An economically based ex-ante approach to analyze structural impacts of biogas support on agriculture - applied on the EEG 2009 in Lower Saxony (Summary of PhD Thesis T. de Witte)

Since 2000 German policy has been funding the generation of electricity from biogas within the framework of the "Erneuerbare-Energien-Gesetz (EEG)" (Renewable Energy Law). Farmers have been responding by investing heavily in the generation of biogas. By the end of 2011, there were 7.000 biogas plants with an electric capacity of 2.700 MW. The required agricultural resources cover about 8 % of the arable land in Germany. Over the years, the number of plants has been following the development of funding conditions.

Until the first EEG-amendment in 2004, energy was predominantly generated with liquid manure and waste materials from food processing. Since the EEG 2004's installation of a bonus for renewable primary products, mainly corn silage has been used. The second amendment to the EEG in 2009 improved the conditions for funding and introduced the liquid manure bonus to promote the fermentation of manure.

Even though the promotional terms are the same all over Germany, the generation of biogas is scattered very different throughout Germany. Whereas, in the mid-German areas of traditional arable farming the installed electric capacity is about 4 to 8 KW per 100 ha of arable land, regions in Germany's Northwest and South that are characterized by livestock farming show a capacity that is up to ten times higher. This is reflected by the percentage of energy corn: in the mentioned arable farming regions the proportions of energy corn are about 4 to 8 % of the arable land, the livestock farming regions in northwestern and southern Germany show up to 20 % of energy corn.

In the light of this and in view of the development of the EEG, politics depend on information about structural effects of different EEG-options. It is important to know a) what the decisive motivations for farmers are to invest in biogas and b) which operational reorganizations will follow those investments and c) what will be the consequences for the international competitiveness of different value chains.

Scientific policy advice mainly uses the agricultural sector model RAUMIS to perform ex ante analyses of agricultural land use for the funding of biogas. Model results about future energy corn cultivation expect parts of the regional concentrations of biogas generation to change. The results of modeling the competitiveness of energy corn cultivation show higher percentages of energy corn in arable farming regions. According to those results, the core regions in northern and northwestern Germany that have currently shown in nationwide comparisons will not be of special importance on the long run.

As it is a supply model it merely shows the regional competitiveness of energy corn cultivation in comparison with other crops. Therefore, investments in the generation of biogas have to be assessed with different models. First results of linking with the ReSI-M model have not shown a complete overview of the demand for energy corn substrate, either. Cause is that ReSi-M only considers some chosen factors that influence farmers.

Against this background, the thesis develops an economically based approach that facilitates for chosen types of region a) to identify important motivations for investment in the generation of biogas b) to analyze regional competitiveness of the generation of biogas and c) to trace specific regional direct and indirect structural effects from these findings. On this basis, conclusions for international competitiveness of different value chains can be drawn. The approach is being tested using EEG 2009 as an example.

The approach is partially basing on model calculations of different biogas plant constellation and typical farms. However, such an approach can not consider all regional locational conditions. For this reason, a dairy production dominated region, a region with intensive livestock farming and an area of arable farming are chosen that are assumed to have very different operational and local conditions for the establishment of a "biogas" branch.

Thus in Lower Saxony the administrative district Cuxhaven is chosen as a grassland area with high dairy concentration, the administrative district Cloppenburg as a region with a high density of livestock and the administrative district Hildesheim as an area of arable farming with a low concentration of livestock. The regional choice is limited to Lower Saxony, as a) by now the installed electric capacity is the highest b) the focus of the mentioned production areas clearly delineate from each other c) the individual production regions are relatively adjacent and questions of interregional exchange (e. g. liquid manure or fermentation substrate) can be analyzed appropriately.

Prior to calculating the specific regional competitiveness of the generation of biogas and to tracing the theoretic impacts on agrarian structure it is necessary to choose types of plants that are relevant under the conditions of EEG 2009. For this, cost effectiveness and profitability of different plant types are analyzed. The following results have shown up:

- Because of lacking economies of scale and thus high cost of capital, plants with a capacity of less than 100 kW can generally not operate economically.
- Among plants with direct electricity generation the highest returns are realized with an electric capacity of 200 kW to 500 kW and a percentage of 35 % of liquid manure. The absolutely highest returns are generated in plants of 200 kW. Plants of this size are subject to the highest wages and the most important willingness to pay for raw materials.
- Plants with biogas treatment and feed-in realize less returns and willingness to pay for raw materials than 200 kW-plants that directly sell the methane. But in case of elec-

tricity generation in heat-controlled decentralized 500 kW-combined heat and power generating units the realized returns can be compared to those of the 200 kW-plant. Due to low natural gas prices, it is much more favorable to use natural gas for electricity generation in heat-controlled combined heat and power generating units and to realize remuneration as per the act of combined heat and power generation. Therefore this type of plant is not subject to further analyses in this thesis.

– Even if varying important location parameters as costs for raw materials and waste disposal costs for fermentation waste, there are no changes in the excellence of these types of plants.

Against the background of these results, a 200 kW-plant with a percentage of liquid manure of initially 35 % is being chosen for the calculation of the regional competitiveness. For the analysis of the regional competitiveness the percentage of liquid manure and the mixture of raw materials are adjusted depending on regional and organizational conditions.

However, it remains unsettled whether or not the adaptations that have been calculated will be realized by the farmers or whether other factors could influence possible adaptations. Furthermore, important structural effects cannot be calculated. The question, whether or not farmers modify their organizational growth intentions in the light of the EEG is one of those. Therefore, farms having invested in the generation of biogas in the chosen regions will be subject to further studies.

In the following there is a summary of the most important findings regarding the structural effects of the EEG 2009. During a workshop the results have been confirmed by consultants that are familiar with the region.

– If the EEG 2009 remains unchanged, the generation of biogas will expand in dairy regions, as the highest yields and returns will be realized there. In this case, the biogas generating farmers will buy most of the energy corn from other dairy farmers that formerly produced cereals on these fields.

– Furthermore, there will be high growth rates in the areas with intensive livestock farming. The reasons for this are comparable yields because of synergies between biogas generation and broiler fattening even though the generation of biogas increases the already existing surplus nutrients. Additionally, farmers in areas with intensive livestock farming use biogas plants as a strategy to increase their competitiveness on the land market. When they are able to rent additional land they can increase their livestock production without becoming a commercial operation in fiscal terms.

– As the amount of organic fertilizers in the chosen regions is relatively small, there are additional transport costs. These costs diminish the yield of biogas plants in comparison to dairy regions or areas with intensive livestock farming. For this reason the quantity of new installations will be much lower. Unlike the situation in dairy regions

or areas with intensive livestock farming, biogas plants in the chosen regions do not cause direct land competition between biogas generation and livestock farming.

– The consultants agreed to the estimation, that the results of the present analysis are generally applicable to similar regions. In this context, they highlighted the limits of the individual ability to judge.

Furthermore, critical parameters are identified, that can change the future economic efficiency of the biogas plants in the regions.

– In the dairy regions, there is less arable land available than in other regions. In case of continuous increase in biogas generation and / or dairy farming, there will be a shortage of arable land that is not used for the production of corn silage. In this type of scenario, the operators of additional biogas plants have to compete directly with dairy farmers for the arable land. Given this situation, the opportunity costs for arable land would not be those from arable farming but those from livestock dairy farming. In the following, the cost efficiency of biogas generation will decline and the growth rates of biogas generation in the dairy region will decrease.

– In case of combination with livestock farming, biogas generation in the arable farming area could realize higher yields than in other regions. Yet, the low social acceptance towards livestock farming and the personal preferences of the operators make such investments in arable farming regions not likely.

– Even in case of a lasting rise in the numbers of new installments in regions with intensive livestock farming, no changes in cost efficiency of these regions' biogas plants are to be expected. Only the costs for the export of digestate will increase moderately because of the increasing percentage of nutrients – a fact that will only slightly influence the cost efficiency of the installations.

In the following it is analyzed, to what extend the identified structural impacts of the EEG 2009 influence the international competitiveness of individual value chains.

– In the value chain "poultry" the individual synergies between the generation of biogas and the fattening of broilers positively influence the whole sector. This is due to the fact that because of the synergies German broiler fatteners can even compensate production cost disadvantages of about 40 % of the direct costs.

– On the contrary, the international competitiveness of the value chain "pig" is diminishing. Reason for this is that the raising export costs for nutrients are increasing the production costs.

– A decrease in international competitiveness is to be anticipated in the value chain "dairy", too. This is caused of the fact that the demand for arable land in connection with the high economic rents of biogas generation increase costs for arable land and thus feed costs. Additionally, dairy farmers that invest into biogas plants do not in-

vest into growth steps that have been planned before. By not doing this they do not realize possible cost diminishing potentials due to economies of scale.

Contrary to other model results regarding future energy corn cultivation, the approach allows to understand differences in regional developments. Short-term adjustments are identified as well as the long-term parameters that are critical for regional competitiveness of biogas generation. In view of the development of agro-economic research, the question arises how results from such economic approaches can be integrated into agricultural sector models.

This thesis' approach to combine economic calculations with case studies has fundamentally proven to be an appropriate instrument to analyze structural impacts of complex political interventions as the funding of biogas. As interplays with structural and natural conditions are considered on regional as well as on operational side, it is possible, to capture the structural impacts differentiated by region. In this process, information is gathered, that could normally not be considered by statistic procedures. Examples are the changes in growth strategies of agricultural operators caused by political interventions. In the light of this it seems obvious, to use this approach to analyze comparable topics in the field of scientific policy advice.

For any future use of the approach to capture the structural impacts of alternative EEG options, primarily the economic effects of the alternative options have to be analyzed. Subsequently, the results of these calculations have to be evaluated in case studies with agricultural entrepreneurs. Operations of this kind have not been possible as part of this thesis as during its writing there have not been any concrete alternative policy options.