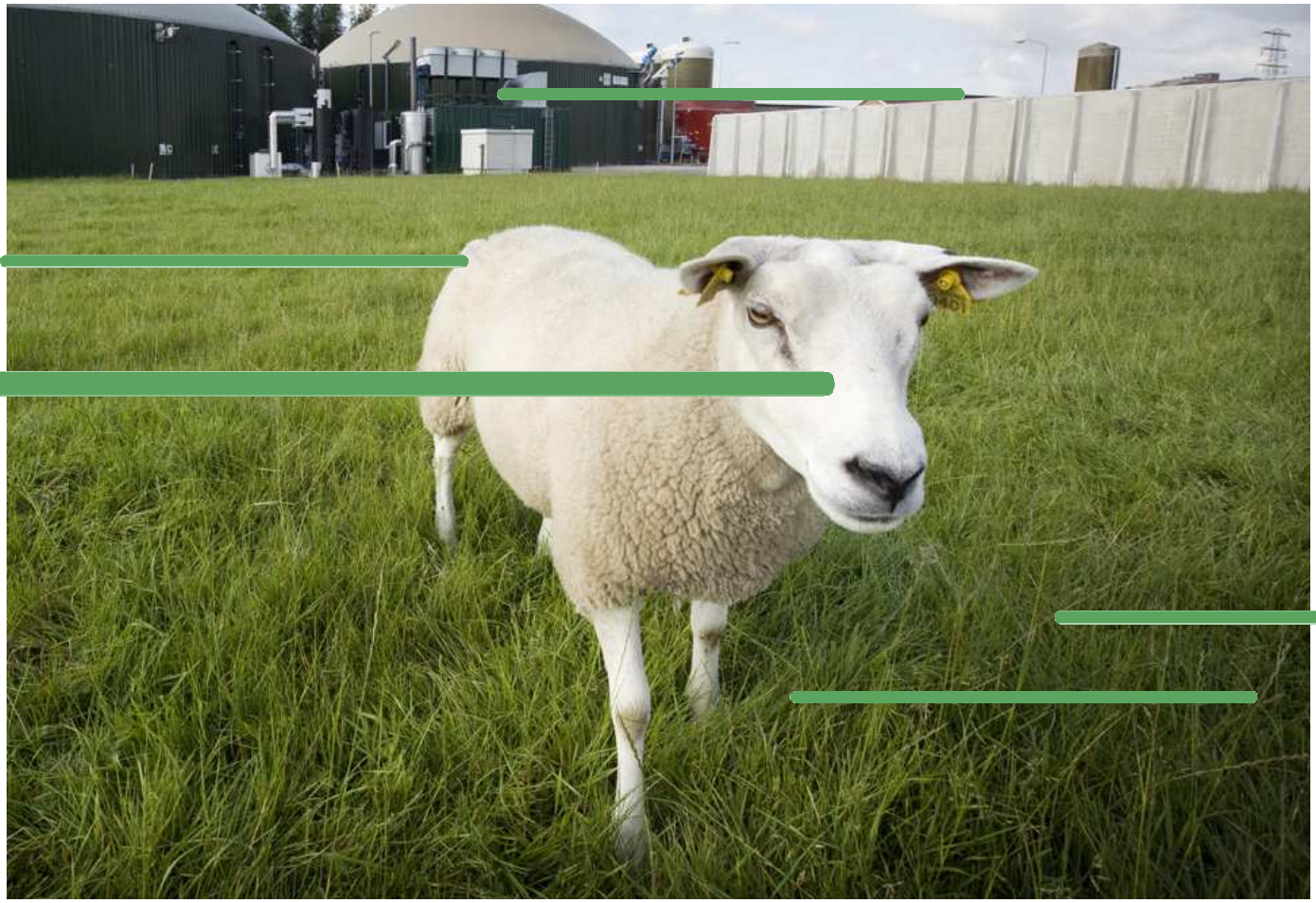
GREEN GAS GRIDS



Proposal for a European Biomethane Roadmap

Work Package 3

December 2013

INTELLIGENT ENERGY EUROPE
FOR A SUSTAINABLE FUTURE

Coordinator: Attila Kovacs

Contact: European Biogas Association

Renewable Energy House

Rue d'Arlon 63-65.

1040 Brussels, Belgium

www.european-biogas.eu

kovacs@european-biogas.eu

Note on legal topics

All legal topics published in this report exclusively serve the purpose of general information and do not refer to individual legal concerns. The authors and other parties involved assume no liability regarding the correctness, timelines, completeness or usability of the information made available. The assertion of claims of any kind is excluded.

This Report has been created within the project GreenGasGrids supported by the Intelligent Energy - Europe programme (contract number IEE/10/235/S12.591589).

Webpage: www.greengasgrids.eu

THE GREENGASGRIDS PROJECT PARTNERS

German Energy Agency - dena (Germany)

Fraunhofer UMSICHT (Germany)

Austrian Energy Agency (Austria)

Energetski Institut Hrvoje Požar -EIHP (Croatia)

Agence de l'Environnement et de la Maîtrise de l'Energie - ADEME (France)

Renewable Energy Agency – REA (UK)

University Szeged (Hungary)

European Biogas Association

Consorzio Italiano Biogas (Italy)

Agentschap NL (The Netherlands)

Krajowa Agencja Poszanowania Energii – KAPE (Poland)

Slovenská Inovacná Energetická Agentúra - SIEA (Slovakia)

Natural Gas Vehicle Association - NGVA

Roadmap for developing the European biomethane production and trade

Content:

Executive summary

This Roadmap has been prepared by the Green Gas Grids Project in the frame of Intelligent Energy Europe. The main purpose of the Roadmap is to draw attention to the unique possibilities offered by upgrading biogas to biomethane and to elaborate the key conditions for dynamic growth of this industry.

Biomethane can be produced from all kind of organic materials and can be used for electricity generation, as a biofuel in transportation and for providing heating and cooling. Biomethane can be blended with natural gas in any proportions and – correspondingly – the available natural gas distribution and storage network can handle biomethane too. The technology for upgrading biogas to biomethane is mature, efficient and safe.

Historically the biogas industry viewed „green" electricity as its main deliverable, while the support systems in nearly all European countries gave preference to local production of electricity instead of upgrading biogas to biomethane. This Roadmap shows the ways how this situation could be reversed, resulting in substantial increase in production and use of biomethane.

While preparing the Roadmap all renewable energy related European Union policy issues (such as environmental and climate protection, sustainability, ILUC, clean fuels for transportation, etc.) have been reviewed. The conclusion of the analysis is that promoting the production and usage of biomethane is in full harmony with the short-, medium- and long term energy and climate policies of the EU.

The IEE GGG project has reviewed the present market status and has thoroughly looked at the obstacles hindering the broader production and application of biomethane. The Roadmap indicates, that - if the necessary actions will be taken - the level of biomethane production could reach 18-20 million m^3, about 3% of the European natural gas consumption by 2030 and biomethane could provide min. 10% of total gaseous vehicle fuel consumption. Whether this role of biomethane would be reached is not a technical or raw material availability question – this is essentially the question of willingness, determination and consequent support by the political decision makers.

The key pre-conditions of realising the full biomethane potential are:

- the national renewable energy support/incentive schemes should treat the “green gas” (biomethane) equally with “green electricity”;
- the National Renewable Action Plans should be extended with a specific biomethane section to quantify the targets and determine the needed measures for achieving them;
- imported biomethane (if properly certified) should receive equal treatment (same support/incentives) with domestic production;
- national/domestic biomethane registries should be established in every biomethane producing country;
- the national/domestic biomethane registries should develop a Europe-wide cooperation aimed at coordination and harmonisation of their activities;
- the European natural gas network should be declared as a single, closed mass-balance unit.

The Roadmap addresses all the above issues along with other questions relevant to the development of the European biomethane industry.

1. Vision

By 2030 the European biogas industry will produce as much “green gas” (biomethane produced by upgrading of biogas and SYNGAS) as “green electricity” and by using the European natural gas distribution network it will be available for consumers all over Europe. It will be used for generating electricity, heating and cooling and as a biofuel in transportation.

2. Mission

By 2030 18-20 billion m^3 of biomethane could be produced in Europe, this would correspond to about 3% of the natural gas consumption of the European Union. The biomethane production will achieve substantially different levels in each European country due to different local conditions. Consumption, on the other hand will be determined by the political and economic environment. Very likely, the level of consumption will differ from the production capacity within the national

borders. It is assumed that biomethane will be used all over Europe in the transportation sector. Biomethane trade should be developed to enable balancing of production and consumption on the European level.

3. Present status and potential

Currently the total biogas production in Europe corresponds to about 14 billion m^3 in natural gas equivalent.[1] The level of total biogas production foreseen for 2020 in the National Renewable Energy Action Plans is about 28 billion m^3 (in natural gas equivalent)[2].

In the middle of 2013 biomethane was produced in 14 European countries and in over 230 upgrading plants with a total capacity of 0,8 billion m^3/year. The produced biomethane is mostly fed into local natural gas grids and used for power generation. Grid injection is in practice in 11 European states (AT, CH, DE, DK, FI. FR, LX, NL, NO, SE, UK), Vehicles are fuelled with biomethane (either pure or in blend with natural gas) in 12 European countries AT, CH, DE, DK, FI, FR, HU, IS, IT, NL, SE, UK). Biomethane is also used for heating purposes either directly or blended to natural gas.

The partners participating in the Intelligent Energy Europe Green Gas Grids project (www.greengasgrids.eu) are convinced that substantially higher volumes of biogas respectively biomethane could be produced without significant impact on food and feed production on cultivated land.

The biomethane production forecast for 2020 and 2030 is provided in Attachment 1.

See also: "Report on Assessment of Biomethane Potential" by Green Gas Grids project.

The production of biomethane is not and will not be equal to the national demand in various countries. The development of a cross-border trading system for biomethane would provide a solution for addressing this discrepancy between national supply and demand

[1] Biogas Barometer by EUROBSERV'ER December 2012
[2] National Renewable Energy Action Plans: EBA's evaluation of the biogas contribution (www.european-biogas.eu)

levels, similar to the cross-border trading system for renewable electricity.

Currently the cross-border trade of biomethane is very limited; it has a local, sporadic character. In most cases the international biomethane trade is realised through physical road transport (rather than using the natural gas pipeline network). A number of important factors are limiting the cross-border biomethane trade, such as

- without an appropriate international registration system the mass-balancing requirements cannot be met,
- the support incentives (financial and other) are restricted to the domestic biomethane producers and users only, imported biomethane does not qualify for support in most of the European countries,
- the available incentive schemes are giving strong preference to "green" electricity production/use as opposed to "green" gas production/use.

The following countries have established biomethane registries or certification schemes so far:

AT: Biomethan Register Austria (AT)
CH: VSG (Federation of Swiss Gas Industry)
DE: Biogasregister
DK: Energinet
FR: GzDF
NL: Vertogas
UK: Green Gas Certification Scheme
Biomethane Certification Scheme

For the biomethane potential see Attachment 1.

4. Goals and objectives:

In order to pave the way for the envisaged biomethane production and use the following issues must be resolved and the following key barriers should be removed:

4.1. The policies of EU institutions and governments related to biomethane

The current energy policy framework is summarised in the three headline targets to be achieved by 2020:

(1) an EU based target for GHG emission reductions of 20% relative to emissions in 1990;

(2) a 20% share for renewable energy sources in the energy consumed in the EU with specific target for the Member States;

(3) 20% savings in energy consumption compared to projections. In addition, there are specific 2020 targets for renewable energy for the transport sector (10%) and decarbonisation of transport fuels (6%). The National Renewable Energy Action Plans provided by the governments of the Member States should ensure reaching those targets on the EU level.

However, the Green Paper[3] „A 2030 framework for climate and energy policies" draws attention to the need for „*new measures in most Member States to achieve their 2020 targets reflecting the scaling back of support schemes and more difficult access to finance in the context of the economic crisis."*

The referred Green Paper also declares that *"the 2030 framework should take into account the longer term perspective which the Commission laid out in 2011 in the Roadmap for moving to a competitive low carbon economy in 2050[4], the Energy Roadmap 2050[5], and the Transport White Paper[6]. The European Parliament has adopted resolutions on each of the Roadmaps. These Roadmaps were developed in line with the objective of reducing GHG emissions by 80 to 95% by 2050 compared to 1990 levels as part of necessary efforts by developed countries as a group."*

The scenarios in these Roadmaps suggested the following key findings:

- By 2030 GHG emissions would need to be reduced by 40% in the EU to be on track to reach the GHG reduction goal of between 80-

[3] [COM (2013) 169]
[4] [COM (2011) 112 dated 08.03.2011]
[5] 2050 Energy Roadmap COM (2011) 885 final]
[6] Roadmap to a Single European Transport Area COM(2011) 144 final (28.03.2011)

95% by 2050, which would be consistent with the internationally agreed target to limit atmospheric warming to below 2℃.

- Higher shares of renewable energy, energy efficiency improvements and better and smarter energy infrastructure are "no regrets" options for transforming the EU's energy system.
- For renewables, the policy scenarios in the Energy Roadmap 2050 indicate a share of around 30% of final energy consumption in 2030.

The 2050 Low Carbon Economy Roadmap[7] suggests that a 40% reduction in emissions by 2030 compared to 1990 would be cost-effective. A reduction of less than 40% would increase the long-term costs of decarbonising the economy. The roadmaps also suggest that GHG reductions of 40% by 2030 can be achieved without unduly increasing the costs for the EU energy system.

The Energy Roadmap for 2050 has shown that the share of renewables in the energy system must continue to increase after 2020. *„The analysis of all scenarios shows that the biggest share of energy supply technologies in 2050 comes from renewables. Thus the second major pre-requisite (Note: improving energy efficiency is the first) for a more suitable and secure energy system is a higher share of renewable energy beyond 2020. In 2030, all the decarbonisation scenarios suggest growing shares of renewables of around 30% in gross final energy consumption*".

The Green Paper[8] does not confirm the 30% renewable energy share as target for 2030, instead it states: *„A 2030 target for renewables would have to be carefully considered as many renewables sources of energy in this time frame will no longer be in their infancy and will be competing increasingly with other low-carbon technologies. Any target or policy for renewables will have to take into account the growing evidence-base on sustainability, costs, the state of maturity of technologies and its innovation potential."*

[7] "A roadmap for moving to a competitive low carbon econimy in 2050" COM(2011) 144 final dated 28.03.2011)
[8] [COM (2013) 169]

The Commission will likely introduce a new climate and energy package for 2030 in 2014 and the relevant European Union decisions may make some adjustments in this Roadmap necessary.

„All scenarios in the 2050 Energy Roadmap show that electricity will have to play a much greater role than now almost doubling its share in final energy demand to 36-39% in 2050... the power generation system would have to ... achieve a significant level of decarbonisation already in 2030 (57-65% in 2030 and 96-99% in 2050) …The share of RES in electricity consumption reaches 64% in a High Energy Efficiency scenario" [9].

4.2. The contribution of biomethane

The partners participating in the Intelligent Energy Europe Green Gas Grids project (www.greengasgrids.eu) believe that biomethane can and should play an important role in achieving these EU political targets. Upgrading biogas to biomethane and injecting it to the natural gas grid offers the most feasible possibility for storing renewable energy source and applying it to renewable energy resources based electricity generation at times of need (thus contributing to compensation of wind and photovoltaic electricity production fluctuations). Under these considerations renewable energy source based electricity generation will likely remain the main form of using biomethane in the future.

Another major biomethane application area is for biofuel in transportation. The Communication from the European Commission on the status of renewable energy in the European Union[10] specifically underlines the importance of developing the production of advanced biofuels. "Advanced biofuel" means a biofuel commonly referred to as "second generation" or "third generation" and shall not include any conventional biofuels. Biofuels produced from cellulosic materials contained in conventional crops, or in the co-products produced by conventional biofuel processes, shall be advanced biofuels. With further development of anaerobic digestion and SYNGAS (gasification of biomass) technologies the bulk of future biomethane production will meet the criteria of "advanced biofuel" and will gain an increasing share amongst other biofuels in the forms of blends with natural gas (CNG/CBM and LNG/LBM).

[9] [COM (2011) 885 final].
[10] [COM (2012) 271] dated 06.06.2012

The Communication[11] from the Commission also underlines that "*significant further use of biomass requires additional measures to ensure its sustainability*" and "*the Commission will investigate the most appropriate use of bioenergy after 2020 in a way that is consistent with the EU energy and climate ambition to 2030 while fully taking into account environmental, social and economic considerations*".

The European Alternative Fuels Strategy[12] from 24 January 2013 praises the resource-efficiency and environmental benefits of biomethane. The communication aims at increasing diversification of transport fuels by means of pursuing biofuels, electricity, hydrogen and natural gas including biomethane. The accompanied proposal for a directive on the deployment of alternative fuels infrastructure prompts Member States to have a sufficient number of publicly available refuelling points for gas vehicles.

The Green Paper „A 2030 framework for climate and energy policies"[13] raised the possibility of introducing a sole CO_2 reduction target within the 2030 EU energy framework. This evokes strong concerns among the renewable energy industries. Pursuing only a certain CO_2 reduction level would send an environmentally dangerous signal to the European society and industries promoting technologies with strong geological limitations such as nuclear and CCS. In addition to CO_2 savings and other environmental benefits, renewable energies improve security of supply and employment.

Biogas and biomethane deserve specific attention and specified support among the renewable energy sources while these are products of low-carbon technologies securing the closure of natural circuits. The biogas/biomethane industry can significantly contribute to further development of rural areas too.
Due to the constant technical development the production costs of electricity from some renewable technologies – like wind and solar – are decreasing. However, renewable energy industries still require long-term commitment both from the EU and national politics. This is especially true for biogas/biomethane where the fluctuations of

[11] [COM (2012) 271]
[12] "Clean Power for Transport: A European Alternative Fuels Strategy" [COM (2013) 17 final dated 24.01.2013]
[13] [COM (2013) 169]

agricultural production and prices have a direct influence on feasibility. Biomethane can be competitive with its fossil equivalent (natural gas) only in special cases. On the other hand biomethane as transportation fuel is definitely cost competitive with the liquid biofuels (biodiesel and bioethanol) on energy equivalent basis.

Only ambitious and legally binding targets provide investors with the security for financing decisions and encourage Member States to further develop biogas/biomethane technologies and maintain their support schemes in the best possible way for the envisaged entire period for which the support/incentive schemes served as basis of investment decisions. A sign of permanence and commitment in form of long-term binding targets would also help prevent highly damaging disturbances caused by the retroactive changes made to national support schemes which are currently observed in several EU states.

In order to realise the full potential it is crucially important that the European Union maintains a reliable policy environment for biogas/biomethane producers, technology developers and equipment manufacturers. Biogas/biomethane investors require stable conditions for more than a decade - otherwise these capacities will not be built and operated. (Stability here means that the framework relevant for the project, mainly the support/incentive scheme valid at the time of construction and commissioning must not be changed negatively during the lifetime of the projects).

At national levels, only a few EU Member States have set explicit targets for biomethane. Sweden has a target to replace all fossil fuel in transportation by 2030, Denmark has set a target of 2,0 PJ biomethane production by 2030, the Netherlands 2020 target is 670 million m^3 biomethane consumption. According to the energy & climate strategy of the government of Finland 10% of natural gas should be replaced by 2025 with bio-SNG made from wood and injected into the natural gas grid. On the other hand, the previously announced ambitious plans of Germany (replacing 6% of national gas consumption with biomethane by 2020 and 10% by 2030) are being revised.

At the European level, biomethane is seldom explicitly mentioned in policy and legislative papers; it is usually included in the terms of natural gas or biofuels and even ignored in modelling work and impact assessments.

4.3. Support systems

Under the current market conditions, biomethane cannot compete with natural gas in sales price except for special cases. Nevertheless, biomethane is definitely competitive with liquid biofuels and renewable electricity (on energy unit basis) if similar incentives are granted.

The current support schemes that have been set up for renewable energies around Europe tend to be limited to “green” electricity while the grid injection of biomethane is most often neglected.

It is obvious that the production of biomethane would increase at substantially higher rates if (similar to “green” electricity) feed-in-tariffs for biomethane grid injection were introduced in every EU member states. On the other hand, it is up to the national governments to decide which forms and means of support to apply for achieving the targeted levels of biomethane consumption on their territories.

Currently two countries (France and United Kingdom) have introduced feed-in-tariffs for biomethane injection into the natural gas pipeline network at level which make the production of biomethane economically comparable with the generation of “green” electricity.

In the UK biomethane support is covered under the Renewable Heat Incentive[14] (RHI) for supplying heat or injecting biomethane to the gas grid, or the RTFO for transport fuel.[15] In 2013 the RHI provides a 7,1 pence per kilo-watt hour feed-in-tariff on top of the prevailing market value of methane. In France the biomethane feed-in-tariff is dependent

[14] “Non-Domestic Renewable Heat Incentive” [DECC (2013) dated 27th February 2013]
[15] Renewable Transport Fuel Obligation Guidance Version 6 [DECC (2013), dated April 2013]

on the size (biomethane producing capacity) of the producing plant and on the category of feedstock used. The feed-in-tariff is in the range of 45-95 EUR/MWh for landfill plants and in the range of 69-125 EUR/MWh in anaerobic digestion plants while preference is given to smaller size units and to units processing organic waste materials.

Biomethane feed-in-tariffs are not the only means for promoting the production of biomethane. In Germany and Austria – for example – biomethane producers are entitled to receive a "technology bonus" if their product is used for generating renewable electricity. Other countries (like Sweden) provide tax relief and other incentives.

The cross-border biomethane trade will broadly develop only if imported biomethane will be treated as equal to biomethane produced domestically. Any support provided in a EU Member State to locally produced biomethane (FIT, tax benefit, etc.) should be provided to biomethane imported from another EU Member State in the same way and extent - always under the condition that the imported biomethane carries all necessary attributes and this is confirmed by the competent national/domestic registry in accordance with the rules agreed among the registries. The documentation of the GHG reduction in CO_2 equivalent could be the basis of granting equal support.

It is principally important that double support and double counting must be excluded. The general rule should be the exclusion of subsidies to biomethane production in the country of production in case biomethane is being exported to another country. Following this principle any investment subsidy/financial support granted in the country of production must be clearly reported by the relevant national/domestic registry to the national/domestic registry acting in the country of final consumption.

Financial support to imported biomethane may become a domestic political issue if such support to imported product hinders the domestic biomethane production. On the other hand, the financial support (or the application of other incentives) will be accepted if the import is needed to meet national renewable energy/biofuel targets which could not be fulfilled without importing.

4.4. National/domestic biomethane registries

The monetary value of biomethane is the sum of its physical value and its intrinsic (green, renewable, sustainable) value. The main challenge of biomethane trade (especially of cross-border trade) is that the physical and intrinsic values do not move together. It is the task of biomethane registries to provide trustworthy documentation which certifies the special (renewable) features of the product. The national/domestic biomethane registries are the competent bodies to provide for such documentary confirmation within the boundaries of their national borders. This documentation is issued in accordance with the domestic legal, regulatory and market requirements.

The establishment of national/domestic biomethane registries in all European countries producing biomethane is strongly recommended as an important tool supporting large-scale biomethane development and cross-border trade. The national/domestic biomethane registries provide professional, reliable, transparent and independent documentation and strengthen market confidence.

The national governments may elect not to declare the establishment of national/domestic biomethane registries mandatory but still set up a regulation which provides access to financial and other incentives only in case the production is properly certified by an accepted and qualified registry.

It is also possible that the national regulator itself handles the support claims, without involvement of registries. This is the case presently in the UK where the biomethane producers file a claim for the RHI support directly with the regulator (Ofgem) independent of any requirement to register the biomethane in any registry.

4.5. Cross-border cooperation mechanisms

The Renewable Energy Directive 2009/28/EC from 23. 04. 2009 contains the concept of cross-border cooperation mechanisms that enable renewable energy produced in one Member State to count towards the target of another.

Directive 2009/28/EC Whereas (25): ”*Member States have different renewable energy potentials and operate different schemes of support*

for energy from renewable sources at the national level. The majority of Member States apply support schemes that grant benefits solely to energy from renewable sources that are produced on their territory. For the proper functioning of national support schemes it is vital that Member States can control the effect and costs of their national support schemes according to their different potentials. One important means to achieve the aim of this Directive is to guarantee the proper functioning of national support schemes, as under Directive 2001/77/EC, in order to maintain investor confidence and allow Member States to design effective national measures for target compliance. This Directive aims at facilitating cross-border support of energy from renewable sources without affecting national support schemes. It introduces optional cooperation mechanisms between Member States which allow them to agree on the extent to which one Member State supports the energy production in another and on the extent to which the energy production from renewable sources should count towards the national overall target of one or the other. In order to ensure the effectiveness of both measures of target compliance, i.e. national support schemes and cooperation mechanisms, it is essential that Member States are able to determine if and to what extent their national support schemes apply to energy from renewable sources produced in other Member States and to agree on this by applying the cooperation mechanisms provided for in this Directive."

The EU endeavours to further facilitate cross-border cooperation by increasing harmonisation between the national support schemes for renewable energies: The new state aid guidelines that are currently being drafted to apply from 2014 and the future guidance for support scheme reforms promote converged schemes and opening of the schemes to renewable energy produced in other European countries.

The envisaged Europe-wide cooperation among the national/domestic biomethane registries follows the concept of cross-border cooperation as foreseen in the RED.

4.6. Sustainability

A successful European cross border biomethane market relies heavily on environmentally and economically sustainable production across the

entire biomethane lifecycle, without maintaining long-term sustainability the biomethane industry cannot develop on a large scale.

The prevailing EU regulations are principally different for biofuels and solid/gaseous biomass used for generating electricity and for heating/cooling purposes. The sustainability criteria for biofuels are legally binding, while those for solid/gaseous biomass are currently implemented at the discretion of Member States. This Roadmap aims to promote sustainable biomethane production and trade for all applications reflecting the expectation that in the future all biomethane applications will be subject to meeting sustainability criteria.

4.6.1. Sustainability regulation for biofuels (including biomethane used in transportation)

The Renewable Energy Directive (RED) sets out in Article 17, 18, 19 and Annex V the sustainability criteria for biofuels and bioliquids. The legally binding criteria apply across the European Union (EU) and do not allow for additional criteria to be imposed by Member States. Biomethane used as transportation fuel falls directly under these stipulations.

All biofuels and bioliquids produced within the EU must comply with the sustainability criteria specified in the RED in order to receive government support or count towards mandatory national renewable energy targets.

The set of sustainability criteria aims to promote (vehicle fuel designated) biomethane production in a sustainable form by focusing on several key areas:

- Reduction in GHG emissions
  - GHG emissions savings from the use of biofuels and bioliquids to be at least 35% compared to fossil fuels.
  - Rising to 50%, January 2017.
  - Rising to 60%, January 2018.
- Biodiversity
  - Raw material may not be obtained from land regarded/classed as having high biodiversity,

  - May include: primary forest, designated nature protection areas, highly biodiversity grassland.
- Land of high carbon stock
  - Raw material may not be obtained from land with high carbon stock (after January 2008).
  - May include: wetlands or highly forested areas.

4.6.2. Sustainability recommendations for solid/gaseous biomass

In order to comply with Article 17(9) within the RED the Commission was required to report on sustainability schemes for the use of solid and gaseous biomass for energy other than biofuels and bioliquids. The recommendations broadly follow the criteria in the RED focusing on several key areas.

- Protection of biodiversity land
- Protection of high carbon stock land
- GHG emissions savings (in % terms) as stated in the RED
- Differentiation of national support schemes in favour of installations that achieve high energy conversion efficiencies
- Monitoring of the origin of biomass

Despite initial indications of a potentially EU wide binding sustainability criteria for solid and gaseous biomass in electricity, heating and cooling, the criteria is still assessed solely through non-mandatory voluntary schemes.

European Commission's efforts to establish sustainability criteria for solid and gaseous biomass and to update and extend the GHG default values are included in Annex V. It is crucial for the investors that clear and scientifically sound criteria are being set up in order to guarantee predictability and long-term investment security. The methodology has to be designed in a way that the greenhouse gas emissions for all the different feedstocks and their mixtures can be calculated easily with low administrative burden.

It is expected that the European Commission will propose a Directive on sustainability criteria for solid and gaseous biomass used in electricity and/or heating and cooling and biomethane injection into the natural gas pipeline grid. Such Directive could surpass the binding

sustainability criteria for biofuels and bioliquids stated in both the RED Directive 2009/28/EC and the Fuel Quality Directive (FQD) 98/70/EC. Thus one overarching Directive applicable to installations greater than or equal to $1MW_e$ or $2.5MW_{th}$, and to all biogas installations would be created.

4.6.3. Substrates used for biogas/biomethane production

In the EU, the biofuel production does not compete with food production: there is enough surplus land to produce both. This opinion is also acknowledged by the Commission's proposal for the new Common Agricultural Policy (CAP)[16]. According to the proposal, a mandatory set-aside land (7%) should be reserved for ecological focus areas where non-food crops are cultivated[17].

Therefore biomethane produced from any substrates contributes to the Commission's energy and environment targets. Agricultural biomethane from energy crops and manure (co-digestion) has proved to be the most energy-efficient biofuel: one hectare of land used for biomethane production allows a running distance of a gas vehicle longer than then with the production of any other biofuel including advanced biofuels. Furthermore, there is no need for developing new costly technologies since biomethane-fuelled vehicles, unlike electric vehicles, can fully profit from existing facilities provided by natural gas infrastructure.

Crops grown for biogas/biomethane can also be integrated into crop rotations which improve the overall productivity and flexibility of the farm, including subsequent food crops, while reducing emissions from agriculture. It should therefore not be assumed that crops for biogas take land out of food production – the related European regulations (including the proposed ILUC calculation methods) need to recognise models and technology which use land efficiently to produce food and fuel, and the wider environmental benefits which more sustainable farming practices can bring, such as improved biodiversity and soil quality.

Catch crops or second crops (e.g. ley, buckwheat, ryegrass etc.) contribute to biodiversity and deliver valuable environmental

[16] The Commission's Communication: „The CAP towards 2020" [COM (2011) 625 final]
[17] [COM(2011) 625 final/2, Article 32]

advantages as they can be integrated into crop rotations and in this way improve the overall productivity of the farm. Under these considerations the use of catch crops should be promoted even though they may not always be able to reach the 60 % threshold of greenhouse gas savings due to their low yield per hectare. Thus, for the evaluation of biogas/biomethane potential, it is essential that also the crop rotation systems are taken into account. Besides catch crops there are other ways and means to expand the raw-material base of biogas/biomethane production without negatively impacting the food and feed production potential.

Dedicated energy crops are an important feedstock for AD as they offer a high level of energy generation. Such crops can also be sustainably integrated either by using substantial parts of (animal) waste or within local farming practices using crop rotation. When produced from agricultural waste, biomethane may even further reduce CO_2 emissions due to the fact that methane from naturally decomposing manure, slurry and waste is prevented from being released into the atmosphere. Morover, methane is a low carbon fuel. The so-called manure credits (assigned in return for the avoided raw manure emissions) must be considered when the GHG balance of manure based biogas production is calculated.

4.6.4. Digestate

When assessing the sustainability of biomethane production and calculating the GHG emissions related to biomethane production, the positive effect of digestate, the by-product of anaerobic digestion, should be taken into account: the digestate is a high value bio-fertiliser substituting artificial fertilisers and helping to reduce emissions during storage and land application of untreated manure.

The biogas production with anaerobic digestion generates digestate with a high fertiliser value. Use of local feedstock for biogas and digestate production for fertilising purposes closes nutrient cycles in regional ecosystems and omits CO_2 emissions that would be released during the production of mineral fertiliser. Thus, this positive fertilising effect of the digestate should be taken into account based on its nutrient content, and it should be allocated based on monetary value. It is needed that the update of Annex V to the RED considers the fertilising effect of digestate.

It is important to consider also the avoided emissions owing to biogas production when greenhouse gas emissions for biogas technology are calculated. When digestate is spread on fields, instead of raw manure, methane emissions can be reduced and odours mitigated.

5. Action plan

5.1. National/domestic biomethane registries

The government of European countries producing biomethane should take care of establishing national/domestic biomethane registries. Such registries may be set up either on mandatory basis or as a result of voluntary cooperation among the market participants. In any case the national/domestic biomethane registries should be independent from individual market actors and should demonstrate a high professional level. The IEE GGG Project (and a respective follow-up project) should provide the assistance for organising these national/domestic registries based upon the experience of the countries already operating such registry.

5.2. Cooperation among the national/domestic biomethane registries

A functioning European biomethane market is highly dependent on a transparent, reliable and effective system of comprehensive information transfer among the national/domestic biomethane registries across national borders. The cooperation between the national/domestic registries is needed to create the necessary framework conditions for such a transfer of information. For this purpose the national/domestic registries cooperating in the creation of the European biomethane trading scheme should agree on a coordinated set of criteria/attributes all of them apply in the same way and should harmonise their procedures.

The broad cooperation and coordination among national/domestic biomethane registries will be the first important steps towards creating the conditions for a free cross-border biomethane trade in Europe.

Key issues of cooperation among the national/domestic biomethane registries:

- to create the best possible, most efficient conditions for transfer of information related to biomethane transactions among the national/domestic biomethane registries,
- to establish a harmonised methodology by which the complete information pertaining to biomethane "Guarantees of Origin" is transferred between each registry,
- to ensure highest possible compatibility between the national/domestic registration systems,
- to set the conditions for mutual acceptance of Guarantees of Origin for biomethane (at the start on bilateral, later also on multilateral basis),
- to set up a harmonised set of rules for the exchange of information between registries, if possible a set of rules to be applied by all registries.

The criteria/attributes represented and documented by a "Biomethane Guarantee of Origin" should correspond to the criteria/attributes which must be fulfilled by imported biomethane in order to be qualified for support in individual member states of the European Union and European Economic Area.

The Partners in the international cooperation of national/domestic biomethane registries should agree on minimum criteria to be included in the Guarantees of Origin.

Exclusion of double counting and registration

On the domestic markets each biomethane registry is carrying the responsibility for the exclusion of double counting. The same has to be secured in the frame of the international cooperation among the national registries.

In international context it is strongly preferred that only one national/domestic registry from one country is a party to the international cooperation. (In case of the existence of several registries in one country, they should agree among themselves to appoint one of them to represent the country in the international cooperation of the registries).

Obviously, the mass-balance circle must be closed also in case of cross-border biomethane transactions. This requires that the book-out step of the chain is reported back to the national registry which

has issued the Guarantee of Origin at injecting the biomethane into the natural gas grid.

Exclusion of double counting in international context means that the volume of biomethane should not be counted towards meeting renewable energy/biofuel targets and commitments in *both* the producing *and* consuming countries. The easiest way to handle this in cross-border trade would be the **general acceptance of the principle that biomethane will be counted towards the national targets and commitments exclusively in the country of final consumption**. This again adds to the responsibilities of the national biomethane registry acting in the country of production: the registry should also be able to confirm and document that the volume of biomethane for which it has transferred the European Biomethane Guarantee of Origin to its counterpart registry has not been counted for in the country of production (as part of renewable energy/biofuel supply).

5.3. Coordination with stakeholders

The deliverables of the working groups engaged in the cooperation among the biomethane registries should be discussed in workshops organised with the participation of stakeholders involved in biomethane production, transportation and use on the European market.

5.4. European mass-balance accounting unit

Mass-balance is an important factor in registering quantities of biomethane. In a mass balance system feed-in and withdrawal are recorded in the relevant registries and audited. Under Directive 2009/28/EC Article 18 (1) (“Mass-balance”), a mass-balance system is defined as an electronic registry which is used to trace the chain of custody (injection – trade – offtake) of biomethane injected into the natural gas grid. Individual molecules are not tracked; assignment of the right of withdrawal (“trade”) suffices to document transfer. In a mass-balance system Guarantees of Origin cannot be traded in isolation from a physical quantity.

A crucial pre-condition for eliminating the hurdles on the way of free biomethane trade is to recognise the European natural gas network as one single balance-circle (Bilanzkreis), i.e. to accept that the mass-balancing requirement is fulfilled as soon as the respective volume of

biomethane has been taken out of the European natural gas network (and this transaction has been properly certified).

The respective EU legislation is needed to recognise the European natural gas network as one single mass-balance accounting unit (Bilanzkreis), i.e. to accept that the mass-balancing requirement is fulfilled as soon as the volume of natural gas corresponding to the injected volume of biomethane has been taken out of the European natural gas network (and this transaction has been properly registered and certified).

In a system where the European natural gas network is recognised as a single, closed mass-balancing unit the national/domestic biomethane registries participating in the international cooperation will have to certify and confirm two key facts:

a) the specified volume of biomethane (expressed in energy equivalent) **has been produced and injected** into the natural gas pipeline network in accordance with all related regulations on the territory of their country AND

b) the specified volume of biomethane **has not been taken out** from the natural gas pipeline network on the territory of their country.

5.5. European electronic biomethane platform

The national/domestic registries should jointly develop a common, transparent electronic platform for registering and transferring all related information among themselves. This will require investment both for hardware and software. Such electronic platform would serve all-European interests and – as such – should get financing from EU funds as long as the European cross-border biomethane trade does not reach the magnitude where the system could be financed from the turnover.

5.6. CNG/LNG infrastructure

The network of natural gas filling stations is still a barrier for the introduction of more natural gas driven vehicles in many European countries. The total number of natural gas vehicles (NGVs) in the EU-28 amounts to 1,1 million as of June 2013, being this running park quite

scattered between different member states, while the total number of filling stations is around 3.000.

The GGG Project partners welcome the measures proposed in the European Commission's Clean Power for Transport Package which aims at fostering the European gas infrastructure for transportation fuel application.

The consumption of natural gas (together with biomethane) as vehicle fuel is currently at the level of around 3 billion m^3/year. It is expected by the partners participating in the Intelligent Energy Europe Green Gas Grids project (www.greengasgrids.eu) including the Natural Gas Vehicle Association and the European Biogas Association that the share of natural gas/biomethane mixtures will be increased to 10-15 billion m^3 by 2020 (reaching 5% market share in the transport sector) and 25-30 billion m^3 by 2030 (reaching 10% market share in the transport sector) The development of European biomethane production and trade will enable at least 10% renewable share in CNG/LNG vehicle fuel consumption.

5.7. Life Cycle Assessment

The Lifecycle Assessment methodology must be applied everywhere in the biomethane industry, it has the potential to provide several benefits:

- stops the problem of shifting environmental impacts;
- helps to minimise secondary effects if used in conjunction with design;
- helps to reduce environmental pollution and to improve resource use;
- enables understanding of true and total costs;
- improves profitability through introduction of environmental management techniques (including LCA).

The RED methodology for LCA was developed for calculating the GHG emissions from solid biomass and biogas used to generate heat and electricity, and covers every step from feedstock production through to energy generation. This enables biomethane producers and other stakeholders to analyse the life cycle emissions from bioenergy using different feedstocks, production processes and transport methods and

to assess the emissions associated with biomethane production across the bio-energy lifecycle from cultivation to processing and grid injection.

Further development and broad application of RED Lifecycle Model in relation to all biomethane producing units with capacity above 100 m^3 biomethane/hour is to be encouraged.

The application of this methodology in all Member States will:

- help biomethane producers to report emissions consistently and fairly,
- provide full compatibility with the RED for calculating GHG emissions,
- enable full assessment of the performance of feedstocks for anaerobic digestion and SYNGAS technology in terms of targets for improving life cycle emissions.

5.8. Measures for reducing GHG emissions related to biogas/biomethane production

The measures aimed at limiting/reducing GHG emissions during the life cycle of biomethane and SYNGAS production should be developed and the broad dissemination of information on best practices should be realised. Such measures include:

- Limitations on processing energy crops (catch crops, perennial crops, biomass with high hemicelluloses content, etc.);
- Digestate use (when plant operators use or sell their digestate as a fertiliser for crops and pasture, costs_and emissions of artificial fertilisers can be saved and mitigated. Evaluations have shown that 13 kg CO_2eq/tonne can be saved when digestate replaces a mineral fertiliser);
- Nitrogen inhibitors;
- Substrate sourcing from short transport distances;
- Reduction of methane-slip in the AD plant;
- Covered digestate storage (storage of fermentation residue in properly covered tanks should become compulsory, while it significantly prevents methane emissions);
- Use of co-generated thermal energy;

- Reduction of methane-slip in the upgrading unit.

See also: "A review of sustainability criteria and best practice methods to their implementation" by Green Gas Grids project.

5.9. Development of technologies

- anaerobic digestion,
- biogas upgrading,
- SYNGAS

5.10. Research and Development

The Research and Development activity in relation to the biogas/biomethane industries should be focused on the following issues/targets:

- full utilisation of organic waste streams, including digestion of materials with high cellulose content,
- production of biogas raw materials with fill respect of biodiversity on the agricultural fields,
- increasing of the stability and biological efficiency of the anaerobic digestion systems,
- minimising the methane slip during biogas upgrading treatments and maximising the methane concentration of biomethane,
- reduction of energy consumption both in the anaerobic digestion and the upgrading stage.

5.11. Technical standards for biomethane

The application of unified European biomethane quality standards has a double importance for the industry:

- the standards provide the necessary technical guidance for the companies developing the biogas upgrading (biomethane producing) technologies,
- the standards strengthen the confidence of the biomethane customers.

As of November 2013, even though of biomethane is a common practice in several EU member states, there is no unified approach regarding the requirements for injecting biomethane. Nevertheless, last November 2010 the Directorate-General for Energy of the European Commission addressed the potential that biomethane could bring when increasing the security of energy supply as well as when contributing to the reduction of Green House *Gas* (GHG) emissions as committed in the framework of the Kyoto Protocol. This move was backed by means of a specific Mandate (M/475) to CEN for the development of standards for biomethane for use in transport and injection in natural gas pipelines.

This task was accepted by CEN, and the responsibility was assigned to a newly created committee, the CEN/PC 408. This committee has been working since 16th September 2011 and many stakeholders are participating there, assuring a balanced representation of the interests involved.

It has taken 10 plenary meetings for CEN/PC 408 to be able to prepare the first Working Drafts which will be distributed for CEN enquiry by the end of the year. Some of the main parameters covered by the current text are: silicon, hydrogen, compressor oil, dust and impurities, water dew-point, halides, carbon monoxide, mono and poly aromatic hydrocarbons, ammonia, amine, oxygen, hydrogen sulphide, sulphur, hydrocarbon dew-point, carbon dioxide, Wobbe index and relative density.

See also: "Standards for biomethane as vehicle fuel and for injection into the natural gas grid" by Green Gas Grids project.

5.12. Increasing public awareness

The stakeholders (companies and non-governmental trade organisations) should strengthen their activity to ensure that the public understands the importance of producing and using biomethane in every application. The public awareness work should be targeted at the following issues:

- the resistance of local population against erecting biogas/biomethane producing sites in the neighbourhood must be taken seriously and must be addressed in due time on course of developing the projects,

- the citizens should be informed about the environmental benefits and sustainability of biomethane production and use – this should result in increasing the number of customers who are ready to pay an extra price for “green” gas based upon their environmental awareness.

6. Reference documents elaborated by the GGG Project

- A review of sustainability criteria and best practice methods to their implementation
- Standards for biomethane as vehicle fuel and for injection into the natural gas grid
- Overview of biomethane markets
- Guidelines for development of biomethane feed-in projects
- Report on the assessment of biomethane potential – Biomethane Potential Market Matrix

The partners participating in the Intelligent Energy Europe Green Gas Grids project (www.greengasgrids.eu) believe that through realisation of the set of actions suggested in this Roadmap biomethane will substantially contribute to reaching the key long-term European policy objectives in sustainability, environmental protection and renewable energy supplies.

Attachment No. 1.

to the European Biomethane Roadmap

Biomethane production forecast 2020 – 2030

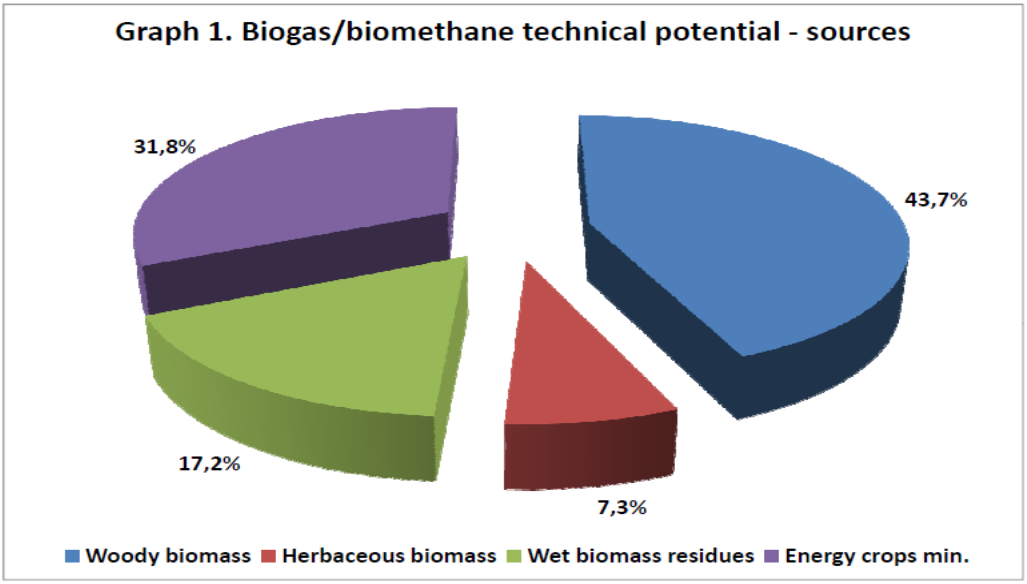
The maximal technical biomethane potential in EU-27 (according to the detailed study and analysis carried out by DBFZ)[18] is in the range of 151 – 246 billion Nm^3/year (5.477 – 8.884 PJ/year). This technical potential contains both the biomethane produced by anaerobic digestion and the syngas (bio-SNG) produced from biogenic feedstocks. The following resources have been considered as part of the technical potential (in billion Nm^3 of biomethane):

Resource	Billion Nm^3	%
Woody biomass	66	43,7 - 26,8
Herbaceous biomass	11	7,3 - 4,5
Wet biomass residues	26	17,2 - 10,6
Energy crops	48 – 143	31,8 - 58,1
Total	151 – 246	100,0

Table 1. Maximal technical biomethane potential

The resource composition in case of minimal volumes from energy crops is illustrated in Graph # 1.

[18] "European Biomethane Potentials" presentation by Daniela Thrän on the GGG Workshop on 21. February 2012 in Brussels (www.greengasgrids.eu)



In case of consequent political commitment and efficient support systems 32 - 33% of the minimum technical potential could be realised by 2030 in the EU-27 countries (without the potential of the CIS countries) – giving 48-50 billion Nm^3 of methane production (cumulative in form of raw and upgraded biogas) out of AD together with Syngas (bio-SNG).

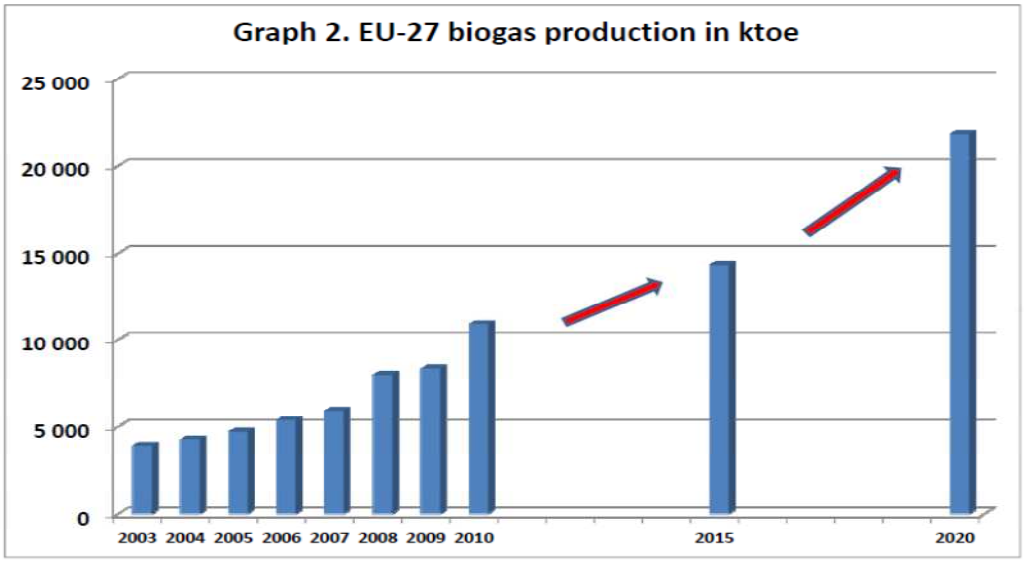
Until 2010 the development of the European biogas industry was focused on producing renewable energy source for electricity generation and – correspondingly – the upgrading of biogas to natural gas quality and injecting biomethane to the natural gas grid was seldom considered. The core reason for the dominant role of “green electricity” (as opposed to “green gas” was in most European countries (with a notable exception of Sweden) financial support was provided for generating “green” electricity (most importantly in form of guaranteed feed-in-tariffs). On the other hand, the injection of biomethane to the natural gas grid was not receiving comparable support and did not expand parallel with the “green” electricity production from biogas.

Nevertheless, in the recent years the benefits of biomethane production (the possibility of using the well developed natural gas distribution and storage network, producing gaseous biofuel, etc.) have become more and more understood and acknowledged and the GGG partners assume that by 2030 about 40% of the produced biogas will be

upgraded to biomethane and the remaining 60% will be used directly (without upgrading) for electricity generation, heating and cooling.

This could result in 18 billion Nm^3 of biomethane production in 2030 both for grid injection and use as gaseous biofuel.

Government targets are available only till 2020 – in form of the National Renewable Energy Action Plans.



Graph # 2. Illustrates the development of the European biogas industry between 2003 and 2010 (Source: EurObserVER Biogas Barometers) together with the planned increase under the National Renewable Energy Action Plans provided by the governments of the member states.

In nearly all countries the NREAP's were focusing on RES electricity production from biogas – 81,5% of total biogas production foreseen for 2020 is designated for electricity generation.[19] It is to be noted though that this includes both raw biogas and biomethane. Some member states (for example AT, DE) have introduced financial incentives to encourage RES electricity generation from upgraded biogas (forwarded to the power stations through the natural gas grid). This means that the

[19] National Renewable Energy Action Plans – EBA's evaluation of the biogas contribution (www.european-biogas.eu)

biogas production targets of the NREAP's indirectly and partially include biomethane too.

Biomethane directly appears in the NREAP's among the biofuels. The action plans of six member states (AT, DE, HU, IT, SE, SK) include specific support for the use of biomethane as transport fuel.

Through comparing the NREAP targets for 2020 with the technical potential it can be concluded that the member states on average reckon with the realisation of 16% of the technical potential of 151 billion Nm^3 (at minimum level of energy crop use).

The increase of biogas production forecasted by the NREAP's of EU-27 between 2010 and 2020 is 201%, i.e. the biogas production will be doubled in the 10 years period, reaching 24,2 billion m^3 methane (21,8 million toe)[20] in 2020. The further development beyond 2020 will largely depend on the 2030 EU targets for renewable energy and on whether the governments of the member states follow the example of France and United Kingdom – these countries have introduced biomethane feed-in-tariffs for grid injection. Another important area is transportation application where CNG/CBM and LNG/LBM have the best chances for accelerated growth.

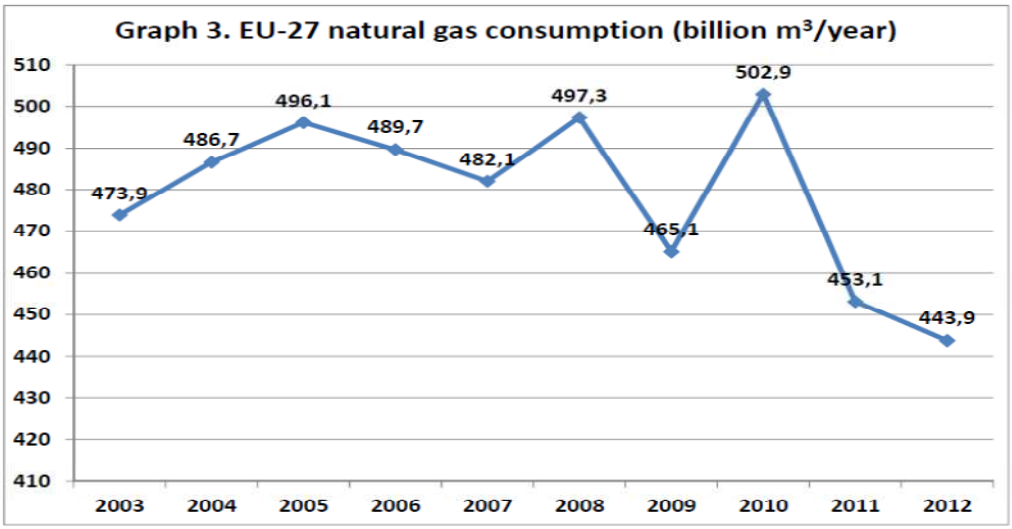
Assuming continued political commitment by the European Parliament and European Commission towards sustainable development and RES support the biogas/biomethane production could be again doubled during the decade between 2020 and 2030. Such assumption is strengthened by expectation that the bio-CNG technology will become mature and widely available by 2020. Thus the production of 48 - 50 billion Nm^3 (44-45 million toe) of methane (in forms of raw and upgraded biogas combined) in 2030 is achievable – this would mean the realisation of 32 - 33% of the (low energy crop use case) technical potential of 151 billion Nm^3.

The 48 - 50 billion Nm^3 (methane) production projection for 2030 includes all products: raw biogas, upgraded biogas (biomethane) and Syngas. Power-to-Gas is included only if the applied power is generated from renewable sources and the hydrogen is biologically converted to methane.

[20] National Renewable Energy Action Plans – EBA's evaluation of the biogas contribution (www.european-biogas.eu)

The share of pure biomethane in 2030 is estimated in the range of 40%, i.e. 18-20 billion Nm^3.

The development of the European biogas/biomethane market cannot be separated from the development of the European natural gas market. The statistical data for the last 10 years (Graph # 3. – source: BP Statistical Review of Word Energy 2013) suggest that the natural gas consumption of EU-27 is unlikely to reach levels substantially beyond 500 billion Nm^3 per year[21]. This would mean that the biogas/biomethane production estimated in the NREA's for 2020 (24,2 billion Nm^3 in natural gas equivalent) will correspond to about 4,5-5% of the EU-27 natural gas consumption.



The partners in the GGG project have developed a biomethane supply forecast model. The methodology is described in the corresponding report named "Biomethane Potential Market Matrix". Using this methodology the following estimation can be made for the biomethane supply potential in Europe:

[21] See also IEA Energy Journal Spring 2013 page 32

		Biomethane supply forecast				
		2012	**2015**	**2020**	**2025**	**2030**
Country	Population	TWh	TWh	TWh	TWh	TWh
Austria	8 477 000	0,08	0,23	0,89	1,55	2,14
Croatia	4 258 000	-	0,17	0,67	1,17	1,62
Germany	80 640 000	6,00	12,00	20,00	25,00	30,00
Italy	59 789 000	-	2,44	9,42	16,41	22,69
Hungary	9 894 000	-	0,02	1,03	3,08	7,18
Sweden	9 595 000	0,78	0,90	1,01	1,76	2,43
Netherlands	16 795 000	0,39	3,00	6,70	7,80	8,50
Slovakia	5 413 000	-	0,22	0,85	1,49	2,05
Spain	46 958 000	-	0,26	2,56	5,12	7,68
Poland	38 548 000	-	1,58	6,08	10,58	14,63
UK	64 231 000	-	3,50	13,50	23,50	32,50
France	63 820 000	-	1,00	10,00	20,00	30,00
Subtotal	408 418 000	7,25	25,32	72,71	117,44	161,42
Rest of Europe	90 000 000		5,57	16,00	25,84	35,51
Total	**498 418 000**	**7,25**	**30,89**	**88,71**	**143,28**	**196,93**

Table 2. Biomethane supply forecast (according to GGG methodology)