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Geographic Distribution and Economic Potential of Biogas from Croatian Farming Sector

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Farming sector, in general, is a big producer of manure and thereby also a big producer of greenhouse gasses. Methane production from animals on farms should be seen as an opportunity in utilizing green and sustainable energy which would contribute to the reduction of green house effect. We can say that Croatian farming sector is still pretty undeveloped if we compare it to the other EU member states. This is one of the legacies from past state where agriculture was not something worth of heavy investments. This was not only the case for Croatian farming sector, but also Croatian agriculture in general for the last twenty or more years. However in the last five years there were a lot of improvements and investments in agriculture and in the farming sector. More and more questions regarding energy issues and energy management on farms are becoming important. But this is still not enough if we want to use all the resources and potentials available. The fact that there are still no serious biogas plants in Croatia's agriculture sector is just one of the indicators of underdevelopment of biogas utilization. All of this information with a promising increase in agricultural investing leads us to a question of total biogas potential for the farming sector in Croatia. Through this paper total biogas potential for Croatian farming sector will be shown with special emphasis on two most promising farming sectors: cows and pigs. After showing geographical distribution of that potential additional methodology of calculating economic aspect of utilizing biogas will be presented. One of the biggest barriers in utilizing biogas potential in Croatia are relatively small farms that are not capable of having economically viable biogas production. That is why community biogas plats will be important in increasing biogas utilization in Croatian farming sector. That is why a methodology for regional analysis of biogas potential of Croatian farming sector will be presented with cost assessment of community biogas power plants considering transport distances, transport costs and size of the power plants and family farms involved in community biogas production. The value of finding Croatia s farming sector biogas potential is also important since farms are consuming a lot of energy in their everyday operations and part of that energy consumption can be compensated from renewable energy source like biogas.

1. Introduction

Modern agricultural production demands new approaches regarding cost reduction, modernization and greenhouse gas control (Lund 2006). With the increase in fossil fuel prices, energy efficiency and renewable energy sources are becoming crucial aspect in economically viable agricultural production (Yiridoe et al. 2009, Schneider et al. 2007,

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Schaefer 2000, Lipošćak at al. 2006, Krajačić et al. 2011, Fowler et al. 2009). Biogas possibilities in agricultural sector is the most logical choice when addressing energy production, both heat and electrical, greenhouse gas reductions and manure management (Batzias et al. 2005, Dagnall et al. 1999, Kaparaju et al. 2009). During previous research (Puksec et al. 2010) basic methodology regarding technical biogas potentials in Croatian farming sectors were shown. One of the focuses of that work was the potentials of large Croatian farms and family enterprises regarding their technical biogas potential. One of the main shortcomings of that research was better understanding the possibilities of tapping biogas potential from Croatian family farms. The present situation is characterized with a lot of small family farms which do not represent economically viable enterprises. These kinds of farms do not have significant biogas potential and basically represent waste of energy regarding biogas production. Biogas potential of family farms is interesting information for finding out how much energy is dissipated and lost because of the inefficient agricultural system. Through this paper we will show what mechanisms are necessary to use and utilize some of the biogas potentials coming from Croatian family farms. Community digesters are the most logical solution in utilizing biogas potential from Croatian farming sector allowing farmers to manage their manure but also to participate through centralized community digesters and earn an extra profit for their farms (Raven et al. 2007, Taal et al. 2003, Danish Institute of Agricultural and Fishery Economics 1999). In this paper main focus will be on family farms whose main activity is cow and pig production. One of the key parameters influencing in viability of community biogas digesters in Croatia will be the distances between farms and digesters, feed in tariffs and manure prices in the case of other party ownership.

2. Methodology

Through this paper it is important to show how farmers can benefit from centralized biogas digesters. One option is to sell their manure to centralized biogas digesters operated by third party or to actively be involved in ownership structure of centralized biogas digesters. Our initial focus will be on biogas plants in third party ownership. First it is important to show what is the dependency between biogas plant size and profitability, in the case of Croatia. Also it is interesting to see what is the influence of feed in tariffs in the plant s profitability. Based on the profitability of a certain biogas size plant we can determine what is the maximum manure price at the biogas power plant (Pipatmanomai et al. 2009):

$$P_{PP} = \frac{\left(FIT \cdot \left(\frac{B \cdot E \cdot \eta_{CHP}}{1 + R_{el/heat}} \cdot A \right) \right) - (C_I - C_{O\&M})}{M_y} \quad (1)$$

Where: P_{PP} = Maximum price of manure at the biogas power plant (€/t), FIT = Feed in tariff (€/kWh), B =Yearly biogas production (m^3/h), E =Energy value of biogas (kWh/m^3), η_{CHP} =CHP efficiency, A = Availability (h/y), $R_{el/heat}$ = CHP electrical

energy/heat ratio, C_I = Investment cost (€), $C_{O\&M}$ = Operation cost (€), M_y = Yearly manure input of biogas power plant (t)

Next step was to calculate what would be the price of manure that could be paid to farmers. Price of manure that the farmers could sell to centralized biogas power plants was calculated through:

$$P_F = \left(\frac{P_{PP} \cdot M_F}{M_y} - (S \cdot D) \right) \quad (2)$$

Where: P_F = Maximum price of manure on the farm (€/t), M_F = Yearly manure production of a farm (€/t), S = Specific cost of manure transportation (€/t/km) (Yagüe et al. 2008), D = distance between the farms and centralized biogas power plant (km)

3. Results

Results of this research are presented for centralized biogas digesters up to 1 MWe, and are calculated with the current Feed in tariff for Croatia of 1.2 HRK (0,1632€). Even small increase in feed in tariffs leads to significant increase in profitability making this component very important when discussing centralized biogas plants (Figure1.)

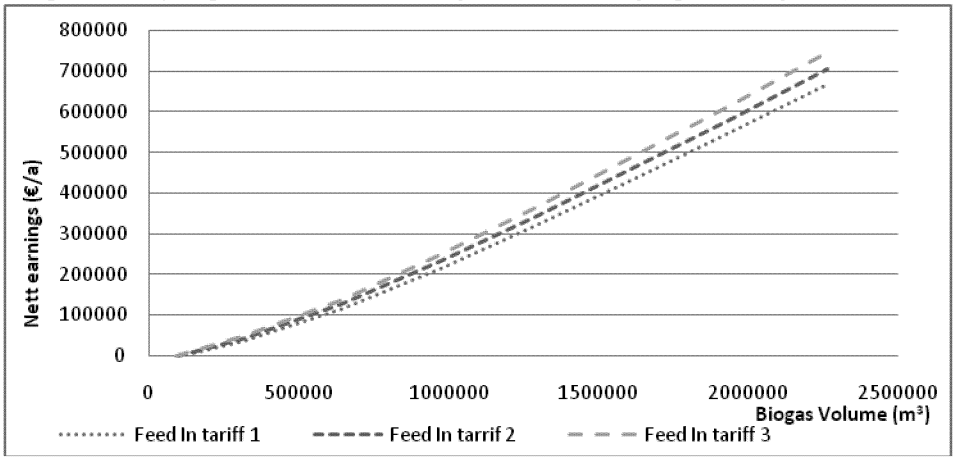

Figure 1: Biogas production and net earnings ratio

Feed in Tariff 1 is the current one valid in Croatia while Feed in Tariff 2 is 1.25 HRK and Feed in Tariff 3 was set on 1.3 HRK. An increase in manure price at the centralized biogas power plant is connected with the biogas plant size. Manure price increases with the size of centralized biogas plant (Figure 2.)

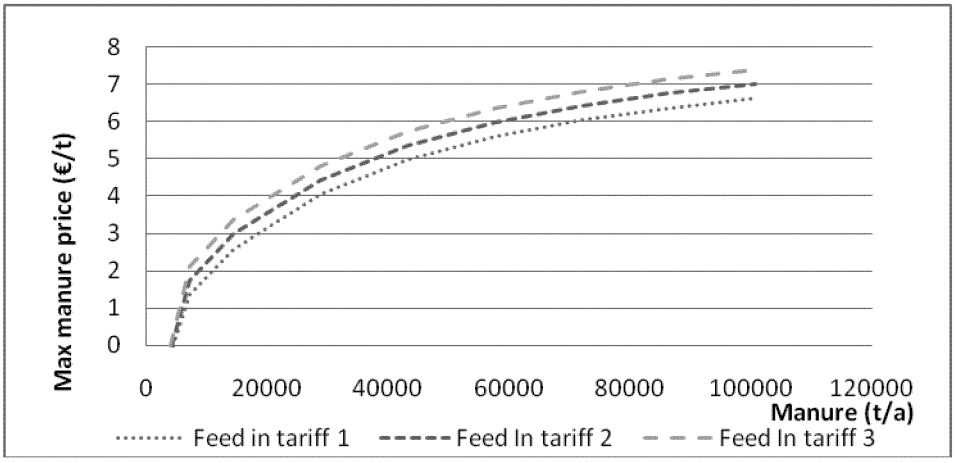

Figure 2: Maximum manure price at the biogas plant

The price of manure that the farmers can sell to third party owner of centralized biogas plant depends on few things: size of the centralized biogas plant, distance of a farm from centralized biogas plant and the size of the farm. On Figure 3 dependence of manure price on the farm and size of the farm can be seen.

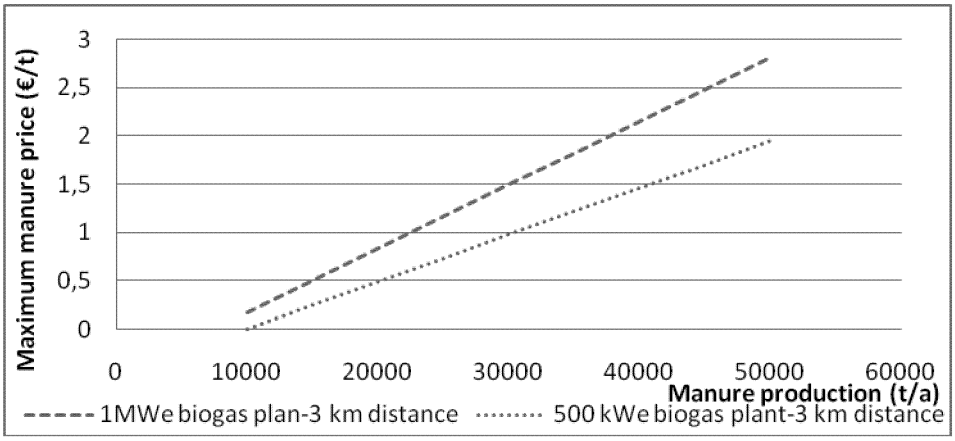

Figure 3: Maximum manure price on farm s location in dependence on the farm s manure production

Manure price that the farmer can get grows with the size of the farm. Also manure price on the farm decreases with the increase of distance between farms and centralized biogas plants (Figure 4).

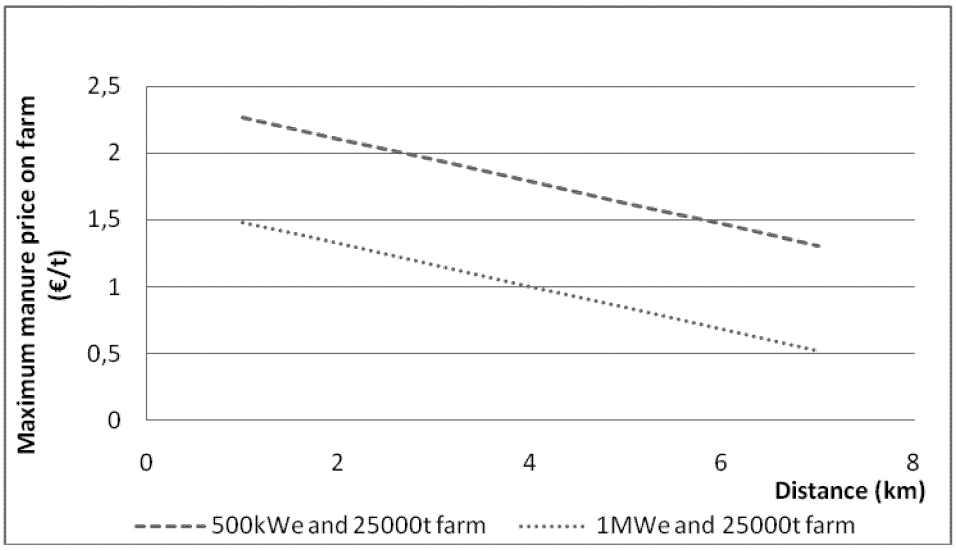

Figure 4: Maximum manure price on farm s location in dependence with farm s distance from centralized biogas digester

From this research it is visible that the price of manure from farms that are further than 10km from centralized biogas plant up to 1 MWe are just not applicable.

4. Conclusion

Centralized biogas plants are a possible solution for smaller family farms in Croatia. The profit itself is not the only and main reason for farmers to participate in this venture. Farmers that participate in centralized biogas plants have the opportunity to manage their manure which will surely be important issue in the future for Croatia. Farmers would have the opportunity to process their manure and get fertilizer substrate from centralized biogas plants and earn money from selling manure on the side. Feed in tariff is an important issue when discussing biogas plant profitability and should be considered sincerely. It is visible that the bigger family farms would have greater economic profit in selling their manure to centralized biogas plants.

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