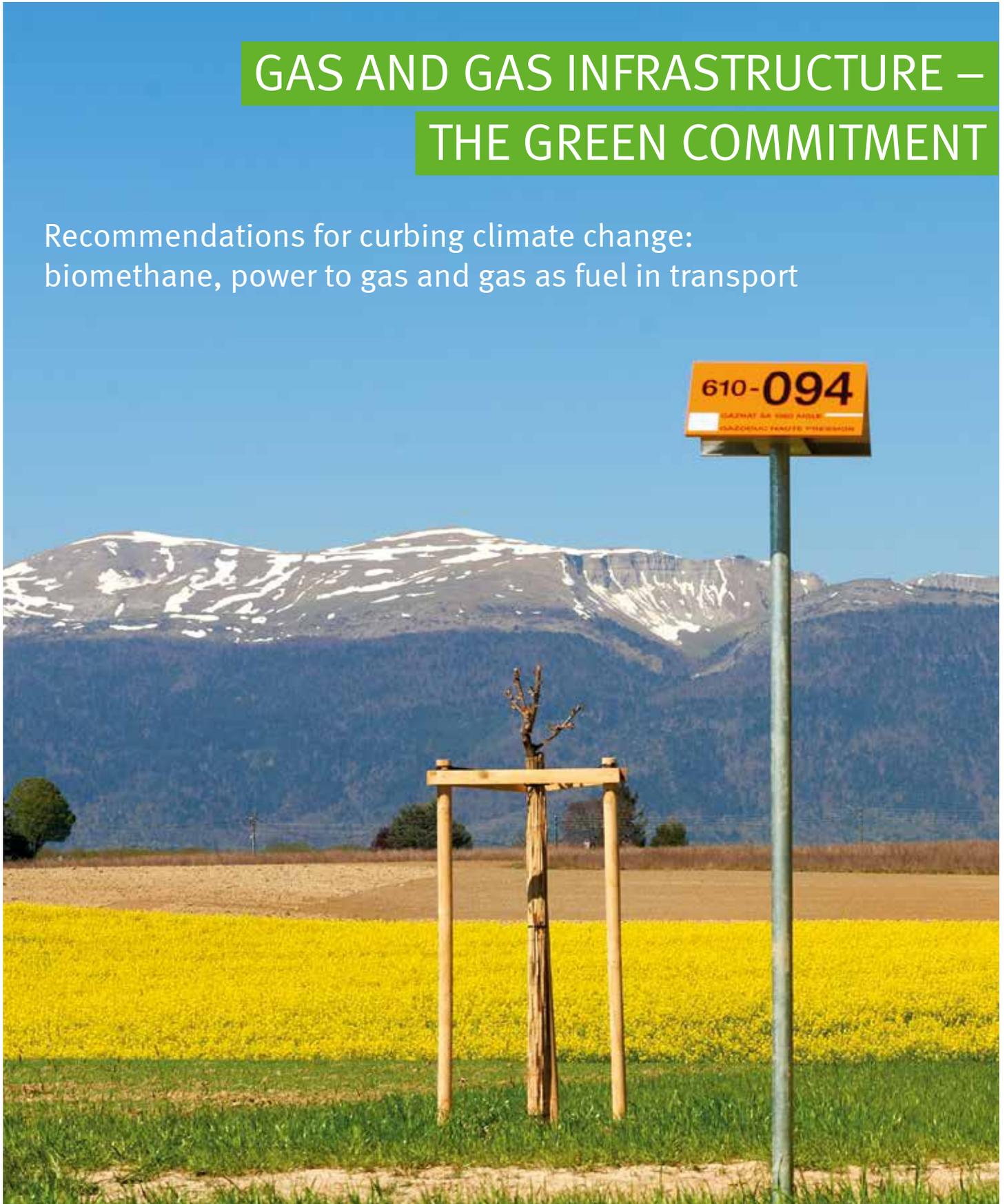


# GAS AND GAS INFRASTRUCTURE – THE GREEN COMMITMENT

Recommendations for curbing climate change:  
biomethane, power to gas and gas as fuel in transport



# THE GREEN GAS INITIATIVE TOWARDS A 100% CO<sub>2</sub>-NEUTRAL GAS SUPPLY BY 2050

Climate change requires urgent action and the ultimate challenge is to carry out the required transition towards a greener future at affordable cost for EU citizens and in line with EU energy security perspectives. The availability of well-developed gas networks in Europe and the complementary function of renewable gases and natural gas vis-à-vis other energy forms make gas and gas infrastructure well positioned to meet this challenge.

Gas systems offer excellent opportunities to secure an affordable energy supply to European citizens and companies and facilitate the increase of the share of renewable energy enabling the development of a low-carbon economy towards 2050. For years gas infrastructure has already contributed to environmental improvement by an increasing integration of renewable gases and the convergence of energy systems.

The members of the Green Gas Initiative (GGI) have signed a joint declaration and committed themselves to the main objective of contributing to a CO<sub>2</sub>-neutral gas supply by 2050. This common goal can be realised by working on a number of options. The topics to be tackled in the first place will be biomethane, power to gas and gas as a fuel in road and maritime transport.

Seven independent gas infrastructure companies form the GGI: Energinet.dk (Denmark), Fluxys Belgium, Gasunie (the Netherlands), Gaznat (Switzerland), GRTgaz (France), ONTRAS (Germany) and Swedegas (Sweden). As infrastructure operators the companies share their long-term strategic horizon with Europe's green vision for 2050. Their cross-border cooperation seeks to achieve benefits for all parties involved through knowledge-exchange and targeted communication on both national and European levels. Each company has its particular expertise. Working together within the GGI, the members learn from each other and spur each other to develop broader know-how.

The GGI members consider the combination of using biomethane, power to gas solutions and using gas as an alternative fuel for road and maritime transport as the most promising solutions for curbing climate change currently. Therefore this joint report offers recommendations for the further development of these three approaches. A brief overview of each topic's characteristics and recent developments is followed by recommendations to achieve smooth implementation of the associated technologies.

*A GREEN VISION  
FOR EUROPE*

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## BIOMETHANE – NATURALLY GREEN GAS

Europe currently has an extensive gas network totalling 2.2 million kilometres of pipelines. This network allows gas to be transported easily from the point of production or entry point to the customer and across borders.

Working towards a common vision of green gas grids in Europe calls for maximising the potential offered by biomethane production. This energy resource has to be produced, transported and used in a cost-effective, environmentally friendly and efficient way.

Biomethane is a renewable fuel with strong inherent benefits: It can be produced with a nearly constant output and quality. It can be stored, it can be traded and transported efficiently over long distances and it provides flexibility to intermittent energy resources. Production of biomethane also provides societal benefits such as production of energy from waste streams. Furthermore, by-products of biomethane can be used as fertilizer and thus reduce greenhouse gas emissions in the agricultural sector.

The use of biomethane is diverse. It can be used in all sectors – households, industry, power generation and transportation. Biomethane is a pipeline-quality gas that is fully compatible with conventional natural gas and can be transported in the existing natural gas pipelines. The current well developed gas infrastructure can be used as a means for a gradual and cost effective de-carbonisation of different fossil dependent sectors in Europe.

Biomethane markets are developing in a number of countries, driven by green agendas, innovation policy and subsidy schemes. In GGI member countries (Belgium, Denmark, France, Germany, the Netherlands, Sweden and Switzerland) we can observe an upward trend in both the numbers of plants connected and the volumes injected. European gas companies and gas infrastructure companies are active in several ways to support and facilitate biomethane production, some by industry funded schemes, some by investing in network reinforcements such as reverse flow capacity and some by funding plants and operational costs.

**BIOMETHANE IS A  
RENEWABLE SOURCE  
OF ENERGY WITH  
POSITIVE EFFECTS ON  
WASTE MANAGEMENT  
AND THE AGRICULTURAL SECTOR**

## MARKET DEVELOPMENT

The forerunner in biomethane in Europe is Germany where ambitious targets and implementation of legal frameworks, like the Renewable Energy Act, have spurred production. 170 biomethane plants existed with a capacity to feed about 5600 GWh into the German gas grid in 2014. France set up its first injection in 2012, but has since set up another 16 projects, representing a total annual capacity of almost 280 GWh. During the next couple of years, at least 150 projects are planned both for low pressure and high pressure grids for more than 3500 GWh of annual capacity.

In Denmark, new regulatory models have paved the way for increased biomethane injection into the grid. Sweden, with limited gas grid coverage, has built alternative distribution infrastructures to supply biomethane first and foremost to the transport sector. In 2014, the two first biomethane connections were made to the high pressure grid. In Belgium, there are currently few incentives to upgrade biogas and distribute biomethane through the grid. About 575 GWh of electricity was produced from biogas in Belgium in 2015. There are several injection projects underway during the next few years.

The Netherlands have experienced a shift in biogas usage from power generation to injection of conditioned biomethane in the grid. Biomethane production capacity in the Netherlands was 300 GWh in 2014 and currently adds up to 1000 GWh. In Switzerland, there are no state funded subsidies for biomethane in place, but the gas industry supports incentives. About 30% of the biomethane produced is used in the transport sector.

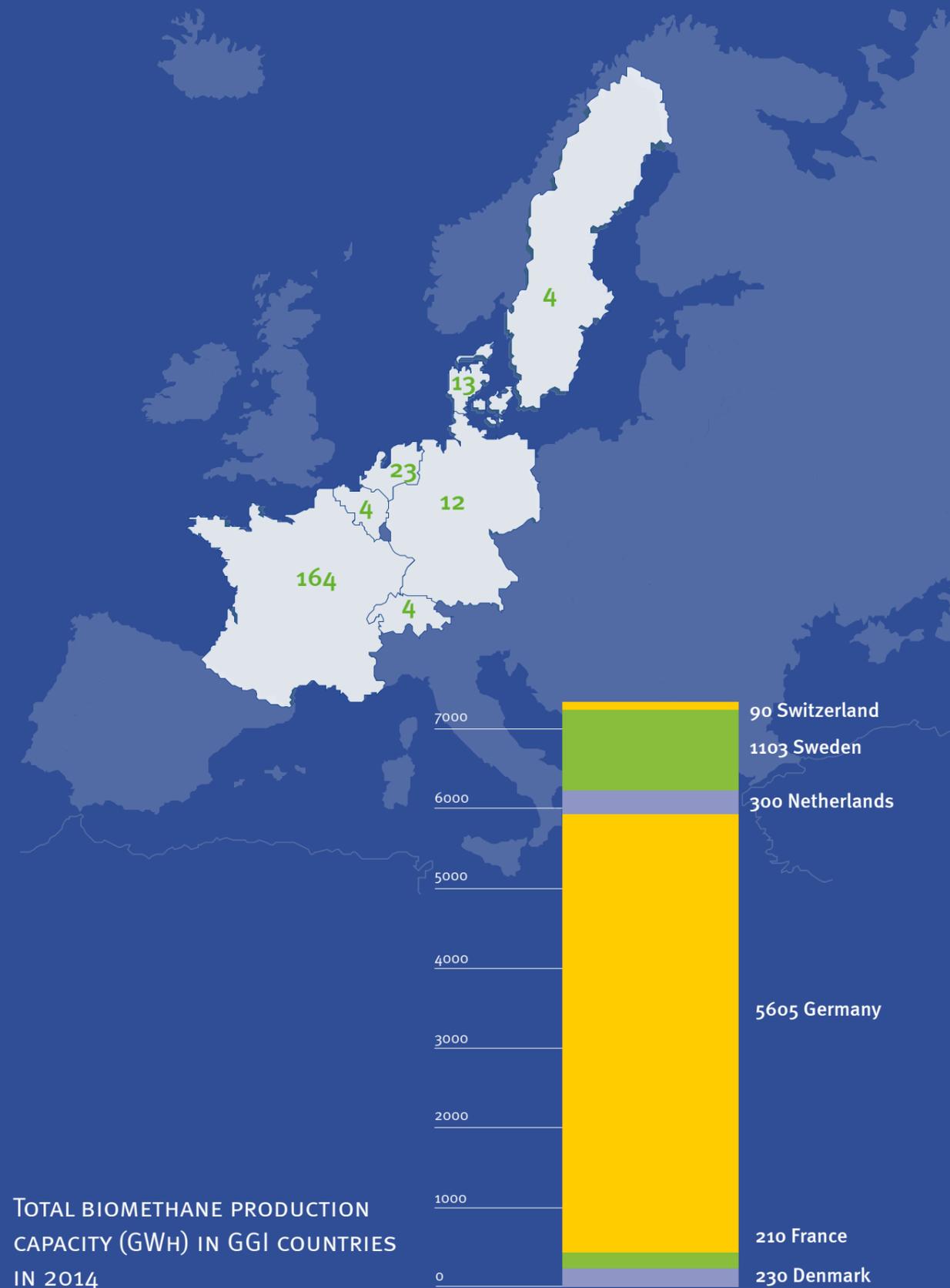
## SELECTED PROJECTS OF GGI MEMBERS

Swedegas has benefited from the cooperation possibilities within the GGI. The experiences gained have been fed into prioritized projects for Swedegas, such as the development of a national strategy for biogas and power to gas. As a result of years of work together with different stakeholders, biomethane use is steadily increasing in Sweden. In 2015 injection of biomethane in the grids of transmission system operators (TSO) and distribution system operators (DSO) in south-west Sweden increased 60% compared to 2014 (to 497 GWh in 2015, up from 306 GWh in 2014, upper heating value). This development of increased injection into the grid will continue and shows that cooperation with several partners, both nationally and on a European level, is crucial.

In September 2015, biomethane was injected into France's gas transmission network for the first time – into the GRT-gaz transmission network at Chagny (eastern France). The injected biomethane had been produced by processing local household waste at the SMET 71 factory.

The age of purely green gas has already become reality within part of the gas transmission system of the German TSO ONTRAS. Two pipelines regularly carry almost 100 percent biomethane. One pipeline approximately 20 km long runs west of Leipzig and is fed by the Thronitz biomethane feed-in plant. A second one is fed by the megabiogas plant of BioEnergie Park in Güstrow, Germany, with up to 5000 m<sup>3</sup>/h of biomethane.

## TOTAL NUMBER OF UPCOMING BIOMETHANE PROJECTS IN GGI COUNTRIES (ESTIMATION)



Sources: CBS Statistics Netherlands (2014), Deutsche Energie-Agentur GmbH (2015), Energistyrelsen (2014), Green Gas Initiative, GRTgaz (2015), Swedish Energy Agency (2015).

## GGI RECOMMENDATIONS: ENHANCE COOPERATION AND CREATE STRUCTURES

### FACILITATE CROSS-BORDER TRADE

Cross-border biomethane trade is needed to establish and maintain the supply-demand balance on regional and European levels. It enables the transfer of biomethane to those parts of the continent where the demand exceeds production and vice versa. The facilitation of cross-border trade of biomethane would increase the producer's opportunities to reach significantly larger markets and enhance the introduction of large scale production plants of biomethane in Europe. Current interpretation under the Renewable Energy Directive (Directive 2009/28/EC) of mass balancing is an important administrative barrier to an increase of cross-border trade and integration of biomethane markets. At the moment, market driven cross-border trade in renewable gas is not possible.

Therefore, the creation of a European biomethane certificate market with the European natural gas network as one single mass balance unit would provide opportunities for market growth within this segment and increase possibilities of significantly lowering the usage of fossil alternatives in Europe.

### COMMIT TO A TARGET

Supportive policy frameworks are crucial to developing biomethane markets. Setting national targets for biomethane production in European countries will increase the possibilities of reaching a carbon-neutral gas supply in 2050. Currently Germany and France are the only GGI member countries to have a target for biomethane production. Setting national targets elsewhere in Europe and not only for the long term, but also for shorter time horizons like for 2025, creates milestones and provides better monitoring and self-control options on the way to the 2050 goal for public and private involvement.

### EXCHANGE EXPERIENCES

There are huge economic benefits in sharing best practice and learning from experiences amongst countries and TSOs. Biomethane markets are in their initial phase of development where experience is gained with different concepts and under various technical and legal frameworks. Industry could benefit from a common knowledge base with regard to the investigation of technologies and costs for direct injection of biomethane into the transmission grid as well as the establishment of reverse-flow technology, i.e., the flow from the distribution network to the transmission network. The differences in experiences in these areas between European countries could be levelled out by systematic knowledge exchange.

### DEVELOP A BETTER UNDERSTANDING

It is crucial to develop a better understanding of the economic basics of biomethane production to create a level European playing field.

Today, biomethane producers work under very different circumstances e.g., different national policy frameworks, regulations in substrate access and European legislation. Support schemes have been very important for the development of the biomethane market. In some countries economic and political barriers prevent any development and there is no viable business model in biomethane production. Good examples can inspire and spur changes and biomethane development. Cross-border sharing of such experiences through national and international organizations should be encouraged.

***CROSS-BORDER BIOMETHANE TRADE IS NEEDED TO ESTABLISH AND  
MAINTAIN THE SUPPLY-DEMAND BALANCE ON REGIONAL AND EUROPEAN LEVELS***



## POWER TO GAS – GREEN ENERGY STORAGE

Working towards a carbon-neutral energy supply in 2050 will lead to an increasing proportion of renewables in the energy mix, with strong preference to wind and solar energy. One challenge with wind or solar energy is that there is limited control over the supply – nature is in charge. So it is almost inevitable that there will be a mismatch between demand and supply. Gas functions as an instantly available back-up in case of shortages and as an efficient storage medium in case of surplus of renewable electricity. By converting excess electricity into hydrogen or, preferably, synthetic natural gas, electricity can actually be stored in gas networks and storage installations. In this way, gas supports the electricity networks to accommodate the large future volumes of sustainable energy excess, helps prevent suboptimal use of costly sustainable energy and contributes to the reduction of CO<sub>2</sub> emissions.

Power to gas (P2G) can be an important technology to achieve a reliable, affordable and sustainable energy supply. P2G is the conversion of renewable electrical power into a gaseous energy carrier. Practically, this means that green electricity is converted into hydrogen (H<sub>2</sub>) by electrolysis and with a possible sequential process of methanation (CH<sub>4</sub>) by the synthesis of hydrogen (H<sub>2</sub>) and carbon dioxide (CO<sub>2</sub>) into synthetic natural gas.

After transformation of power into gas it is possible to store renewable energy for days, weeks or months. Currently 99% of the European large-scale electricity storage is in Pump Hydro Storage but its potential for expansion is limited (to a maximum of 70 TWh in the EU). Pump Hydro Storage requires a suitable site combining geographical height and water availability. Those sites are rare and their exploitation often raises ecological questions.

## ENERGY STORAGE IS A KEY TO ENERGY TRANSITION

P2G as a green energy storage will not be the only solution but it will make an important contribution to the transition from fossil to renewable energy systems. There are many examples for the roles P2G could fulfil: It can be a solution to problems in the electricity sector, such as congestion or balancing challenges. The produced hydrogen can be utilized in the chemical industry or mobility sector, stored in a hydrogen buffer in order to be reconverted into electricity or liquid transport fuels at a later time, or converted into synthetic natural gas. P2G can also overcome electricity transmission capacity constraints and avoid shutdown or startup costs at conventional power plants.

An intensified cooperation between gas and power system operators such as in identifying optimum locations for P2G plants can be an important step towards the convergence of energy systems required for a greener future.

Overall, power to gas does not only offer the possibility to store renewable energy but also to transport it over long distances using the natural gas transport system. Therefore, the total cost of energy systems can be reduced by using these assets that already exist.

## RESEARCH & DEVELOPMENT ARE STILL NEEDED

P2G has gained ground since the first pilot project. Various demonstration projects all over Europe attest to this progress. Nevertheless, further research and development are needed to increase efficiency and lower investment costs for a large-scale roll-out.

Efforts in R&D are expected to bring the greatest benefits in the technology of methanation because synthetic natural gas can be injected into the gas grid without major restriction. The injection of hydrogen is limited for technical reasons. Even if, in general, an admixture of up to 10% by volume of hydrogen to natural gas is possible, the results of a study within the GERG Hydrogen Project (Altfeld/Pinchbeck 2013) indicate that there are slightly lower limits concerning underground porous rock storages and steel tanks in natural gas vehicles than for gas turbines and engines. GGI members encourage and welcome any research aiming at making P2G products compatible with natural gas infrastructure or making infrastructure fit for P2G products – at reasonable costs.

## POWER TO GAS DEMONSTRATION PROJECTS IN GGI-COUNTRIES



## SELECTED PROJECTS OF GGI MEMBERS

Two P2G plants are connected to the grid of ONTRAS. Since the summer of 2014, the hybrid power plant at Prenzlau, Germany, feeds in hydrogen. It is operated by ENERTRAG AG, a wind energy company. The P2G plant at Prenzlau is the world's first power station generating electricity, heat and wind gas. In this hybrid power plant excess power is used to split water into hydrogen and oxygen by electrolysis. With the resulting wind-hydrogen the energy supplier Greenpeace Energy supplies thousands of its wind gas customers. Each hour the system provides up to 120 m<sup>3</sup> of hydrogen.

An additional P2G plant feeds hydrogen into the ONTRAS network in Falkenhagen, Germany, since 2013 and a third one is planned near Grapzow, Germany. One important partner in Falkenhagen is Swissgas, a company partially held by Gaznat. On December 2nd, 2015, GRTgaz and its industrial partners officially announced the launch of Jupiter 1000, the first P2G project linked to the French gas transmission network.

Energinet.dk currently demonstrates long time operation with hydrogen in its gas system and examines long-term effects. Energinet.dk's objective is to determine whether the Danish natural gas infrastructure can be operated stably and safely with varying concentrations (up to 15%) of hydrogen.

*FOR THE  
LONG TERM,  
POWER TO GAS WILL  
PROBABLY BE THE  
CLEVEREST WAY TO  
STORE RENEWABLE  
ENERGY*

## GGI RECOMMENDATIONS: POWER TO GAS AS FUTURE TECHNOLOGY

### INVEST IN EFFICIENCY

Although P2G offers myriad possibilities it still remains a minor topic on the political agenda. Efficiency is the sore point of this future technology. Modern facilities that convert power to hydrogen operate with an efficiency of about 70%. Methanation or the re-conversion to electricity is less efficient and thus more expensive. Nevertheless, P2G technology has been improved in recent years and offers future perspectives that cannot be ignored any longer. Therefore, it is important to further invest in the development of P2G technologies, which will lead to efficiency improvements and decreasing capital expenditures. A greater penetration of P2G plants will create economy of scale and finally reduce costs.

### INFORM THE PUBLIC

It is important to make market players, politicians and the public aware of the benefits of P2G. The discussion of the topic is often limited to the aspects of costs and efficiency. However, to fully understand the chances of P2G on the way to a decarbonised energy system, the public has to be made more aware of the contribution P2G can deliver to meet the challenges in balancing the electricity system facing a surplus of renewable power.

### CREATE A FRAMEWORK

It is necessary to create a regulatory framework at European level to develop markets for synthetic natural gas and hydrogen. New business models are needed to integrate the value of CO<sub>2</sub> reduction costs, the use of electricity that normally would be curtailed and the possibility to avoid investment costs in additional electrical lines into business cases.



## TRANSPORT – GAS IS THE GREENER FUEL

Transport is the source of about 25% of total CO<sub>2</sub> emissions in the EU, when including maritime transport. The EC White Paper on transport and the “Future Transport Fuels” report states that EU transport depends primarily on oil (96%) and that this dependency should be reduced. Furthermore, it is the only sector where greenhouse gas (GHG) emissions have almost continuously grown over the last 20 years and are now about one third above their 1990 levels. Road transport represents 71.3% of the overall transport GHG emissions (EEA 2008).

Natural gas and biomethane for transportation offer great opportunities for reducing CO<sub>2</sub> emissions in the European transport sector in the most economical way. Compressed Natural Gas (CNG) and Liquefied Natural Gas (LNG) are currently the best available alternatives to traditional fuels used for road or maritime transport. Natural gas is abundant, widely available and affordable. It is the greenest fossil fuel with significant reductions in harmful emissions (CO<sub>2</sub>, NO<sub>x</sub>, SO<sub>x</sub>, particulate matter) and its technology is mature. Blending it with biomethane can enhance these positive effects. Especially in bigger cities, problems with particle pollution or noise can be tackled with an increased use of gas as transport fuel. A smarter and harmonized use across Europe of these alternative fuels is required in order to help Europe reaching its goal in terms of improved air quality.

These facts have been recognized by the EU. The “Clean Power for Transport” package establishes that natural gas and biomethane are part of the EU mix of alternative fuels. They are required to substitute oil as energy supply for transport in the long term. Both offer a large potential to contribute to the diversification of transport fuels.

Although natural gas-based mobility has experienced significant (double-digit) growth with around 18 million natural gas vehicles (NGVs) worldwide, the situation in Europe is still lagging with around 1.2 million NGVs (a market share of less than 1%). Italy leads with around 0.9 million NGVs. The room for further development of natural gas as a fuel remains large. The GGI members therefore appreciate the efforts of the automobile manufacturing industry to offer a wider choice of CNG and LNG vehicles on the market.

**NATURAL GAS IS  
THE CLEANEST  
FOSSIL FUEL  
OFFERING  
SIGNIFICANT  
REDUCTIONS IN  
EMISSIONS**

## SITUATION OF NATURAL GAS MOBILITY IN GGI COUNTRIES

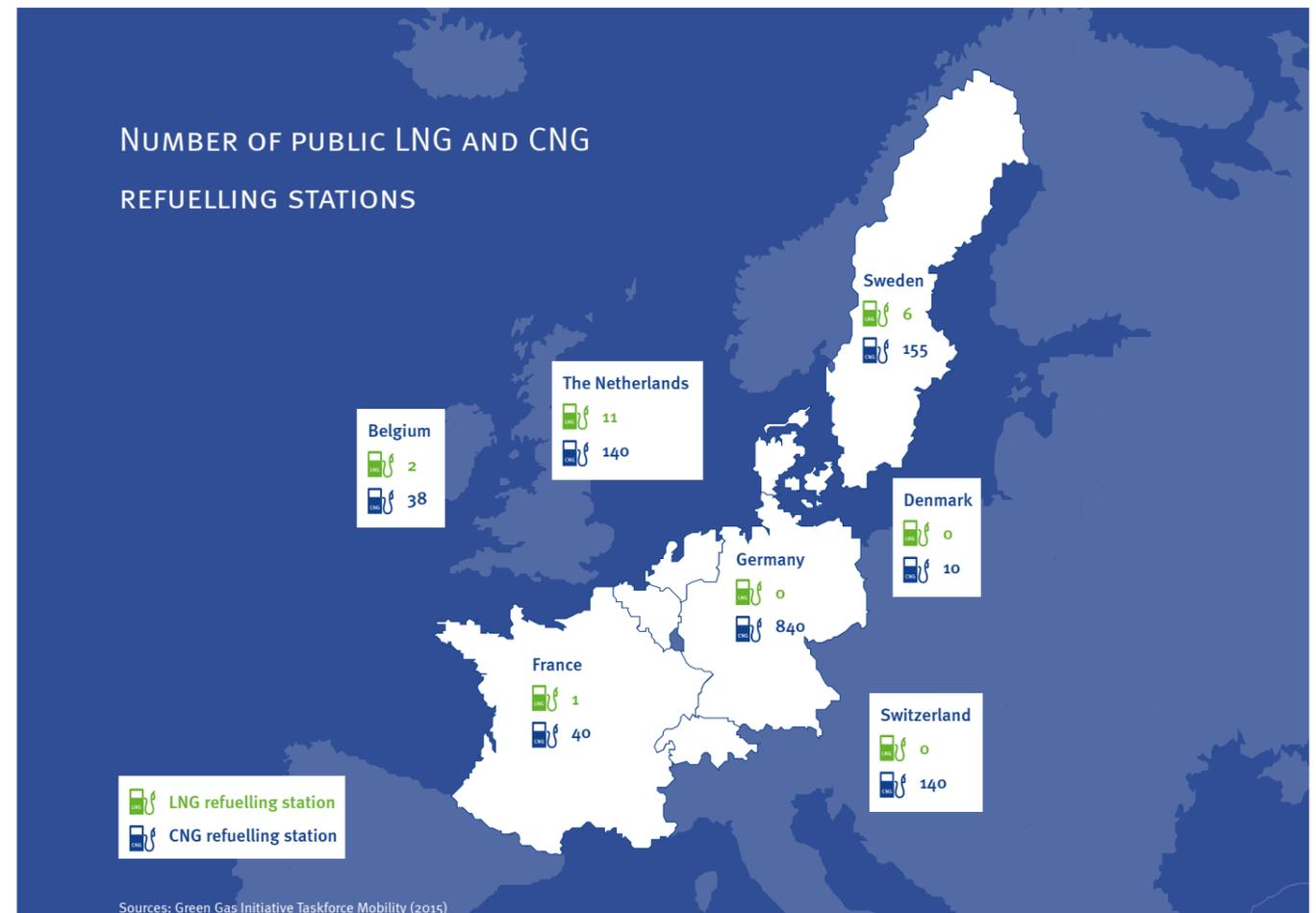
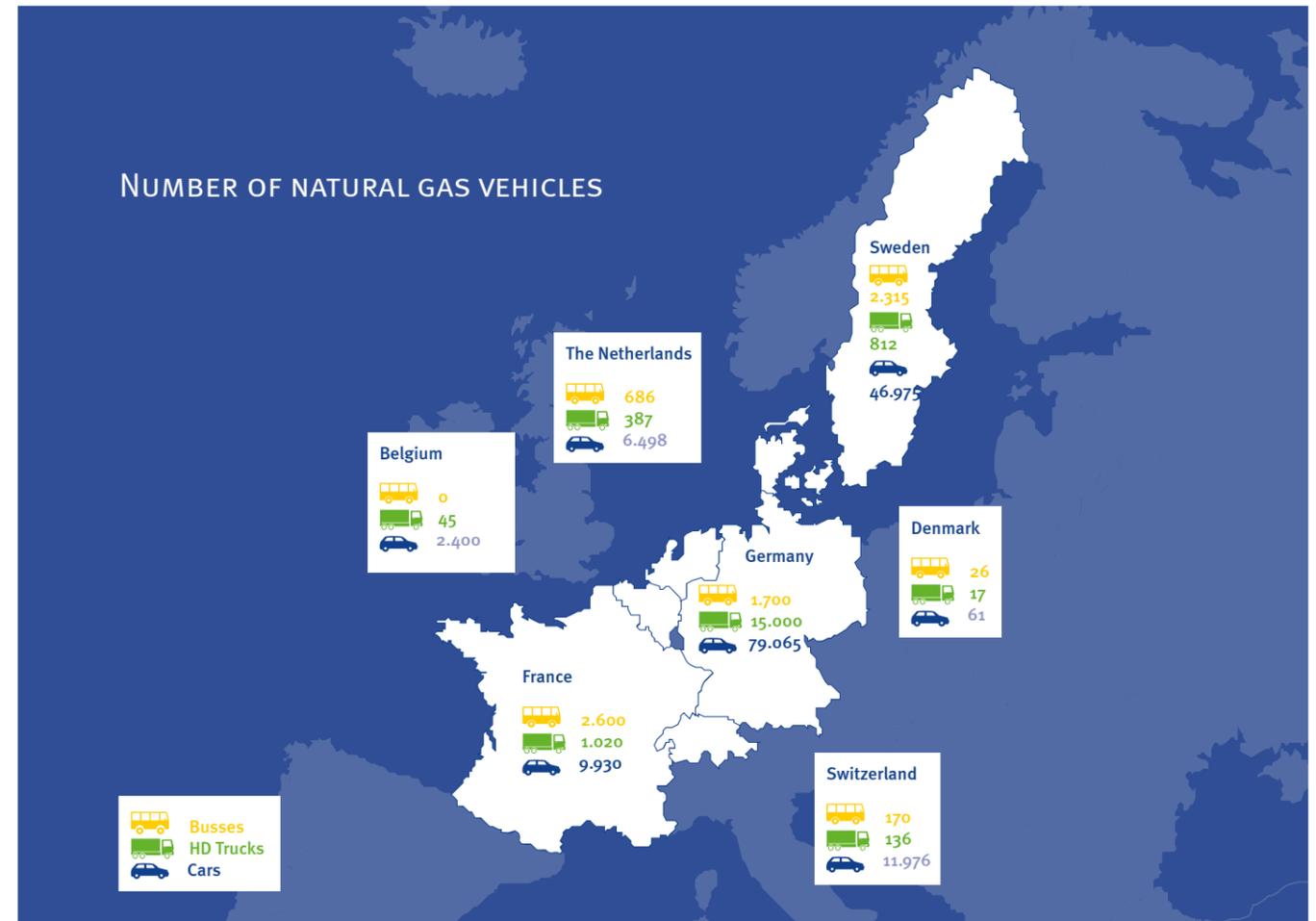
### ROAD TRANSPORT: DIFFERENT APPROACHES IN EUROPEAN COUNTRIES

The situation of natural gas mobility (road transport) in the GGI countries is very diverse and is the result of different approaches with regard to the promotion of natural gas as a fuel.

Support is still needed to enable natural gas as an alternative fuel to gain the market share required for a critical mass, even in countries considered as having the most developed CNG markets amongst GGI countries (like Germany, the Netherlands, Switzerland and Sweden). While the European Natural & Biogas Vehicle Association (NGVA) evaluates that a 5% market share could be reached by 2020, GGI members believe that this figure could be much higher.

The situation with regard to LNG for heavy-duty trucks seems to be evolving in a positive direction in Sweden, the Netherlands and Belgium. If, in countries like Germany, Denmark and Switzerland, the use of LNG in heavy-duty road transport is not developed yet, either because of their focus on the use of natural gas for passenger cars in a nascent stage or because of other priorities, these countries are now becoming more interested in LNG.

In general, LNG market development for heavy-duty transport faces various challenges that still need to be overcome. The weak price signals and the relatively long amortization periods for investments are two important barriers. Very often, potential investors in LNG fuelling stations withhold investment until fleet owners invest in LNG trucks. On the other hand, fleet owners need an attractive refuelling infrastructure before they can invest. Government supported coordination and more information to the greater public are crucial. The Dutch "Nationaal LNG Platform," a national strategy platform supported by the Dutch government, is a good example and could serve as a role model for other countries.



## GGI RECOMMENDATIONS: CNG & LNG MARKETS DEVELOPMENT

### START WITH A VISION

If a new market can be launched based on the sole efforts of first movers and early adopters, the development speed can be increased significantly once authorities have developed a clear vision. The example of the IMO (International Maritime Organization) rules on SO<sub>x</sub> reduction in maritime transport showed how industry could be forced to reconsider its business model based on new emission rules. Many cities and regions across Europe are already role models. The EU directive on the “Deployment of Alternative Fuel Infrastructures” stimulates all member states to develop their action plans and policy frameworks.

### FACILITATE MARKET LAUNCH

Market players should be encouraged to invest in NGVs or in refuelling infrastructures at an early stage. For that reason, the usage of natural gas instead of traditional fuels has to be more attractive. We recommend that authorities facilitate new business developments, provide long-term investment security and reward first movers. A critical mass of first movers can be achieved by using these rewards or regulatory support instruments. As an example, GGI has developed a list of suitable instruments (see Info boxes).

#### EXAMPLES OF FISCAL INSTRUMENTS:



- Creation/extension of long term (5–10 years) road and fuel tax discounts for alternative fuels
- Design of road and fuel tax taking into account all pollutants (CO<sub>2</sub>, SO<sub>x</sub>, NO<sub>x</sub>, particulate matter, noise) and not only CO<sub>2</sub> or engine characteristics (size, power, etc.)
- Tax rebates on the purchase of NGVs
- Exemption from roadway tolls for clean vehicles.

#### EXAMPLES OF REGULATORY INSTRUMENTS:



- Standardization of certification and permit procedures for NGVs, repair and maintenance work shops and refuelling stations
- Priority for NGVs in sensitive areas (e.g., access to city centres, queuing for airport taxis)
- Definition, communication and application of monitoring procedures and fines to ensure the enforcement of new SO<sub>x</sub> emission restrictions for maritime transport

### COORDINATE EFFORTS

In a developing market, there is little space for commercial competition. Market players (Original Equipment Manufacturers, refuelling station operators, energy suppliers, DSOs and TSOs, etc.) should coordinate their efforts. Close cooperation with car manufacturers is a must. In addition, a national or regional platform dedicated to the promotion of CNG and LNG as fuels could be set up.

### WALK THE TALK

Authorities could become a role model by acquiring NGVs and integrating them in their public fleets (public transport, waste collection, ferries, etc.). The same applies to all the stakeholders involved in the development of natural gas mobility. This will not only help to reach the critical mass needed for the market to tip over. By walking their own talk, stakeholders advocating for more natural gas in transport will also gain in credibility.

### SUPPORT BIOMETHANE

As biomethane is 100% CO<sub>2</sub> neutral, blending it with natural gas or using it directly for transport activities allows for an even bigger reduction of CO<sub>2</sub> emissions. Therefore, the production of biomethane should be encouraged with investment support or minimum pricing mechanisms to allow biomethane to be sold at the same price as natural gas.

### INFORM THE PUBLIC

Even in well developed natural gas markets like Germany, the Netherlands and Switzerland, public awareness of alternative fuels could still be improved. Communication and information provided to citizens and companies on the benefits of alternative fuels for the community is paramount – especially concerning the comparability of prices. This is a task for authorities and for market players.

# MEMBERS

The independent gas infrastructure operators Energinet.dk (Denmark), Fluxys Belgium, Gasunie (the Netherlands), Gaznat (Switzerland), GRTgaz (France), ONTRAS (Germany) and Swedegas (Sweden) commit themselves to taking responsibility in supporting a 100% carbon-neutral gas supply in their network infrastructures by 2050.



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