BIO-METHANE REGIONS

Promotion of bio-methane and its market development through local and regional partnerships

A project under the Intelligent Energy – Europe programme

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Regional Action Plan and Strategy

AGRICULTURAL INSTITUTE OF SLOVENIA

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Introduction

The purpose of strategy and action plan is to determine the technical potential of biogas production, identify the obstacles and develop an action plan to support application of anaerobic fermentation, biogas and biomethane.
The study is based on current data of organic agricultural waste, energy crops, organic municipal waste (green cuttings, household organic was, organic waste from public institutions), organic waste from food processing industry…

Main goals of this action plan and regional strategy are as follows:

- creation of best practices of biogas use,
- influence on policy creators,
- improvement of agricultural sector informing,
- improvement of energy sector informing,
- biogas technology program promotion,
- information spreading,
- support for domestic technology development,
- support for preparation of technical regulations for deployment of biomethane technology,
- support for preparation of legislative framework for biomethane technology and
- support for preparation of economic policy for deployment of biomethane in practice.

1. Slovenian Region

Slovenia (Republic of Slovenia) is a European country in the southern part of Central Europe and northern most part of Mediterranean. Slovenia covers an area of 20.273 km² and has a population of around two million people. Country borders Italy on the west, Austria on the north, Hungary on the northeast and Croatia on the south, southeast and east. Capital city of Slovenia is Ljubljana. Slovenia is a very diverse country and consequently has a climate as such: composed of alpine, continental and Mediterranean climate. There are very different landscapes in a small part of Europe which have their own typical social and geographical properties. Farming and food production is very much dependant on this properties and climate characteristics and is therefore very diversified in Slovenia. Livestock sector is mostly present in Alpine and Dinaric and crop farming mostly in the Pannonian area. In other areas of Slovenia, farming consists of mixed livestock and crop production, fruit and winegrowing.

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2. Biogas production potential in Slovenia

This study focuses on the biogas production from biodegradable waste via anaerobic fermentation. Therefore the biogas production potential is divided regarding the type of organic matter (substrate) used in the process and also the type of process utilized. Biogas potential is mainly divided upon the source:

- agricultural waste: animal excrement and green matter,
- organic waste on municipal landfills,
- biodegradable waste from central water treatment plants,
- biodegradable waste from food processing industry,
- waste from public utilities (maintenance of green public spaces, playgrounds, public parks…),
- organic kitchen waste from public institutions (schools, hospitals…), restaurants and grocery stores.

a. Biogas from agricultural waste

Biogas can be produced using manure from cattle, pig and poultry farming. According to the data of Statistical office of the Republic of Slovenia (SURS) for the year 2010, there is 303.763 BCS of cattle, 52.124 BCS of pigs and 11.762 of poultry. The amount of theoretical biogas production potential can be determined from statistical data of dry matter and organic dry matter content, slurry and manure yield and specific yield of biogas from organic dry matter. Using the average methane content in biogas (~60%), the theoretical potential of biogas is 99 million norm cubic meters annually. This value is nearly impossible to reach in practice, but it gives us a hint for the direction, where our society has to aim (the forefront is of course waste management and protection of the environment). The technical potential for biogas production would be xy Nm^3 annualy.

To determine the level of biogas production in the future it is important to recognize the trends in agriculture, specifically in livestock production, which is also the main source for biogas and main greenhouse gas pollutant. Information on farms in Slovenia from 2000 to 2010, acquired from SURS was divided in 5 size categories: 0 to 5 BCS, 5 to 20 BCS, 20 to 50 BCS, 50 to 100 BCS and farms with more than 100 BCS. Diagram bellow shows the trend of number of livestock in BCS from 2000 to 2010.

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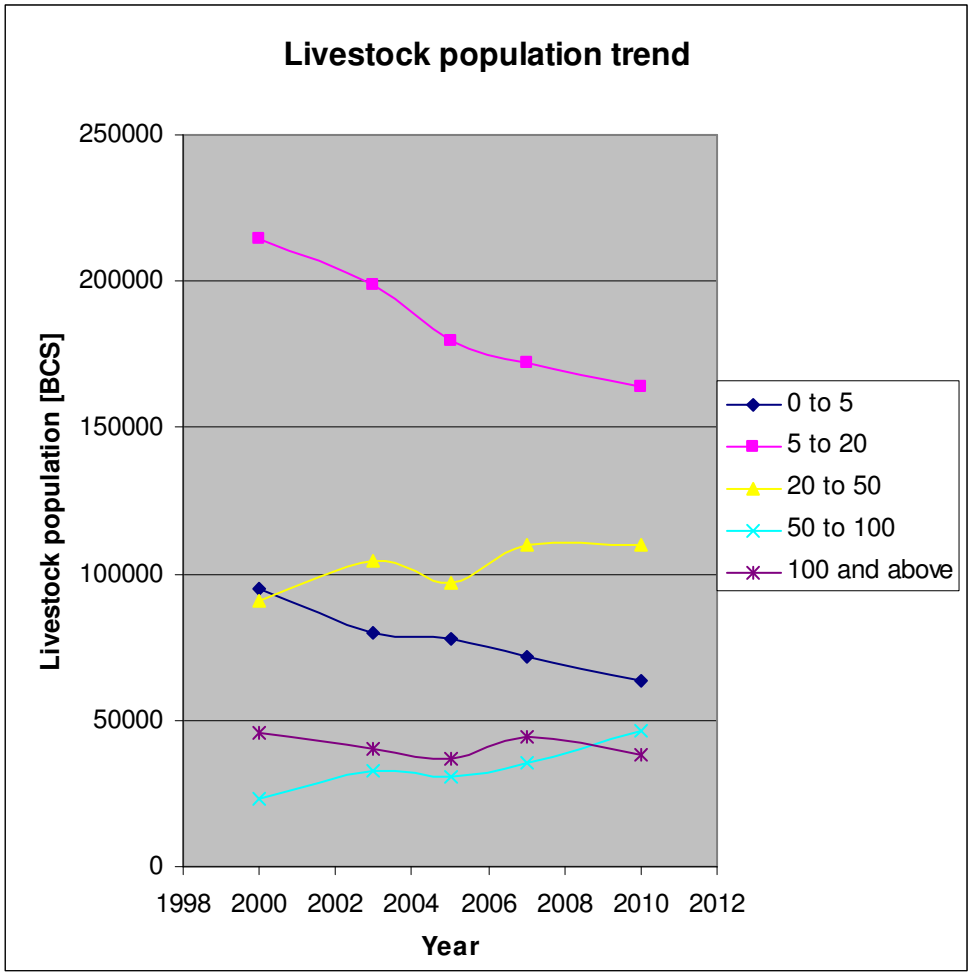

Figure 1: Diagram of livestock population trends in the past decade

Diagram on the figure 1 clearly shows that the largest share of livestock population is in the 5 to 20 BCS category, which represents small livestock production farms. We can see that the population of livestock in this category has been constantly dropping for the past decade, which is a solid representation of the trend of farm growth. Livestock population reduction is also present in the 0 to 5 BCS size category, while 20 to 50 BCS category shows no changes in the past ten years. Minimal changes in livestock population is present on the top two size categories, 50 to 100 and more than 100 BCS.

Diagram on the figure 2 bellow shows substantial fall in the number of farms in the 0 to 5 BCS size class. Farms in this class have no nearly no interest biogas production, because the livestock farming is in such a small extent. Similar trend is revealed also in the 5 to 20 BCS size class. Size category of 20 to 50 BCS shows nearly no changes in the past decade and the top two classes are growing in the number of farms.

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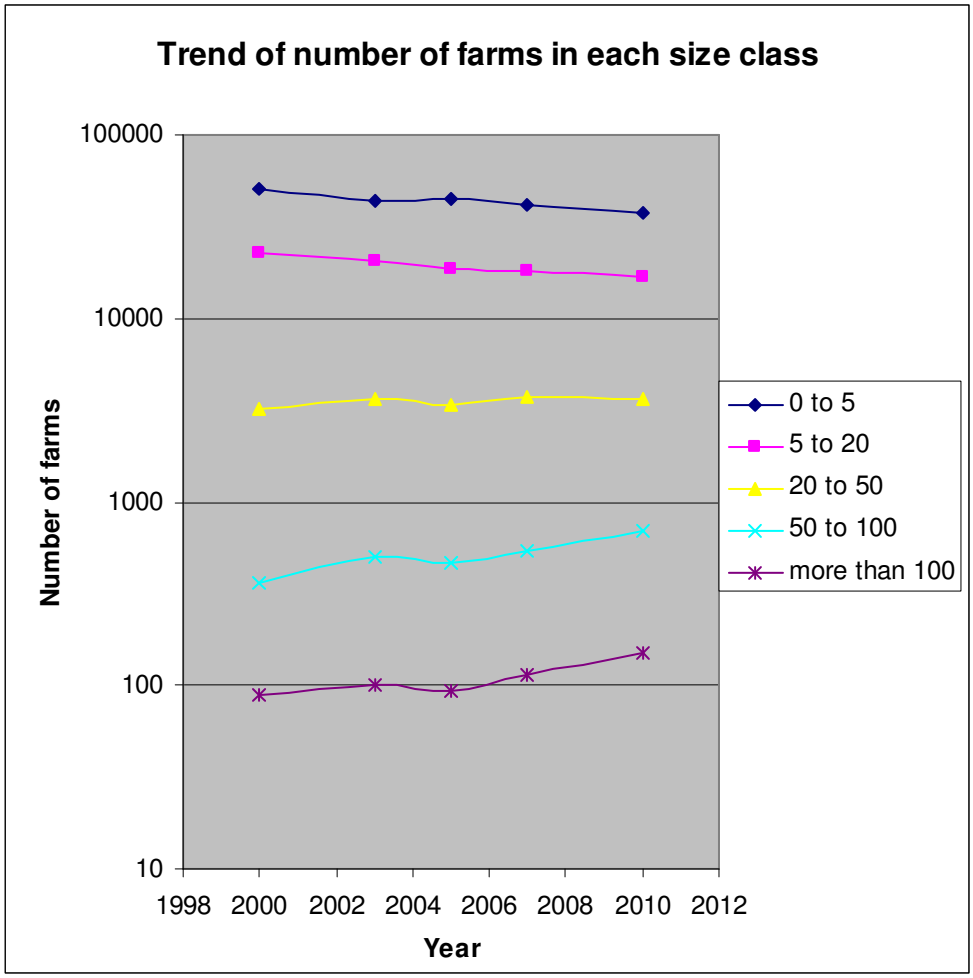

Figure 2: Diagram of trend of number of farms in different size categories for the past decade

The trend described above reveals the guidelines for biogas production development in the future in Slovenia. There are not a lot of farms in the size category of 100 BCS and above, but their numbers and therefore the potential biogas plant sites are rising.

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b. Biogas from organic municipal waste

Organic household waste also has a big potential for biogas production. Data from Slovenian environment agency (ARSO) shows a rise in the amount of collected organic household waste because of a state directive of mandatory separation of household waste. Future assessment of organic household waste amount is 70000 tones annually, which is a huge potential for biogas production through anaerobic fermentation.

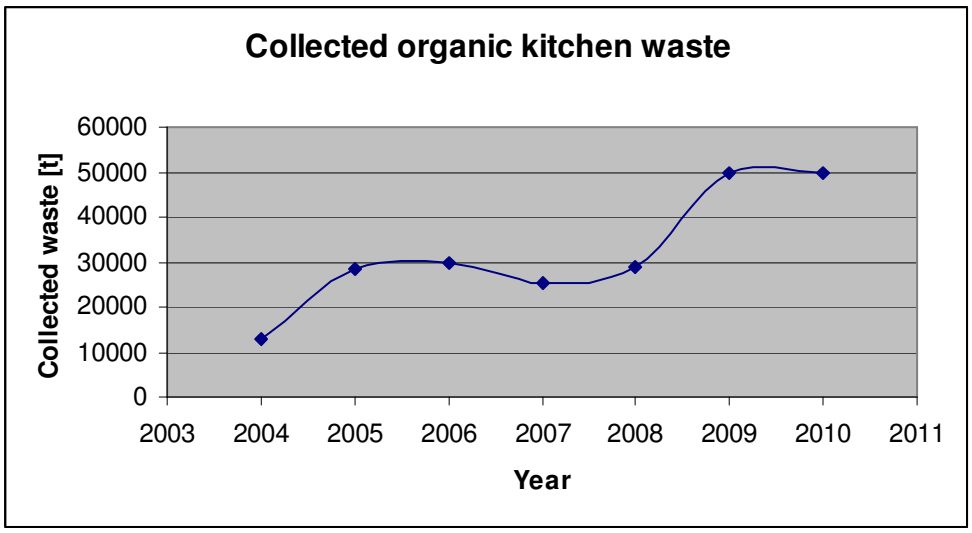

Figure 3: Collected organic household waste per years (source: ARSO)

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c. Landfill gas potential

Potential utilization of landfill gas is limited to functioning landfills in Slovenia which still don't have a built system for capturing and energy utilization of landfill gas. Landfills that won't have a built in system for landfill gas utilization will get shut down in the future. Biogas is already being utilized in one central wastewater treatment plant in Ljubljana and there are also others with similar technology implementation in construction.
Utilization of organic household waste for biogas production is already carried out in some relatively large biogas plants (biogas plant Koto in Ljubljana). Most of the organic waste is still collected on large landfills and that is also the best potential biogas plant site. Because the percentage of organic waste in municipal landfills can be up to 60%, this is a huge potential for biogas production.
The study for long-term energy balance for Republic of Slovenia for the period from 2006 to 2026 assesses the whole potential for electricity production from biodegradable waste. The problem with landfill and organic municipal waste utilization for production of biogas is a lot more process losses compared to farm biogas plants. Most of this is due to transport of the substrate from users to process and biogas plants, the other problem is in consistency of substrate which affects the process of anaerobic fermentation. Conservative scenario shows a rise from 90GWh in 2010 to 180GWh in 2030 and the optimistic scenario indicates a much larger use of potential, up to 420GWh in 2030.

d. Biomass from contaminated soils

Biomass production on contaminated soils for biogas is a very interesting option. Soils contaminated with heavy metals can be ecoremediated with energy crops that can later be used as biomass in the process of anaerobic fermentation. There is a big potential for energy crops from fields with contaminated soil because of a substantial amount of contaminated land in industrial areas in Slovenia, approximately 165 km^2.

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3. Obstacles for biogas plant installation

Biogas plant construction became more intensive after 2002 when regulation about purchase of electrical energy from qualified producers was accepted. This regulation provided purchase and premium for electric energy produced from renewable energy sources. Therefore the knowledge base about effective application of biogas production technology is still very limited as is the supply of technological solutions for central biogas stations. Mandatory application of biogas plants would speed up the research and development of the biogas production technology. Proposed measures for biogas utilization are in the fields bellow:

- legal measures,
- informing and education,
- economic and financial measures and
- technical and organizational measures.

Obstacles prevail in the agricultural sector which is proven by the fact that there is only one finished biogas plant on an average sized farm in Slovenia. It is therefore very important to focus future strategies on the agricultural sector to develop central biogas plants which will use the substrates from more smaller farms. This is the solution for farms that don't have the capabilities to build their own complete biogas plants and as shown in the chapter above, these types of farms have the largest part of the biogas potential in the agricultural sector.

Small number of installed biogas plants on farms can be explained by following facts:

- lack of investments in installing biogas plants in the past because of cheaper energy from fossil fuels,
- lack of funding on smaller family owned farms in investing in new technologies in the past,
- lack of state funding in case of installation of biogas plants on smaller farms,
- lack of knowledge and awareness by farmers, local authorities and food processing industry and
- lack of basic information on biogas plants.

Technical obstacles:

- lack of equipment supply in knowledge transfer regarding the biogas technologies (especially on micro and mini biogas plants),
- lack of hot water pipe grid in regions where the largest portion of biogas plants is installed,
- lack of constant or sufficient substrate supply on some biogas plants,
- some biogas plants have very long transport routes for substrates,
- lack of market for digested substrate from biogas plants,
- nonexistent fee for purchase of biomethane (in case of biogas upgrading) and
- lack of technical regulations for biomethane grid injection.

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4. Strategies and scenarios for biogas production in the future in Slovenia

Main goal of biogas production development in Slovenia is an increase of production and energy utilization of biogas in agricultural sector. Main untapped potential for biogas production is on small livestock production farms and mixed cattle and crop farms. Some of this unused potential is also on large estates. Technology for biogas production implementation on smaller farms is being developed as is the technology for biogas plants on landfills it only needs a new approach. Official and financial institutions are in favour of this activities.

Biogas plants are most suitable for livestock production farms because they are a very appropriate solution for environment problems caused by slurry during the winter months. The easiest solution is to implement anaerobic fermentation – to store slurry in airtight containers and capture the produced biogas.
Pre-feasibility and feasibility studies made within the Biomethane Regions project have revealed the threshold of viability for complete biogas plants on farms to be from 75 to 100 BCS. Livestock population smaller than that would require a lot more added substrate from energy crops which isn't desirable because of government tariff incentive limitations. To make biogas production viable on smaller farms, some sort of connection should be applied.

Farm aggregation for biogas production could be done within different scenarios according to farm size. Biogas plant construction and operation is not viable on farms in the two smallest size categories (0 to 5 and 5 to 20 BCS). The best solution for this kind of farms would be transporting the substrate (slurry) to joint biogas plant via pipelines or tractor transport (not the best option).
In the farm size category of 20 to 50 BCS and perhaps also in 50 to 100 BCS, farm aggregation could be carried out in a slightly different manner. Because of substantially larger amount of substrate (slurry), it's transport would be too costly and better solution would be to build individual bioreactors with associated equipment on farms and transport the captured biogas to joint cogeneration and/or upgrading stations via gas pipelines. Especially cogeneration units should be located near larger settlements for easier and more efficient utilization of produced thermal energy. Other possibility is also to upgrade biogas to biomethane and inject it in the national gas grid.
Above the threshold mentioned above construction of full individual biogas plants (bioreactors, gasholders, corresponding tanks, gas upgrading units, cogeneration units…) on farms would be viable but aggregation should still be necessary in case of desired upgrading of biogas to biomethane because of costly gas cleaning technology.

Size category of 100 and more BCS has the biggest likelihood for biogas construction in the future. According to Statistical office of the Republic of Slovenia (SURS) there were 150 farms in this category in 2010 and according to data their numbers are rising. There is 37945 BCS of livestock on this farms and by acknowledging the average ratio of livestock (cattle, pig and poultry) there is a potential to produce 8,97 million cubic meters of methane annually just in this category.

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Number of farms in size category of 50 to 100 BCs is also rising and in this class there was 46282 BCS of livestock in 2010 (source: SURS). Potential methane production from this class would be 10,94 million cubic meters annually.
This shows that there is a biogas potential with a very large likelihood of nearly 20 million cubic meters of methane annually.

The largest part of biogas potential still lies in the smaller classes (5 to 20 and 20 to 50 BCS) and amounts to 64 million cubic meters annually. The problem is this part of livestock population lies bellow the threshold of viability and the biogas plants on these farms would not be economically successful. Clearly a different approach to anaerobic fermentation application is needed.

Biogas potential from organic household waste should also not get ignored. Expected annual amount of 70000 tones is a large quantity of biomass for anaerobic fermentation process and has a potential of producing 7,8 million cubic meters of methane annually.

Another important aspect of biogas potential has to be considered. Livestock population on farms with more than 20 BCS has the potential to produce 45 million cubic meters of methane annually. Annual fuel consumption in agriculture in Slovenia is around 60000 tonnes of diesel fuel (Agricultural institute of Slovenia, 1997) and considering that one norm cubic meter of biomethane equals 1 litre of diesel fuel according to energy value it is very clear that anaerobic fermentation could enable some energy independence in agriculture.

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5. Possible use of produced biogas

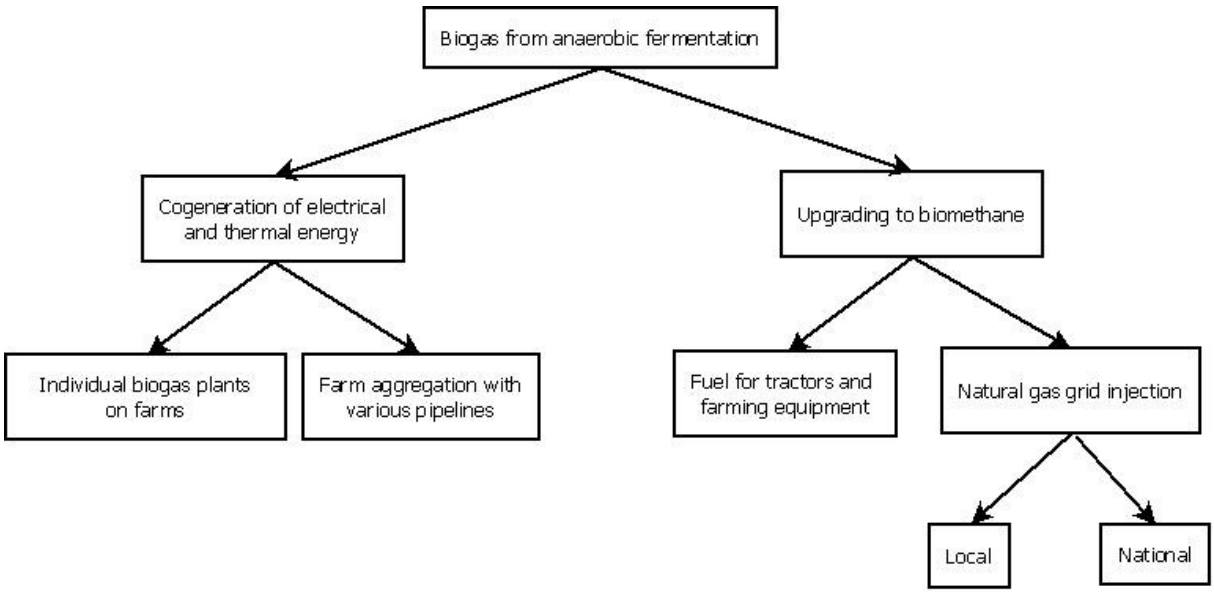

Figure 4: Possible scenarios of biogas use in the future

Biogas, produced on biogas plants could be used in different manners. First division refers to the degree of upgrading of biogas. Cogeneration normally requires fairly less clean biogas than upgrading to biomethane.

Burning of biogas on cogeneration units:

Currently only use of biogas in Slovenia is for cogeneration of electrical and thermal energy. Cogeneration unit produces more thermal (~60%) than electrical energy (~35%) but only a small fraction of about 5% of thermal energy is being used. In case of cogeneration thermal energy utilization is very important for financial efficiency of the whole biogas plant operation. Thermal energy can be used for heating/cooling buildings on the farm itself and also for other houses in the village/town via network. Other options are also drying of various farming products (grain, wood chippings…).

Because thermal energy utilization can be very costly (construction of heat network) it is very necessary that this investment is covered also by local government or other private investors. Local heat network is in great interest of local inhabitants as it leads to low heating costs. Villages and small towns can therefore benefit greatly with biogas technology.

Biomethane for national gas grid injection:

There are no natural gas sources in Slovenia and all requirements have to be met with importing (mostly from Russia and Algeria, source: Energy Agency of the Republic of Slovenia). Annual natural gas consumption in Slovenia is 1,1 billion cubic meters.

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Biogas can be upgraded using appropriate technology to more than 98% content of methane. As such it can be injected in national gas grid and sold as a renewable fuel. Biomethane in gas grid mixes freely with natural gas and it is expected that the biomethane content will rise in the future because of financial incentives.

Natural gas grid injection is also a great option because most of biogas plants are located on farms or wastewater treatment plants which are mostly on remote locations away from bigger cities. This represents an obstacle in utilization of surplus thermal energy from cogeneration units and gas grid injection would therefore transport energy from renewable sources to every grid user.

Figure 5: National gas grid in Slovenia (source: Geoplin d.o.o., Ljubljana)

National gas grid in Slovenia is coincidentally well developed in parts where there is also the largest percentage of biogas plants. A good option for the future when cogeneration equipment on this large plants (>1MW) expires is replacing this equipment for biogas to biomethane upgrading technology and continue the operation as a renewable source gas supplier. Because most of this large plants only produce electrical energy and therefore achieve only up to 35% efficiency implementation of biogas upgrading would lift their efficiency up to 90%.

Biomethane as vehicle fuel:

When prices will drop for biogas upgrading technology it will be possible to produce biomethane on a larger scale and use it for vehicle fuel for tractors and other farming equipment. It is also possible to sell compressed biomethane for use in public transport or other consumers.

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6. Action plan

Basic fields for proposed measures for biogas use development are:

- legislative measures,
- informing and education,
- economic and financial measures,
- technical and organizational measures and
- acceptability of biogas in public eye.

Legislative measures:

Goal of legislative measures is improvement of legislation in the direction of simplifying the procedures for obtaining necessary licenses for biogas plants installations.

Proposed legislative measures:

- uniformity of administrative processes,
- simplification of procedures for obtaining necessary licenses for biogas plants installations with shortening the issuing time,
- preparation of legislative measures for biomethane production on farms and companies and its injection in national gas grid,
- legislative terms and conditions for biomethane purchase from agricultural and other biogas plants and
- legislative terms and conditions for biomethane purchase from small biogas plants on farms and aggregated biogas plants.

Informing and education:

The goal is to increase the informing of the public especially in agriculture (farm and farm company owners) and to educate biogas plant operators. It is important to educate and prepare more operators and maintainers for biogas plants.

Proposed measures for eliminating the lack of information are:

- training of the special group for public relations regarding the biomass and biogas use,
- issuing information brochures and booklets on biogas and biomethane use in agriculture and expected benefits from it (local communities development, jobs, methane emission reduction, synthetic fertilizer reduction…),
- issuing information booklets containing best practice examples of successful biogas plants,
- local and national news media articles on biogas and biomethane use,
- seminar, workshop and excursion preparation and
- integration of nongovernmental organizations.

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Proposed measures for education of biogas plant operators and agricultural and energy counselors are:

- educational course organization for biogas plant operators in a form of seminars and crash courses,
- complementary educational program about biogas exploitation technology for agricultural and energy counselors and
- supporting special educational programs in educational bodies (high school, technical college, university…)

Economic and financial measures:

Goal of economic and financial measures is biogas plant investment conditions improvement and their competency improvement.

Proposed economic and financial measures are:

- special fund for investing in agricultural biogas plant installation,
- extra benefits for investment lending for biogas plants for aggregated smaller farms,
- special benefit conditions for buying of electrical energy from biogas plants for aggregated smaller farms,
- financial incentives (premium) for utilization of thermal energy from renewable sources and
- financial incentives (premium) for injecting biomethane in gas grids.

Technical and organizational measures:

Goal is operational improvement of biogas plants with improving existing and introduction of new technologies. It is also very important to focus on substrate transport organization.

Proposed technical and organizational measures are:

- improving the knowledge of biogas plant operators,
- improving technology in existing biogas plants,
- preparation of technical regulations for biogas production on farms and in companies,
- preparation of technical regulations for biomethane gas grid injection,
- introduction of new biogas plants with incorporated biomethane technology,
- introduction of biomethane technology on biogas plants with expiring lifetime of cogeneration unit,
- introduction of biomethane as tractor and other farming equipment fuel,
- preparation of technical regulations for use of biomethane on farms and in businesses and
- organizing continuous flow of substrate and harmonization of suppliers.

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Acceptability of biogas in public eye:

Goal of this measures is improving the public image of biogas and biomethane technology and informing general public about future installations of biogas plants, about pros and cons, risk involved and use of biogas plants.

Proposed measures to improve public image of biogas technology are:

- spreading information about advantages of biogas and biomethane exploitation on local level,
- open discussions with local government and inhabitants about future biogas plant installation concerning all views,
- organizing trips and excursions to biogas plants and
- organizing debates on local level with holders of political decisions on state level.

7. Implementation

Supply of various biogas technologies in Slovenia is rather sufficient, there are also a few domestic manufacturers with products for biogas plants. Some companies offer development and manufacturing of individual parts or whole assemblies for biogas plants. New improvement has appeared this year with one company offered a micro biogas plant in container sized package to the market (up to 50 kW_e and up to 300 kW_e in the future). There has been a constant supply of highly developed turnkey biogas plants from one company in the past.
Agricultural institute of Slovenia, the Department of agricultural engineering supports development of use of biogas in agriculture and food industry in Slovenia. The main focus in the future will be micro and mini biogas plants, especially in areas with difficult conditions for production (areas with limited factors for farming). Forefront of biogas technologies will be solving environmental problems with air, soil and groundwater and lowering environmental footprint of farming in combination with solving energy problems of farming. Dissemination and research and development work on biomethane technologies will also play and important part. Introduction of these technologies will provide higher efficiency on existing biogas plants and on biogas plants installed in the future. Interested customers and individuals can get information on the Department of agricultural engineering on Agricultural institute of Slovenia or try the webpage: www.kis.si.

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8. Strategy, action plan and advisory committee

Slovenian advisory committee consists of approximately 13 members, associated with different institutions, including support societies, experts, investors, government, researchers, manufacturers, farmers, experienced users, administrators… Advisory committee had a crucial role in building the strategy and action plan. It also looks after the net of stakeholders in biogas field. Advisory committee provides important information on biogas especially regarding the regulation changes. Advantage of advisory committee existence is in sharing information, its networking role and obtaining feedback. Records of all advisory committee meetings are on www.kis.si.

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