REPORT

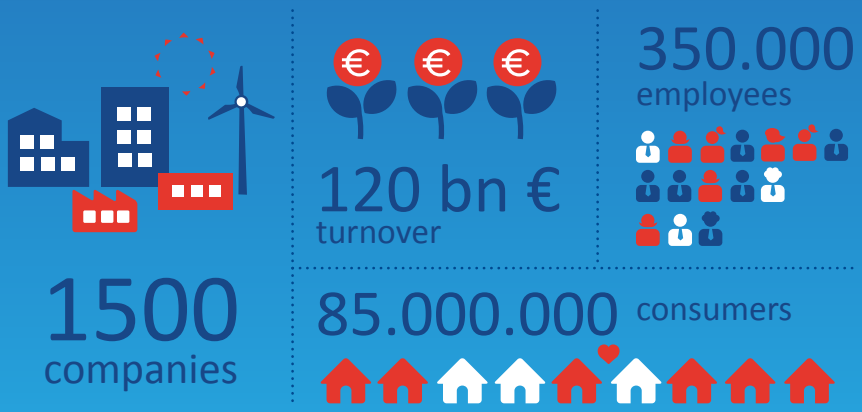
January 2017

CEDEC

CEDEC - WHO ARE WE?

CEDEC represents the interests of local and regional energy companies.

CEDEC represents more than 1500 companies with a total turnover of 120 billion Euros, serving 85 million electricity and gas consumers & connections, with more than 350.000 employees. These predominantly medium-sized local and regional energy companies have developed activities as electricity and heat generators, electricity and gas distribution grid & metering operators and energy (services) suppliers.



The wide range of services provided by local utility companies is reliable, sustainable and close to the costumer. Through their investments and local jobs, they make a significant contribution to local and regional economic development.

INTRODUCTION

Natural gas is a common energy source in the EU with a consumption of about 4,6 billion MWh[1]. Its demand in 2015 increased by approximately 4% compared with 2014. Gas is the fossil fuel with the least emissions, it can be used in electricity generation, heating, mobility and industrial processes and it is easily transported and stored. Furthermore, new forms of sustainable gas are becoming increasingly available. Gas is complementary to renewable electricity in a more sustainable energy system, and each should be deployed where appropriate.

However, gas is currently underexposed in the debate on the future sustainable energy system[2]. Green gas and other sustainable gases are rarely mentioned in policy documents or legislation and only few Member States have set targets for it. The underrepresentation of gas in the future energy design would be a missed opportunity as it provides irreplaceable characteristics and benefits.

Extensive transmission and distribution grids have been built for natural gas, and are readily available for extended and optimised use for different types of gases, for different types of applications and for innovative technologies that link the electricity, gas and heating & cooling sectors.

This report is focusing on the unused potential of sustainable gases and the important role of gas grids to contribute to the EU climate and energy strategy.

1 Based on IEA data for 2015

2 Energy system includes electricity generation, heating & cooling and transport

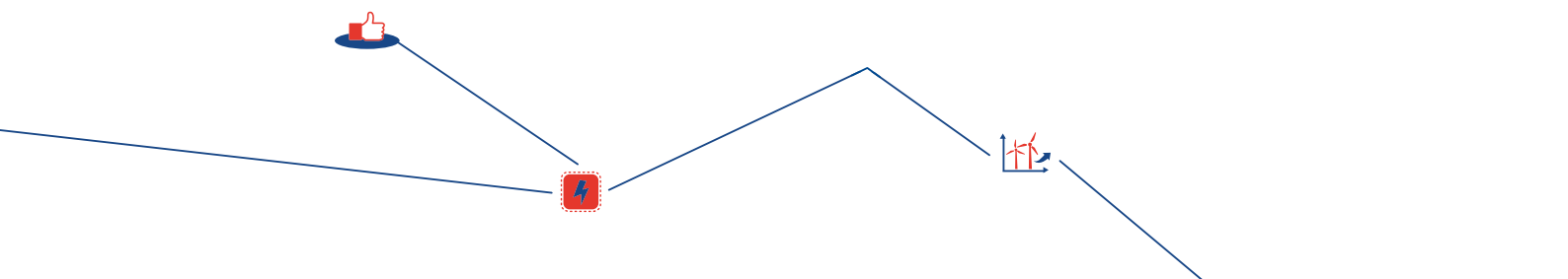
THE SUSTAINABLE POTENTIAL OF GAS

CEDEC sees potential in innovative gas-related technologies, which entail the production and use of sustainable gases. The existing gas grid, built for natural gas, will continue to play an important role in maintaining a reliable, affordable and sustainable energy system since it can be used by sustainable gases and hence serves the goals of climate policy.

Gas is a lot more than a fossil fuel. It can help reducing greenhouse gas emissions when respecting sustainability criteria. Green gas and other sustainable gases and technologies like power-to-gas (P2G) and compressed natural gas (CNG) can play an important role to achieve a reliable, sustainable and affordable energy system. Moreover, the existing gas grids guarantee an easy transportation, storage and distribution of the energy at a high level of security of supply and low cost. In general, gas is a very flexible energy source: seen from a system perspective, it is complementary to renewable electricity generation.

Much has already been invested in grid infrastructure for the distribution of gas, electricity and district heating. Many countries have now widespread high density distribution grids that reach most customers. Therefore, CEDEC believes it is important to explore how these existing grids can be optimally used to develop our energy system in an efficient way.

The current energy design in the Member States is based on their geographical, economic and demographic situations. Therefore the energy design is different in each Member State and the roll-out of a one-size-fits-all solution is not the most cost-efficient solution.

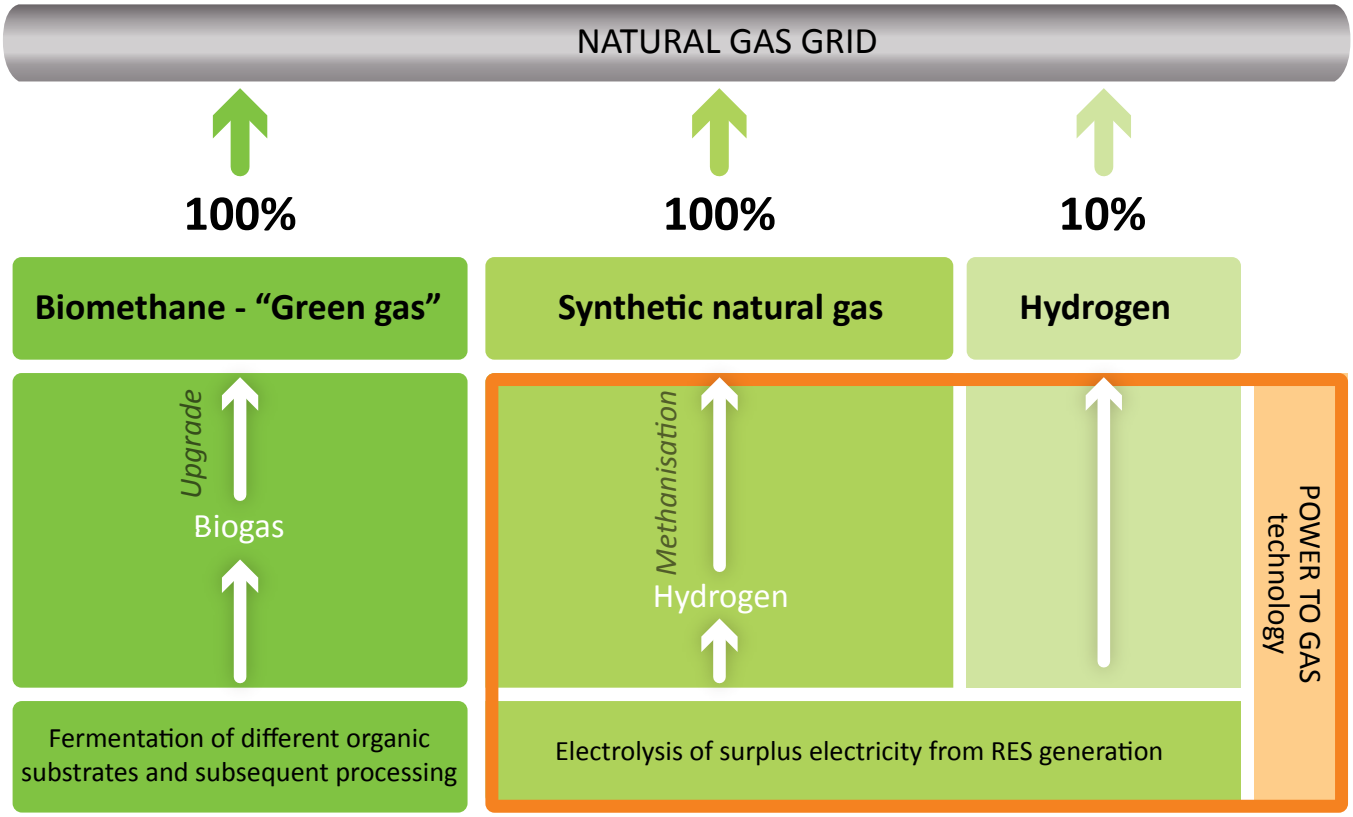


SUSTAINABLE GAS - ALTERNATIVE OPTIONS

Sustainable gas comprises every gas produced from renewable sources, including “green gas”/biomethane derived from anaerobic digestion processes, and gases such as synthetic natural gas and renewable hydrogen, produced from other sustainable techniques.

There are different alternative and sustainable gas options. Distribution grids technically tolerate high shares of sustainable gases.

The illustration below provides an overview of the different forms of sustainable gas.



Sustainable gas can be used for many purposes across different sectors: in electricity generation, industry, heating and in transport. It can be conveyed using the existing gas grids and be stored for use in a flexible manner. Gas has the advantage of providing the consumer flexibility, besides comfort and convenience.

DIVERSIFYING GAS APPLICATIONS IN INTEGRATED SYSTEMS

It is important to look from an integrated system perspective in order to select the best option for the energy source and for the optimal form of transportation and storage. By taking into account the local and regional circumstances, synergies between energy products and infrastructures could be exploited by verifying how they can supplement each other. Increased coupling and interactions are possible:

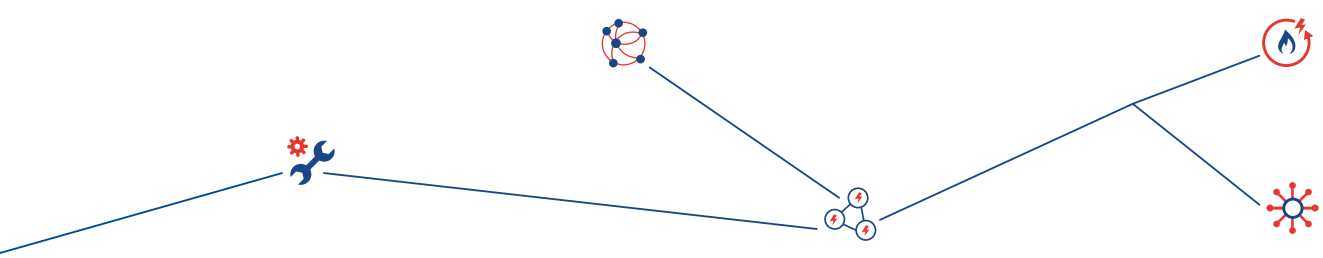
- between energy systems at various scales (from international, national, or community scale down to building level),
- between different systems (electricity/biogas/district heating and cooling/hydrogen),
- between various uses such as electricity generation, heating or transport.

This increased coupling will increase sustainability and security of supply at the lowest cost for society.

From the demand side, new more and diversified gas applications can lead to a more stable usage of the gas distribution grid. For example, CNG or biogas can be used as a fuel for transport, including long distance transport by trucks with storage tanks at petrol stations able to "charge" at the most appropriate time. Not only will this allow for demand response in the gas market, but it would also result in a more sustainable and efficient use of the gas grid, also in summer, when lower demand can pose problems for the infeed of biogas in distribution grids.

The gas grid can also help balancing the electricity system. P2G offers possibilities to use the synergies between gas and electricity infrastructure. It enables the storage of excess electricity during times of high variable RES supply, and its transport to demand centres.

Furthermore, gas powered air-conditioning systems can lower the strain of the peak loads in electricity grids during summer.



RECENT INNOVATIVE PROJECTS

The selected projects give an overview of innovative technologies currently developed in different EU Member States.

Green gas from waste water treatment - Milan

ITALY

Now

- Share of primary energy consumption: 31%
- Connection points to the gas grid: 21,3 million
- Length of DSO-grid: 258.000km

The role of gas is very important. It has a huge share in electricity generation (more than 50%) but is now gradually decreasing. Reasons for decrease are: the energy efficiency measures in place, which reduce the consumption in households and in the industry sector, along with the increase of renewables which decreases electricity generation from natural gas.

Future

Biogas will play an important role with a high potential for biogas from the agricultural, waste and waste water sectors. In the future the use of green gas could supply a relevant share of energy needs in transport. Green gas could become strategic in reaching the environmental targets and reducing gas imports. The regulatory framework for green gas has been recently developed and includes a definition of quality standards for the injection in the grid.

CAP Holding, the utility providing water services to the municipalities of the Province of Milan and to many other municipalities in the Provinces of Monza and Brianza, Pavia, Como and Varese, has implemented a project to allow the production of green gas from sewage by upgrading the biogas produced in the Niguarda-Bresso plant.

The pilot project, in cooperation with Fiat Chrysler Automobiles and National Council for Research, aims to assess the quality and the quantities of the green gas produced before a full industrialisation.

The objective is to transform the existing wastewater treatment plants (WWTP) into bio refineries in order to contribute to the circular economy and the European sustainability targets.

The project in the plant of Niguarda-Bresso can provide 341 tons of green gas per year, able to supply 416 vehicles with 20.000km of coverage. In case of positive assessment of the tests, the green gas will be used for internal consumption, for external needs (by a specific biomethane station which will be built close to the WWTP) or will be injected into the gas grid.

With 670 million m^3/year of gas, the full exploitation of the municipal wastewater potential could ensure up to 70% of the national production of gas and nearly 2% of the national consumption.

Biogas - Bionet, Weesp

THE NETHERLANDS

Now

- Share of gas in primary energy consumption: 40%
- Connection points to the gas grid: 7 million
- Length of DSO-grid: 123.000km

Gas has been a preferential fuel in the heating sector especially since the national gas production at Groningen field in the 1960s. The role of gas in the heating sector is declining mainly due to energy efficiency rules for new buildings. There are some biomethane projects already feeding into the grid.

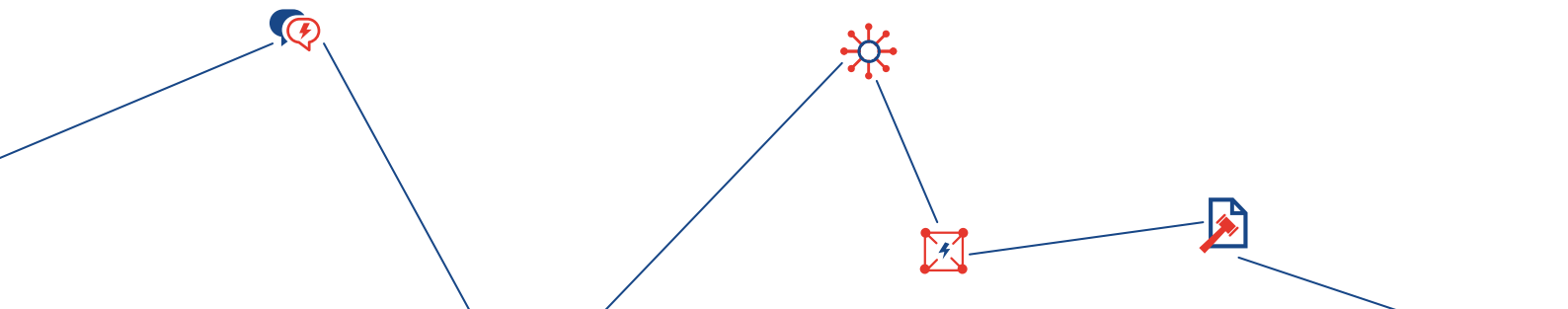
Future

The role of gas will most probably continue to decline in the residential heating sector. However, there is a widespread and continuous search for new gas developments (e.g. feeding of biogas, green gas, or hydrogen into the grids) but also for new applications in the housing sector (fuel cells, cooling with gas), and in the transport sector. Gas grids will continue to serve the need of these innovative technologies.

Bionet is a demonstration project with the goal of showing that gases with different compositions can be distributed in public gas grids.

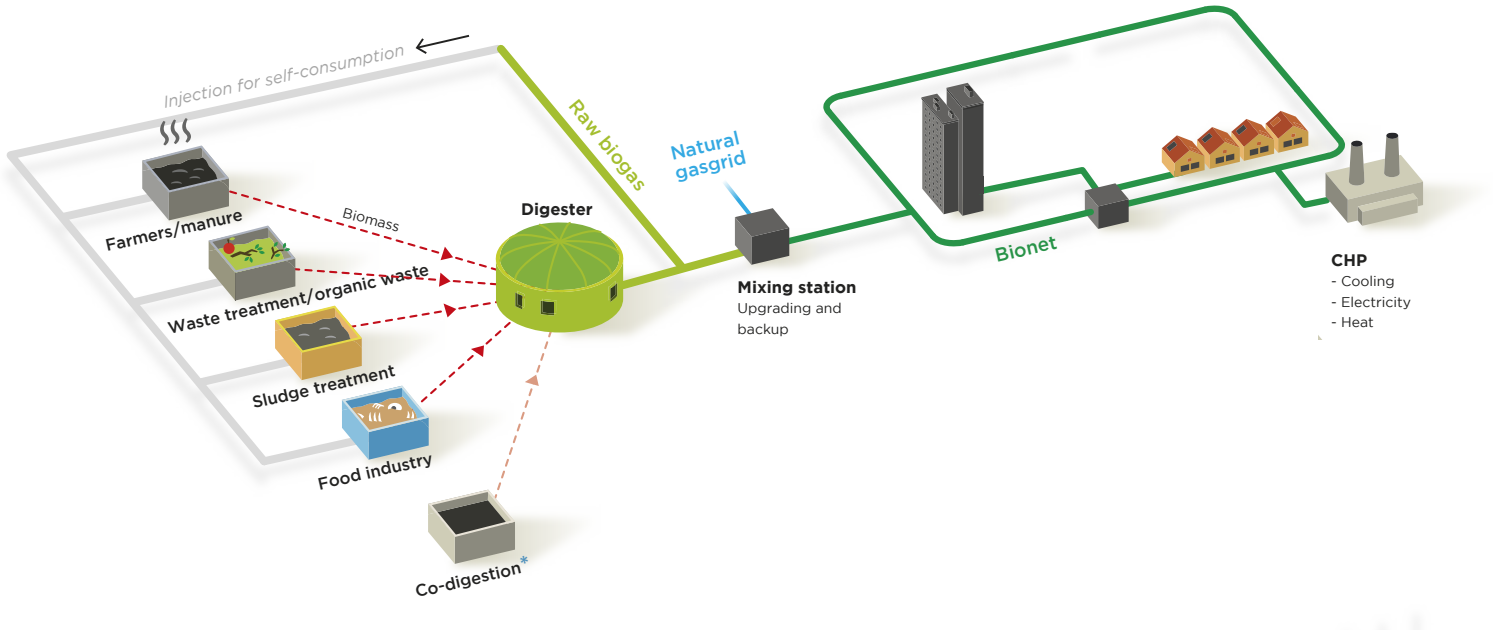
Bionet is a combined grid in which the production of biogas is first maximised and then mixed with natural gas, thus avoiding issues linked to changing gas quality. The investments for biogas installations are low mainly because the costs for upgrading the biogas to natural gas standard are limited. The biogas is cleared of water and sulphur before being directly injected into a mixing station. Depending on the gas quality measured, natural gas is added in order to provide the minimum level of quality in the Bionetwork. This gas is distributed in the residential area and consumed by special adaptive boilers that can burn natural gas, biogas and any mixture of the two. If there is not enough biogas, the area is supplied with natural gas. A new measurement and settlement system has been developed for this purpose.

Compared with alternatives using biogas as a source for heating, for instance district heating networks, the costs of Bionet are much lower. It is a simple solution with a low CO_2 footprint.



Biogas bionet

Sustainable energy produced by digestion of organic material (biomass)



* **Co-digestion:** Digestion of different biomass streams in one digestion installation

CNG refuelling stations using the gas grid - Belgium

BELGIUM

Now

- Share of gas in primary energy consumption: 23%
- Connection points to the gas grid: 3,2 million
- Length of DSO-grid: 72.500km

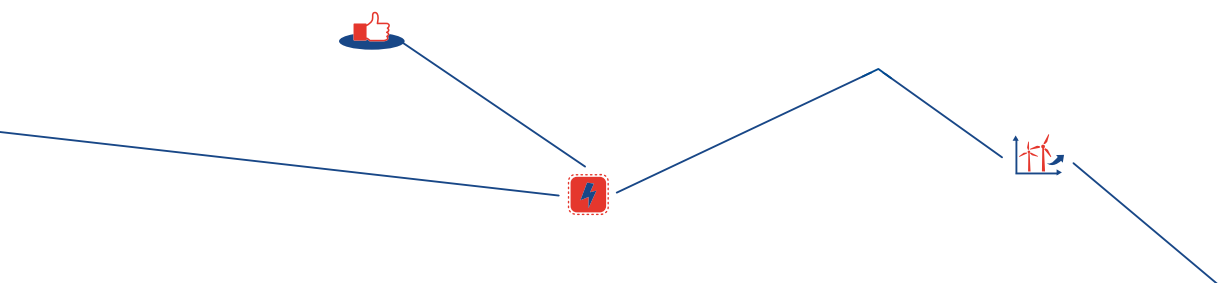
Although energy efficiency measures for buildings clearly have an impact on gas demand, in the residential sector the demand remains more or less constant as new gas connections continue to show healthy year-on-year increases. With refuelling infrastructures steadily on the increase, gas as alternative fuel in transport has taken up.

Future

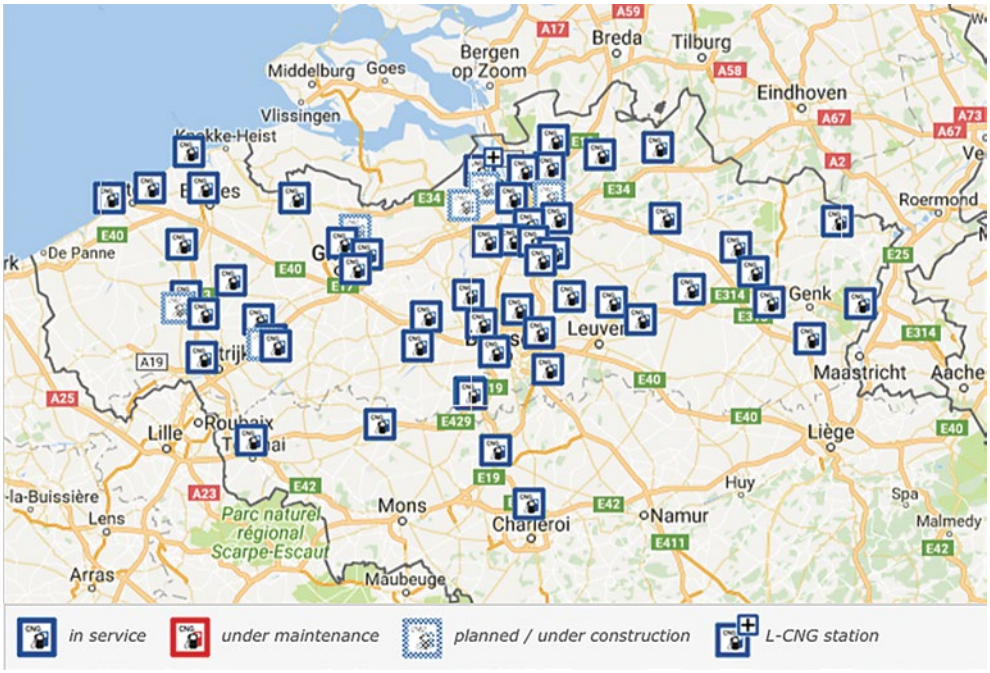
Gas demand for heating is likely to soften on the back of further energy efficiency gains but gas demand for power is estimated to pick up once nuclear generation is progressively phased out. Gas in transport is set to take a leap forward as the LNG bunkering chains for ships become operational.

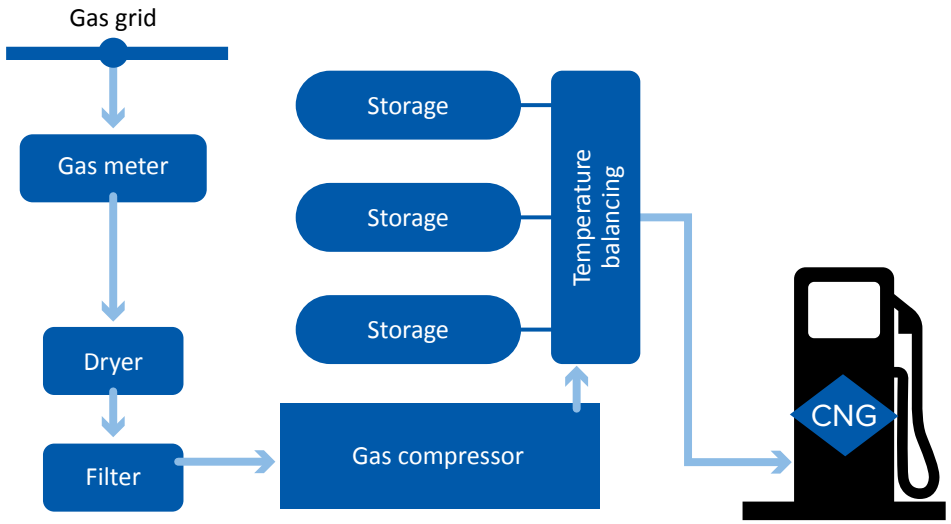
Compressed Natural Gas (CNG) vehicles emit nearly zero fine particles, 27% less CO_2 emissions than petrol vehicles and 12% less CO_2 emissions than diesel vehicles. With CNG vehicles, NOx emissions are reduced by up to 60% compared with petrol or diesel vehicles. CNG vehicles need special fuel points but the technology used can easily be connected to the existing gas grids.

In Belgium the network of CNG refuelling points is expanding. From 4 CNG refuelling points in 2010, the number has increased to 70 in 2016, all connected to the existing gas grids. Around 25 additional CNG refuelling points should be created in the near future to contribute to the reduction of greenhouse gases emissions.



Distribution of the CNG refuelling points





Power-to-gas-project - Städtische Betriebe Haßfurt & Greenpeace Energy, Haßfurt

GERMANY

Now

- Share of gas in primary energy consumption: 21%
- Connection points to the gas grid: 14 million
- Length of DSO-grid: 389.000km

The role of gas is currently very important. Gas is the second primary energy source, after oil.

Future

Germany has ambitious targets in national climate policy where gas plays a minor role in achieving them. Hence the role of gas is expected to decline.

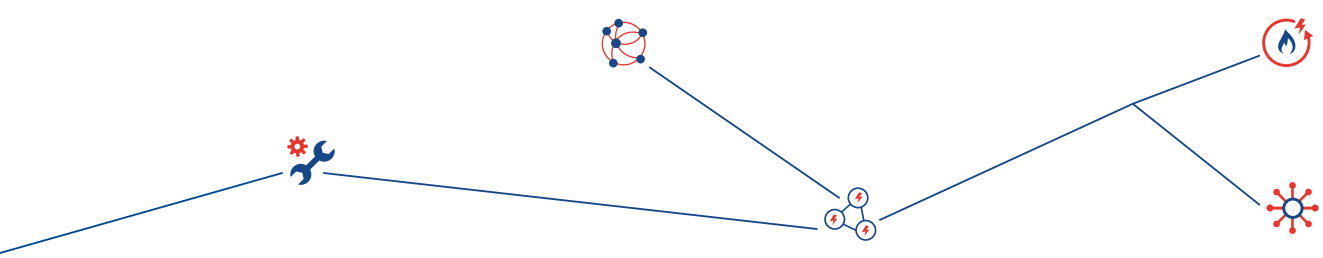
Sustainable gas is seen as positive, though currently still expensive. Sustainable gas provides important advantages as, it is renewable, it can be stored in the existing infrastructure (pipeline grid and storages), and it can reach every plants in Germany thanks to the existing dense gas grid. P2G technology is also seen as an interesting instrument to store electricity and balance wind overcapacity in integrated energy systems.

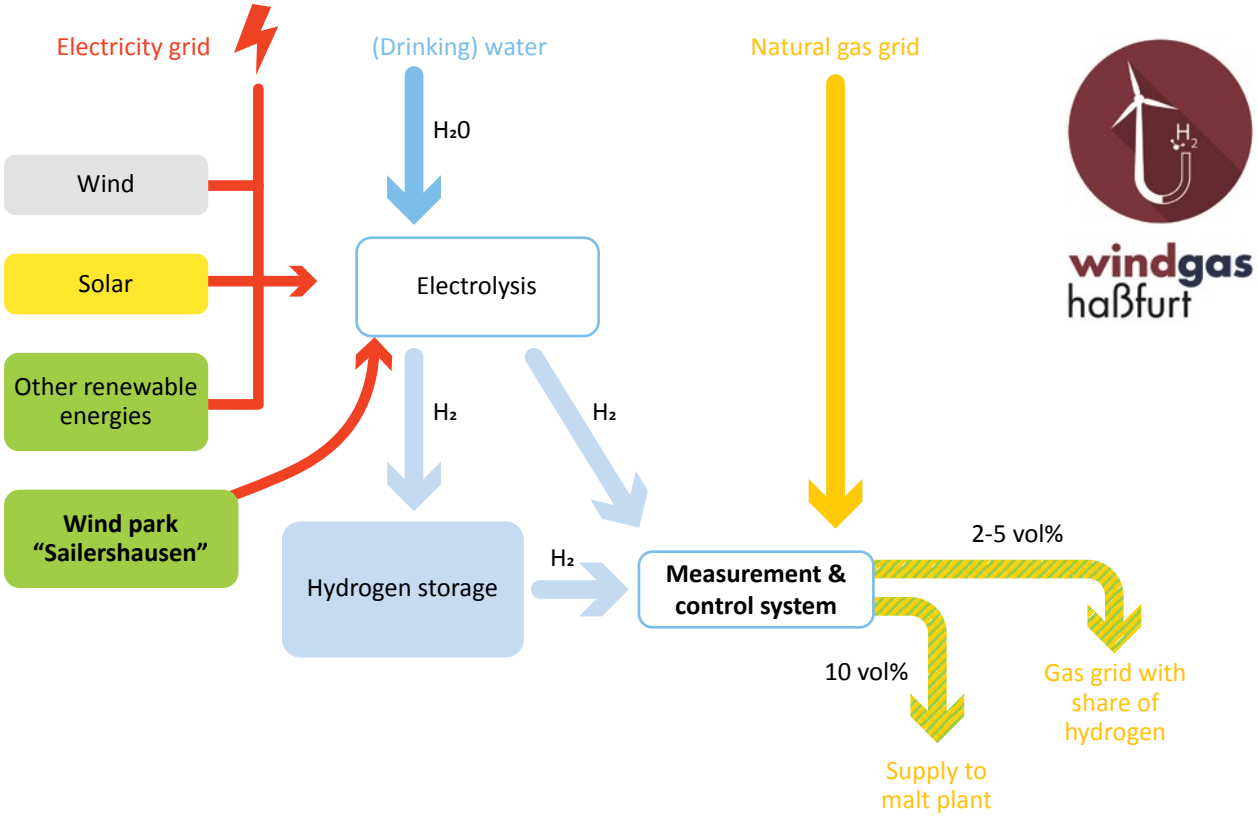
The German Stadtwerk Haßfurt has built a power-to-gas project with Greenpeace Energy as project partner. Since September 2016, surplus power from wind farms has been converted into hydrogen. By means of PEM-electrolysis (PEM = polymer electrolyte membrane) the electricity is used to split water into its components oxygen and hydrogen.

This renewable hydrogen is fed into the local gas distribution grid (about 1 million kWh/year) up to 3 volume percent. Part of the project is also to test a higher share of hydrogen in the local gas grid. A local malt plant is testing the burning of the gas mixture containing 10 volume percent hydrogen in a combined heat and power (CHP) plant.

The flexible PEM-electrolysis produces hydrogen while avoiding shortfalls in the local electricity grid, where the balance of production and demand must always be maintained. Testing the offer of balancing energy by power-to-gas is therefore also in the focus of the project.

The project partner is currently testing elements of a sustainable energy supply for the future: a system of renewable energies like wind and solar, and a high-performance storage. This combination would allow a secured energy supply, both for households and the industry.





Source: Städtische Betriebe GmbH Haßfurt

Biomethane from kitchen waste - Wiener Netze, Vienna

AUSTRIA

Now

- Share of gas in primary energy consumption: 19,3%
- Connection points to the gas grid: 1,4 million
- Length of DSO-grid: 39.500km

CNG vehicles have raised the consumtion of gas at refuelling stations. However, the amount of gas for heating has been reducing due to thermal insulation, climate change and substitution to other energies (e.g pellet-heating, district heating in cities …).

Future

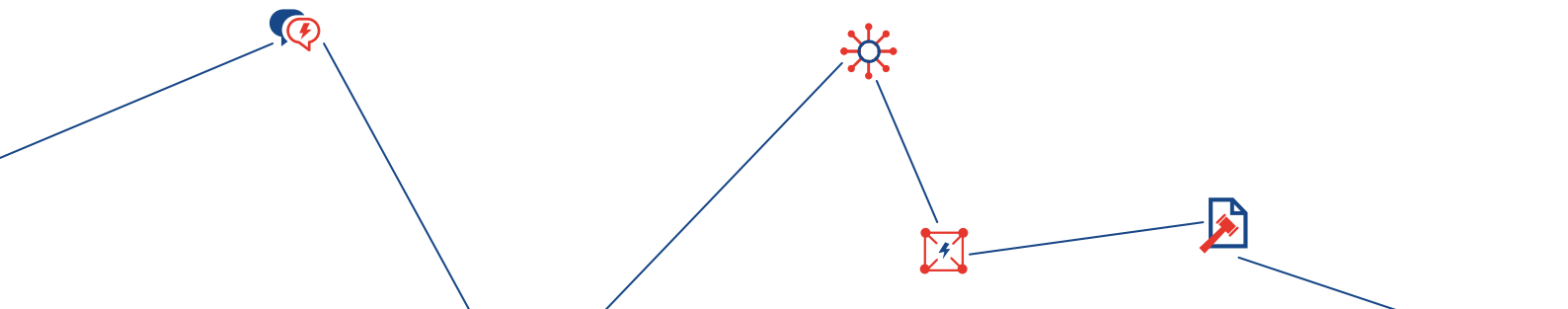
Sustainable gas is seen as positive. Some biomethane projects are ongoing and P2G technology will be tested in designated areas such as Vienna. Gas grids are being re-designed to fulfill transportation needs for future gas-mixes and for innovative smart grids.

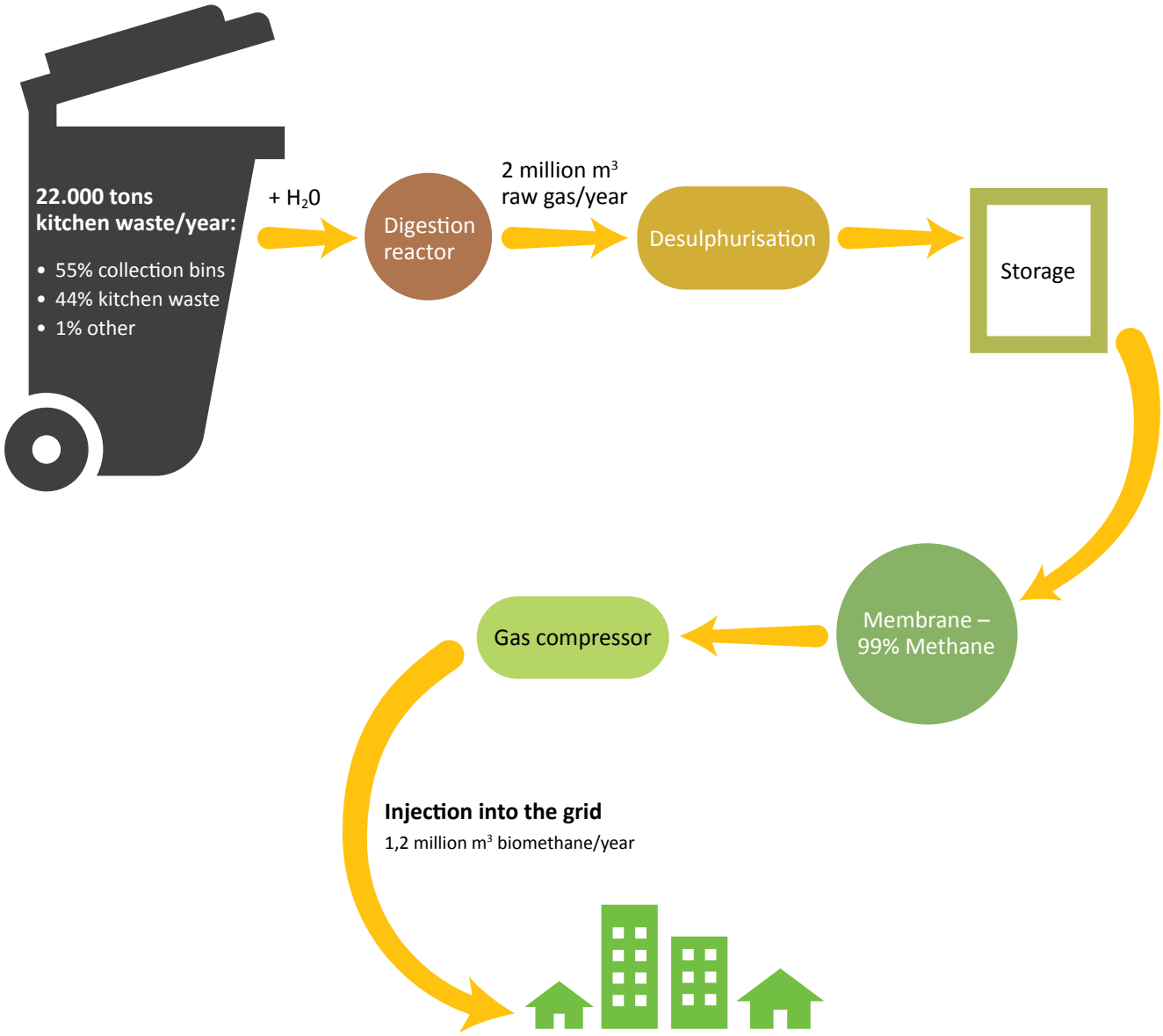
Together with Vienna Energy and the Viennese Department for Waste Management, Wiener Netze GmbH has connected a biogas plant to the local DSO grid. The plant turns biogas produced from kitchen waste into biomethane by using membrane technology that separates other gases from methane. Biomethane can be directly injected to the local gas grid, as it has the same characteristics of natural gas .

The plant treats around 22.000 tons of kitchen waste per year which enables an annual production of 1,2 million m^3 biomethane.

To obtain biomethane, the process is mainly based on biological processes and time. There are no additional costs for the customer since it is not necessary to invest in new household appliances, nor change the logistics for the collection of organic waste.

The biogas production is forecast to increase by 12.000 tons/year hence up to 2,1 million m^3/year biomethane would be injected into the grid.




22.000 tons
kitchen waste/year:
• 55% collection bins
• 44% kitchen waste
• 1% other
+ H_20
Digestion reactor
2 million m^3
raw gas/year
Desulphurisation
Storage
Membrane –
99% Methane
Gas compressor
Injection into the grid
1,2 million m^3 biomethane/year

Biomethane from local biomass - LIGER, Locminé

FRANCE

Now

- Share of gas in primary energy consumption: 14,2%
- Connection points to the gas grid: 11,3 million
- Length of DSO-grid: 198.000km

The share of biogas is planned to increase since the French law has set ambitious targets for green gas: 10% by 2030. At the end of 2015, the annual coverage rate of gas consumption from biomethane was close to 0,02% but is expected to grow.

Future

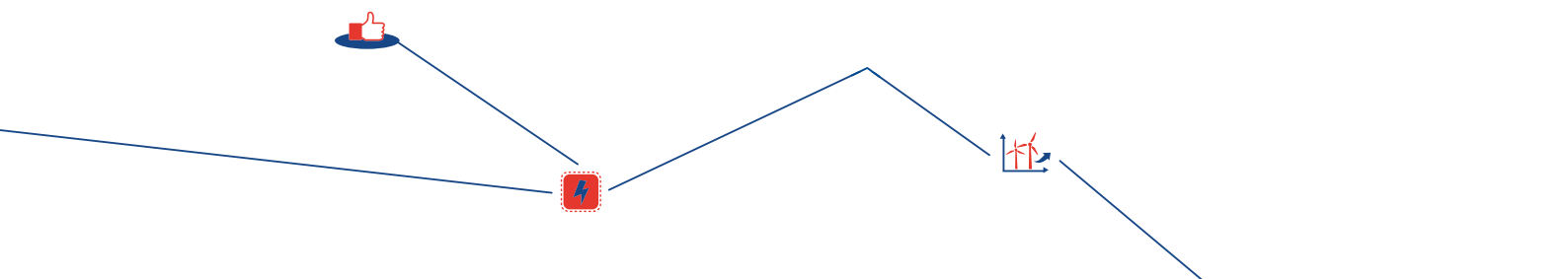
There is a political will to integrate more green gas and use available technologies in the energy grids. The injection of biomethane into the grid is steadily growing, with around 200 upcoming projects connected to the distribution grids. In the transport sector the number of refuelling stations with CNG and LNG should considerably increase. District heating networks combined with boiler plants using biomethane is another innovative technology in which France is investing.

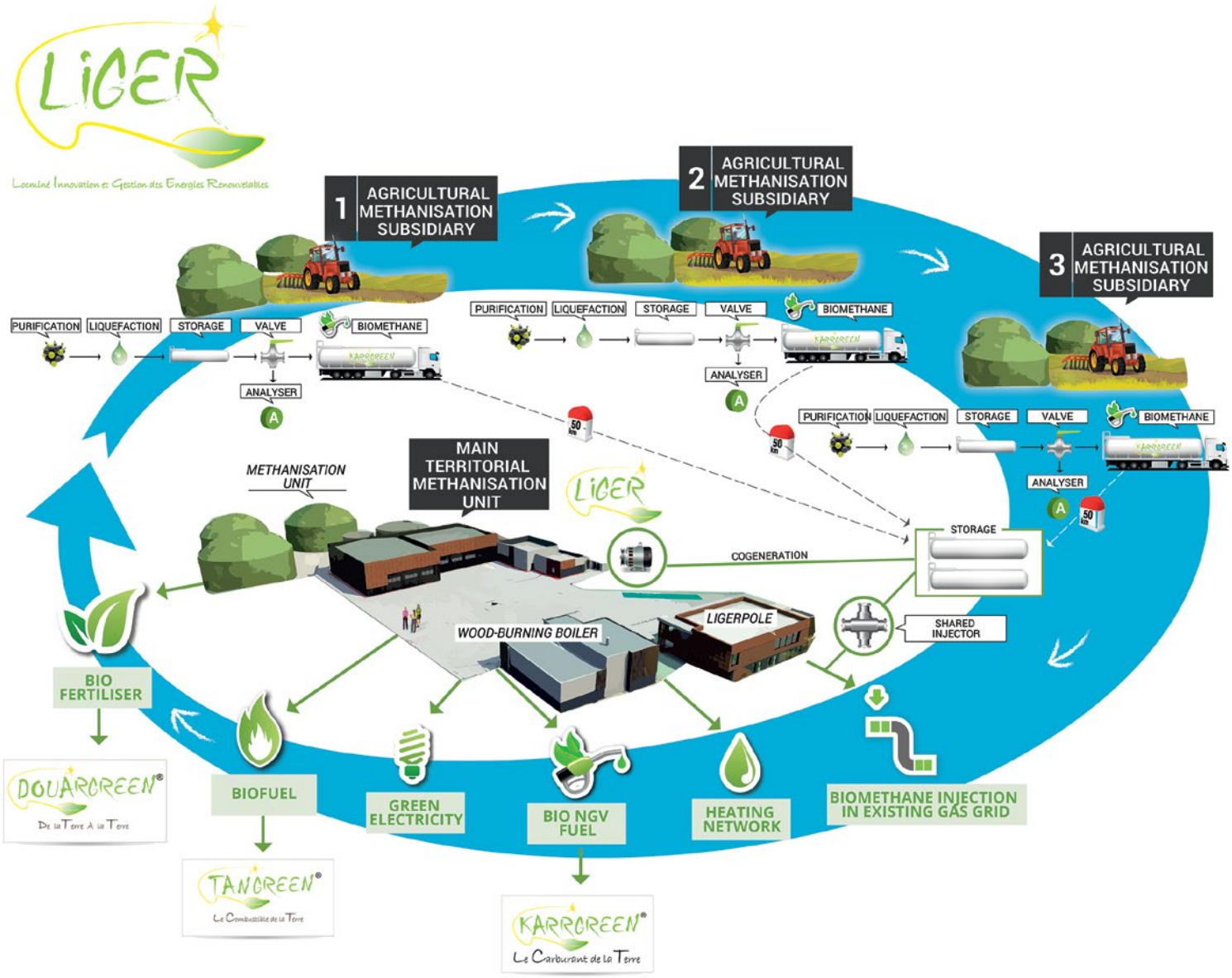
The LIGER project uses two energy sources from territorial biomass —wood and organic resources— to produce electricity, heat, and fuel, as well as organic fertiliser. The project is based on several complementary and integrated processes.

A methanisation unit is fed by 60.000 tons of organic residues from the local area (20km range) and enables the production of biogas, optimised through cogeneration. The electricity produced is injected in the grid and the heat is distributed via a heat network. After purification the biogas is injected in the existing gas grid. Some of the biogas (11%) is reserved for conversion to biomethane fuel for the trucks used to transport materials and vehicles belonging to the community and users of the site.

The wood-burning heat-generation boiler is linked to the methanisation process. With 2MW, the boiler feeds the heating network of 4km enabling to heat public, industrial and private facilities. The burnt wood comes from the local forest residues (max. 25km range).

The project helps structuring the local economy, with a positive impact on local environmental emissions.




LiGER
Loarine Innovation et Gestion des Energies Renouvelables
1 AGRICULTURAL METHANISATION SUBSIDIARY
2 AGRICULTURAL METHANISATION SUBSIDIARY
3 AGRICULTURAL METHANISATION SUBSIDIARY
PURIFICATION
LIQUEFACTION
STORAGE
VALVE
BIOMETHANE
ANALYSER
METHANISATION UNIT
MAIN TERRITORIAL METHANISATION UNIT
COGENERATION
STORAGE
WOOD-BURNING BOILER
LIGERPOLE
SHARED INJECTOR
BIO FERTILISER
BIOFUEL
GREEN ELECTRICITY
BIO NGV FUEL
HEATING NETWORK
BIOMETHANE INJECTION IN EXISTING GAS GRID
DOUARGREEN
De la Terre à la Terre
TANGREEN
Le Combustible de la Terre
KARRGREEN
Le Carburant de la Terre

Biogas for local transport - Ekogas, Gävle

SWEDEN

Now

- Share of gas in primary energy consumption: 1,6%
- Customers connected to the gas grid: 40.000
- Length of DSO-grid: 2.720km

Gas plays a substantial role in the south-western part of Sweden, where the infrastructure has already been built.

Future

Future projects will aim for markets served by regional grids and Liquefied Natural Gas and Liquefied Biogas. There will be a growing share of local biogas production capacity, with subsidies for biogas installations. The future use of gas in Sweden will be focused first and foremost on the transport and industrial sectors.

The Ekogas project was launched to reduce CO_2 emissions from road vehicles. Given that biogas is a well-developed alternative energy with great potential for local production, Ekogas has established a biogas production plant for distribution in a refuelling station.

Ekogas converts domestic wastewater into vehicle biogas at a wastewater treatment plant in Duvbacken, Gävle. The plant has a biogas production capacity of 1 million m^3/year, which is equivalent to 2.500 litres of petrol/day. There is one biogas refuelling station in Gävle, and there are plans to install more stations in the future.

EKOGAS™

POLICY RECOMMENDATIONS:

- Each Member State should take the necessary measures to reach its own optimum in energy grid design and energy mix, since there is no one-size-fits all solution: local externalities (environmental, social, industrial) should be taken into account.
- A more cost-efficient exploitation of the existing infrastructures (gas, electricity, heating & cooling, water, waste, transport) is possible through an integrated energy system approach: synergies should be looked for among the different sectors.
- A coherent and consistent approach for long-term investments must be developed. The potential of natural and renewable gas technologies must be fully exploited.
- The huge investments in existing long-term infrastructures should be taken into consideration, in order to minimise stranded investments, keeping costs for customers under control.
- Know-how and expertise on existing and new technologies should be exploited at its full potential.

ABBREVIATIONS

CHP:	combined heat and power	P2G:	power-to-gas
CNG:	compressed natural gas	PEM:	polymer electrolyte membrane
LNG:	liquid natural gas	RES:	renewable energy sources
MWh:	megawatt hour	WWTP:	waste water treatment plant

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