Size, subsidies and technical efficiency in renewable energy production: The case of Austrian biogas plants

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Executive summary

World electricity generation from biogases grew from 3.7 TWh in 1990 to 13 TWh in 2000 and 80 TWh in 2014. With an average annual growth rate of 13.1 % since 1990, biogases are the third fastest growing source of renewable electricity in the OECD, only outpaced by electricity from solar photovoltaic (44.1 %) and wind power (22.1 %). Germany, the US, Italy and the UK are the largest producers generating 39 %, 16 %, 10 % and 10 % of world production in 2014, respectively.

As many renewable electricity technologies, such as solar photovoltaic and wind power technologies, electricity generation from biogas struggles to compete with less costly but environmental unfriendly fossil fuel electricity generation technologies. Therefore, many countries promote the development and deployment of renewable energy, and electricity generation from biogas in particular. The IEA estimates that in 2015 150 billion dollars are spent to support renewable energy worldwide - with the United States, Germany, China, Italy, Japan, the United Kingdom and Spain leading the way. Feed-in-tariffs (FITs) for renewable electricity generation have become the preferred renewable energy support mechanism in EU member countries. For instance, Germany, the UK, Italy and France provide FITs for biogas plants.

Technical efficiency is an important determinant of a renewable energy plants´ unit cost and competitiveness. Therefore, analyzing and understanding the technical efficiency of renewable energy technologies is important to increase their competitiveness and to make them ready for the market. The objective of this article is to estimate the efficiency of biogas plants and identify determinants of inefficiencies. Data Envelopment Analysis (DEA) is applied on a sample of 86 Austrian biogas plants for the year 2014, covering about one third of the installed electric capacity of Austrian biogas plants. Technical efficiency is decomposed into pure technical efficiency (managerial efficiency) and scale efficiency. Thereby, we are able to distinguish between inefficiencies caused by inefficient operation (managerial inefficiency) and disadvantageous scale size (scale inefficiency). We test for returns to scale and determine the most productive scale size of biogas plants. In a second-stage regression analysis the effects of investment subsidies, production subsidies in the form of FITs, and other variables on managerial efficiency are investigated.

As far as we know, this analysis is the first exhaustive study on biogas plants using DEA. A novelty of this article is that a nearly complete set of inputs and outputs for a large sample of biogas plants is applied. Previous studies suffer from i) omitting essential inputs such as capital, heat or other costs and ii) small sample size. Contrary to standard radial efficiency measures a comprehensive efficiency measure is utilized, providing a more accurate performance index.

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While there exists a large literature examining the effect of subsidies on farm efficiency, only few studies analyse the impact of subsidies on the efficiency of renewable energy producers. As far as we know, we are the first examining the relationship between subsidies and managerial efficiency of biogas plants.

Our results indicate that the biogas production technology exhibits increasing returns to scale. Biogas plants with less or equal than 100 kW installed capacity are found to be scale inefficient due to positive scale effects. We find that plants with an enclosed digestate storage unit linked to the biogas collection system are more efficient. Moreover, the regression analysis suggests that biogas plants receiving higher production subsidies in the form of FITs have lower managerial efficiency relative to less subsidized plants. This result is robust after controlling for the size of the plant and a variety of plant type measures.

Plant operators could benefit from making their digestate storage units gas tight and linking them to the biogas collection system. This measure would not only increase efficiency but also reduces methane emissions making the biogas plant more environmentally friendly.

This study highlights that in addition to the presence of scale inefficiencies in the Austrian biogas sector, production subsidies in the form of FITs could stimulate substantial managerial inefficiencies. This article shows that the managerial inefficiency of biogas plants increases with the level of the production subsidy (FIT minus electricity exchange price) they receive. The result is consistent with the hypothesis that production subsidies provide a disincentive to managerial effort. FITs for agricultural biogas plants can be seen as an income enhancing tool for farmers rather than an opportunity to advance the biogas technology and might have contributed to reduce managerial motivation and effort of plant operators. In addition, subsidy induced managerial inefficiencies constitute an avoidable burden to electricity consumers..

Keywords Quippe: habes enim a rhetoribus; Aliter autem vobis placet.