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Biogas Potential in Croatia

Summary Report

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1 Introduction

Biogas market sector is one of the least developed but also the most dynamic sector among renewable energy sources. A strong push towards biogas production from animal manure came from transposition of Nitrate Directive to the national legislation and introduction of package for RES electricity together with the feed-in tariff system.

There are only three biogas plants working by the end of 2008, one of them being agricultural one.

So far, biogas was not at focus at the highest levels although it could contribute to fulfilment of targets in respect to both renewable energy production and environmental protection, to mention the least.

2 Existing and planned biogas installations in Croatia

The first biogas plant operating in Croatia is situated at Zagreb's landfill Jakuševac. BIO MOTO Ltd. is the company responsible for management and maintenance of the biogas plant. The installed capacity of the plant is 2 036 kW with annual production of 7.5 mil kWh that runs on landfill gas. The venture (app. 3.8 mil. €) started the production in late 2003. The power plant has a 15 year agreement with national power supplier on power trade. This plant demonstrates utilization of urban biomass, with the landfill having 47 probes for collecting gasses that originate from waste decomposition and transferring to the power plant. Gasses differ by quality and quantity but, in general, they are consisted of 50-60 % of methane, 29-35% of carbon dioxide and some oxygen. The probes collect about 700 cubic meters of gasses daily. The gasses power the generator that is flexible to the quality variations of biogas. However, to reduce oscillations in biogas quality, biogas is partially processed (moisture removal) before entering the generator.

A private – public waste water treatment plant Zagrebačke otpadne vode (ZOV) for city of Zagreb started to fully operate last year. ZOV is joint investment of WTE Wassertechnik GmbH (WTE) from Essen, RWE Aqua GmbH (RWE Aqua) from Mülheim and city company Vodoprivreda Zagreb d.d. (VZ). The waste treatment plant has both mechanical and biological treatments and states „production of biogas“ as one of its core activities. In mid 2008, it started test production of biogas. Installed capacity is 2x1.5 MW. Currently, ZOV is pending in the procedure of eligible producer status and, in the mean time, utilises energy for its own consumption.

As for planned biogas installations, it is difficult to number biogas installations that are planned or pending and to sustain correct with more than a week in stated number. Namely, at the beginning of this project there were three most promising biogas sites: Vrana d.o.o. (Biograd na Moru), Veterinarska stanica d.o.o. (Dvor na Uni) and Osatina d.o.o. (Semeljci). A year later, it is known that a 1 MW biogas plant has started its production (without having eligible producer status by January 2009) but is it none of those previously mentioned. It is Biointegra d.o.o. in Slatina. The biogas feedstock is 90% maize silage and 10% sunflower seed or other grains unsuitable for human consumption. Another biogas plant is pending at PIPO Čakovci – Perutnina Ptuj, a large scale poultry breeder and meat processing industry. There is also a word on potential biogas plants at cattle farms at Ivankovo next to Vinkovci and Tomašanci next to Đakovo (both Osatina) and a farm next to Lovas as well as at pig producing farms in Dubravica. Only Osatina, by January 2009, has submitted Environmental Impact Study for biogas plants. Agroproteinka d.d. has expressed its interest in biogas production as well from slaughterhouse waste. In short, one could conclude that biogas market is emerging in Croatia which makes it rather dynamic sector.

3 Utilisation of waste material for biogas production in Croatia

Currently, Croatia is in the beginning of harmonizing its legislation with the EU legislation regarding waste and waste management. A cornerstone document called Strategy on waste management of the Republic Croatia was delivered in 2005. It is followed by numerous new legal documents delivered in 2007. The system is in its transitional period and it would be difficult to estimate which of the declared goals are going to be implemented and if yes, in what period and to what extent. The main idea is to organise waste management from 187 “official” into regional centres for waste management (1-2 by 2010 and 2-3 by 2015) and county centres for waste management (3-7 by 2010 and 7-10 by 2015). This reform is 50% funded by Energy Efficiency and Environmental Protection Fund (Croatia) and the rest is planned to be financed by foreign funds. Therefore, this review will focus more on the existing system with future expectations, where this would be applicable.

Utility companies collect about 1.2 million tons of municipal waste in Croatia. Municipal waste is either generally not separated or voluntarily separated (paper, glass, tins, PVC, batteries, expired drugs, electronic waste, tires). Large municipal waste is collected from households twice per year at designated dates. Most of the vehicles for collection of municipal waste are equipped with press mechanisms. Waste cooking oil is collected separately from large consumers (restaurants, kindergartens, hospitals, hotels...).

Green markets, retail shops and recycling spots are introducing large containers of 10 to 20 m³ with pressing mechanisms. It is very important to stress that waste has been collected 2 to 3 times per week.

Supermarkets are giving their expired foodstuff to Agroproteinka d.d. – the only open type kafilery with maximum capacity of 75 000 t/yr. Agroproteinka d.d. is collecting slaughterhouse waste and other biohazard type waste around Croatia. Waste from food processing industry is difficult to track down.

Estimated share of organic waste in municipal waste is 43.1% and 41% one mainland and the coastal regions, respectively.

It has been estimated to have 97 700 t/yr tourism related waste (Strategy of waste management, OG 130/05). The following table provides information on tourist demand in Croatia which emphasize seasonal period of maritime tourism.

Municipal waste generated on the coastal area and island is growing problem especially during the summer when most of the tourists inhabit that area. Apart of the huge competition for area on the coast, the area itself is mostly made out of sensitive karst and underground waters which makes finding an appropriate location of landfill even more difficult. In that sense, saving each volume of disposed organic waste at the landfill represents added value. Another issue is capacity –during some 30% of the year, tourist:resident ratio is 8:1 which imposes larger investments in infrastructure than in areas in the continent.

One could conclude that Croatia produces a relatively large amount of waste per capita although there is a reported 10% return through recycling with the balance being land filled. Croatia has a feed in tariff system but low tipping fees.

4 Feedstock availability in Croatia

Feedstock availability for biogas production is difficult to obtain at “ready – to – use” level. Namely, it is possible to calculate theoretical agriculture feedstock availability from agriculture (excluding energy crops) at national level which is far from actual biogas potential. It needs serious investment of time and money into intense research to narrow the difference between calculated national theoretical feedstock availability to technical and, eventually, economical potential. Some research (Kulišić & Par, 2008) suggests that, if one assumes that biogas feedstock will be available at sufficient quantities at business entities (commercial farms), overall national theoretical availability shrinks to 20% (from 3.2 – 11.3 PJ/year to 0.7 – 2.1 PJ/year). Nevertheless, that figure still does not represent realistic value due to the lack of spatial data on livestock production. Namely, even if narrowing down livestock production at commercial basis, the companies are registered at some urban centre while actual production occurs somewhere else, often on more than one farm.

Other types of feedstock such as energy crops, expired foodstuff, kitchen waste, organic part of municipal waste, food processing waste, slaughterhouse waste and similar have different obstacles to provide exact numbers or availability. Namely, energy crops (i.e. maize silage) could be grown as it is normally grown for livestock with approximate yield of up to 45 t/ha. Nevertheless, maize silage as well as manure is not market good in Croatia. In 2006, expired foodstuff and slaughterhouse waste has been recorded as about 65 000 tons of thermally processed slaughterhouse waste in Agroproteinka and about 9 500 tons of thermally processed poultry processing industry waste KOKA d.d. Varaždin (AZO, 2008). Municipal waste is not separated which makes organic municipal waste fraction unavailable as biogas feedstock, except as in landfill gas recovery. Food processing industry is reluctant to provide data on waste occurred although there are some records from Environmental Protection Agency.

5 Agricultural structures in Croatia

Croatian agriculture is still trying to grasp with market economy and war repercussions. In 1994, Croatia changed to net importing country of agricultural products. In 2003, Croatia was self-sufficient in 5 agricultural products only: wheat, sugar, maize, wine and eggs. The present ownership structure still largely reflects forty years long socialist system of government (dual system of large *agrocombinates* and marginalised family owned husbandries) and the application of lax inheritance laws. According to the Agricultural Census 2003, there are 448 532 family farms, utilizing 853 196 ha of arable land and gardens, corresponding to an average farm size of 2.0 ha. Same data shows that three quarters of all family farms are smaller than 3 ha, but cultivate only 21% of all utilised agricultural land owned by the private sector. Business entities use much larger areas of the agricultural land, averaging to 159.2 ha. Trends in annual yields demonstrate lack of sufficient knowledge of agrotechniques and strong dependency of agriculture yield on weather conditions.

According to the Croatian Livestock Centre, there are 44 560 of milk suppliers out of which 96% has less than 15 milk cows. Majority of family farms (90%) keep less than 10 cattle, and only 10% more than 10. In order to change this unfavourable structure, Operational Programme for the Development of Livestock Production secures conditions for the establishment of new modern farms with the capacity of up to 100 cows. It is necessary to emphasise that some farmers will continue keeping a small number of animals on the farm. Specialized cattle breeding farms are not yet developed at a large scale. One third (32%) of the legal entities have up to 20 cows and two third (68%) of total 339 producers keep more than 20 cattle out of which 25% or 86 have more than 100 cattle.

In 2003, the average size of family holdings with pigs, or the average number of pigs per family holding, pursuant to the abovementioned data was 8 pigs, while the average number of pigs per legal entity was 464. In the producers structure, the biggest limitation is the fact that 90% of production is represented by about 200 000 small producers. Less than 3 300 (1.5%) producers on family farms have more than 50 pigs. About 12 500 have 20 - 50 heads and out of this category of family farms it can be expected to grow up into commercial producers to some extent. From the category of family farms with 11 - 20 pigs can be divided farms ready to participate in commercial production, while the majority of more than 170 000 farms with less than 10 pigs are out of commercial production.

6 Opportunities for biomethane injection into Croatian natural gas grid

Biogas is recognised in Law on Gas Market (OG 40/07) which is stated in the Article 1, paragraph 2 as:

(2) The rules determined by this Law and corresponding regulations are applicable on biogas, gas from biomass and other types of gas if it is possible both technically and safe transport through the gas system of the gases in question.

Up to the time of writing this summary report (January 2009) there are no corresponding regulations that describe biogas implementation in gas market as gas transport, distribution, storage, supply, supply of tariff customers, LNG terminal management are regulated energy activities while gas production, supply and sales of natural gas from own production, supply of eligible customers, mediation on gas market, representation on gas market are market activities. Nevertheless, one could interpret from the above mentioned article that if biomethane is meeting characteristics of natural gas, the corresponding regulation on natural gas could apply to biomethane as well.

There are 2 grid levels recognised in Croatia: transportation (high pressure 50-70 bar) and distribution (middle pressure 1-4 bar and low pressure <1 bar). The natural gas transmission system comprise 2 034 km of pipelines, 142 exit measuring-reduction stations with 210 measuring lines and 19 entry measuring stations.

The whole system provides gas for 14 out of 21 counties including the City of Zagreb.

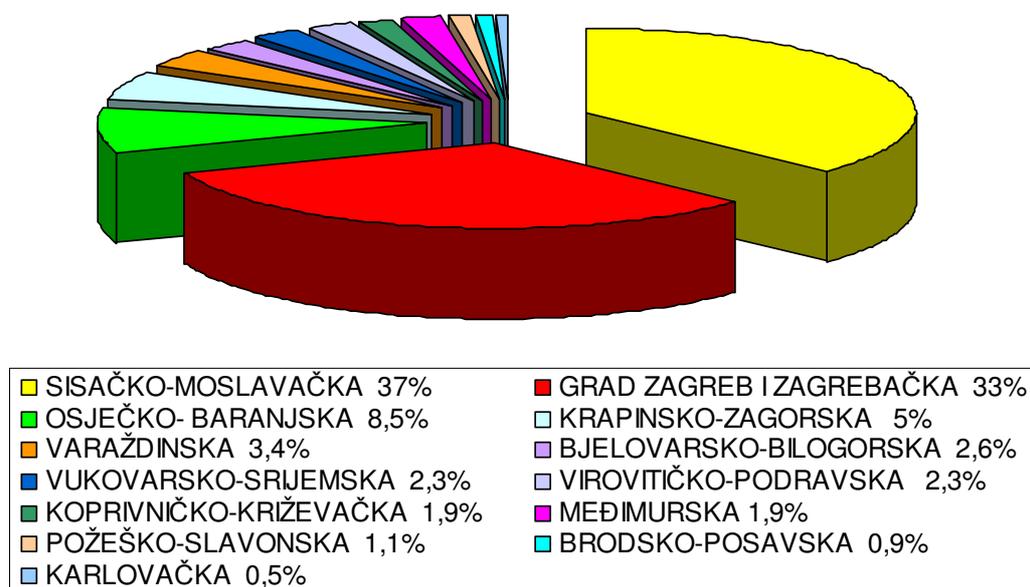


Figure 1 Structure of transported natural gas quantities per Counties (NUTS3 level) in Croatia

Source: Energy in Croatia 2006

7 Impacts of biogas production in Croatia

Impact of biogas production in Croatia could be manifested in several ways which are:

- renewable energy production
- environmental protection
- waste management tool
- rural community development.

Croatia has set target to have minimum **5.8% share or 360 MW of RES-E** in the total electricity consumption **by 2010**. It is fair to expect that the Green Paper on “20 20 by 2020” will be also considered in the national RES targets. The latest official estimates on biogas potential are made within National Energy Programmes – BIOEN – Energy from biomass and waste, in 1998. That document provides **biogas potential** of 2 PJ/year which roughly corresponds to the results of preliminary biogas potential research from agriculture residues in 2008 discussed more in section 4 of this report (**from 3.2 -11.3 to 0.7 – 2.1 PJ/year**). Biogas production and utilisation will be left at modest contribution (up to 1% of the total gross electricity consumption in Croatia) if feedstock is not extended to energy crops and other sources such as food processing industry, kitchen waste, expired foodstuff, slaughterhouse waste and similar. So far, no research has been done in investigating biogas potentials in Croatia other than agriculture feedstock.

Nevertheless, despite its modest contribution at the national level, biogas could represent the first best options for those regions rich in agriculture feedstock. Those regions will not only have locally produced energy and, to some extent, energy independency at local level but also will greatly benefit with biogas production externalities in environmental protection and rural community development.

The Ordinance of **Biofuels** Quality (OG 141/05) recognises biogas as one type of motor vehicle fuel with prescribed properties if placed on market. National target for biofuels share in total consumption of motor vehicles fuels amounts **5.75% or 5.095 PJ by 2010**. For 2009 it is foreseen that only about half of that target could be met based on the existing and expected production capacities. All biofuels producing capacities are focused on biodiesel.

Contribution to the **environmental protection** of biogas in Croatia is in its positive impact on soil, water and air quality as well as on GHG emissions savings. In some of national counterparts of acquis biogas is clearly mentioned as one of solutions to either mitigate or provide solutions of the topic. Such examples are transposition of EU Nitrate Directive, Regulation EC No 1774/2002 (with corresponding amendments) on laying down health rules concerning animal by-products not intended for human consumption; Kyoto and MPME protocols as being the most mentioned.

Transposition of EU Nitrate Directive to the national legislation as *Pravilnik o dobroj poljoprivrednoj praksi u korištenju gnojiva* (OG 56/08) shifted focus of livestock breeding farmers and companies to manure and its disposal. The Directive has four years adoption period where 210 kg N/ha is allowed after which follows the regular 170 kg N/ha. It also determines periods when the land application of certain types of fertilisers is prohibited. Croatian version of Nitrate Directive ends with recommendation that, if a husbandry lacks sufficient agriculture area for manure and slurry application, produced manure and slurry have to be taken care of as so that:

- Apply manure and slurry for fertilisation of agriculture area that is owned by somebody else. This application has to be based on a contract.

- Processing manure into biogas, compost or substrate;
- Taking care of manure in other ways (it is not specified what “other ways” are.).

It is hard to predict dynamics of enforcement but one could assume that the period of “non-management” or “improvisation in animal excrements disposal” is passing by. In addition to that, Croatian livestock production is somewhat concentrated: NW counties (Varaždinska and Međimurska) are known for their poultry production; middle North counties (Koprivničko – križevačka and Bjelovarsko – bilogorska) are known for cattle breeding while eastern parts of Croatia (Slavonia) are more orientated at pig breeding. Whereas Slavonia is predominantly agricultural region with possibility to find agricultural land for manure spreading, other parts of Croatia are not so abundant with land and agricultural areas.

Regulation EC No 1774/2002 (with corresponding amendments) on laying down health rules concerning animal by-products not intended for human consumption is transposed as *Pravilnik o načinu postupanja s nusproizvodima životinjskog podrijetla koji nisu za prehranu ljudi* (OG 56/06). It describes special conditions that an object for production of biogas and compost has to fulfil in Annex VI.

Although Croatia belongs to the Annex B countries of **Kyoto Protocol**, its actual ratification occurred in April 2007. According to the Kyoto Protocol, Croatia has the obligation to reduce the emissions of greenhouse gases from anthropogenic sources by 5% in the period 2008-2012 in comparison with the emissions in the base year (1990).

Croatia finished process of ratification of CRLTAP protocols in May 2008, by ratification of **Protocol to Abate Acidification, Eutrophication and Ground-level Ozone**, so called multi-pollutant/multi-effect protocol (MPME). The main objective of the Protocol is to monitor and reduce the total annual emissions of sulphur dioxide, nitrogen oxides, non-methane volatile organic compounds and ammonia from anthropogenic activities. Croatia is obliged to reduce SO₂ emission for 61%, NMVOC emission for 14%, NH₃ emission for 19% by 2010 in comparison with 1990, while NO_x emission should be in 2010 lower than emission level in 1990. National emission targets defined by MPME protocol are also national environmental strategy targets.

Utilisation of organic fraction of municipal waste as biogas feedstock could be considered as one of the **waste management tools for prolongation of landfill’s life time** since less volume of waste has been disposed. It also **prevents leaching of pollutants to underground waters**. Biogas is mentioned as one of recycling techniques in the Waste management strategy but to utilise organic fraction of municipal waste one has to introduce the whole system of separate collection and disposal of municipal waste.

Since livestock breeding occurs in rural regions, biogas production could be introduced as **new economic activity to the community**. The inputs-outputs flow could be very close to the sustainable concept of having locally produced feedstock and locally utilised output. Although it is most possible that electricity generated in biogas cogeneration plant will be sold to the grid in order to gain from feed-in tariff, heat and digestate remain outputs to be utilised locally.

8 Conclusions and Outlook

Although “renewable energy sources are of strategic interest to the Republic of Croatia” (article 14, Law on Energy, OG 68/01, 177/04 and 76/07), very little attention from top down stakeholders is laid on biogas itself. This could be interpreted in several ways. One could be that biogas is so strongly connected with farming and agriculture itself that asks for synchronised and coordinated action from at least two Croatian ministries: Ministry of Economy, Labour and Entrepreneurship that covers energy issues and Ministry of Agriculture, Fishery and Rural Development. If one adds positive contribution of biogas to GHG emission reduction and other positive environmental externalities, another ministry, Ministry of Environmental Protection, Spatial Planning and Construction should also join above mentioned two ministries. On the other side, compared to other renewable energy sources and within biomass types, biogas shows modest potential at national level since livestock production is concentrated in several regions only.

Despite the fact that biogas is fairly neglected (in Green Paper: Energy Strategy for Croatia (2008) biogas is mentioned only in one sentence) in strategic documents, biogas market is quite dynamic. Although biogas potential indicates its modest contribution to the national RES targets, it could contribute to fulfilment of other challenges such as Kyoto Protocol and Nitrate Directive. Nevertheless, at the regional/local level biogas could have more significant impact on local energy balances since livestock production is fairly concentrated in Croatia.

Farm owners are recognising benefits of biogas production from their own feedstock. In 2007, the first and only operating agricultural biogas plant has passed Environmental Impact Assessment which is one of the pre-requirements for obtaining eligible producer status. There are several announcements to build new ones. Response and expressed interest in this project is rather high. Local/regional authorities are organising public discussions at biogas topics and are willing to support future actions for biogas promotion at their area.

As it could have been seen from this report, our livestock farms are rather small and only few (if any) of them would be able to supply more than 1 MW installed capacity. According to the existing legislation on RES, utilisation of biogas in a cogeneration plant would be the easiest solution for biogas producers. In that respect, biogas purification and its injection to gas grid will be long before economically viable venture without growing energy crops or searching for feedstock in other sectors (food processing industry, expired foodstuff, kitchen waste etc.).

Closing this Summary Report on biogas potential in Croatia, one could not avoid recommending further research in biogas feedstock availability in sources beyond agriculture. In the respect of agricultural biogas plant developments, expanding this research to biogas contribution to GHG mitigation, Nitrate Directive and similar could be beneficial to activate local and regional authorities and include them closer to biogas market development.

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- Agroproteinka d.d.