# Factors influencing the spatial distribution of biogas production in Germany

[a] Lukas Scholz, [a] Andreas Meyer-Aurich, [b] Dieter Kirschke

lscholz@atb-potsdam.de

[a] Leibniz Institute for Agricultural Engineering

[b] Humboldt University Berlin

Selected Poster prepared for presentation at the Agricultural & Applied Economics Association´s 2013 AAEA & CAES Joint Annual Meeting, Washington, DC, August 4-6, 2013.

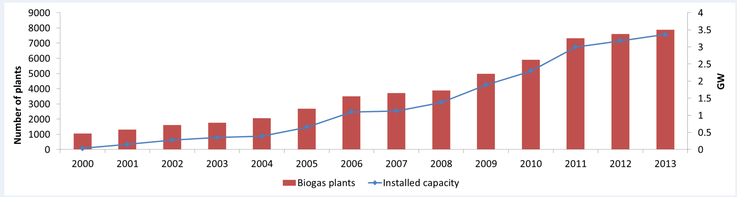
# Factors Influencing the Spatial Distribution of Biogas Production in Germany

**Lukas Scholz[1], Andreas Meyer-Aurich[1], Dieter Kirschke[2]**

[1] Leibniz-Institute for Agricultural Engineering, Potsdam, Germany [2] Humboldt University Berlin, Germany

## Dynamic expansion of biogas production

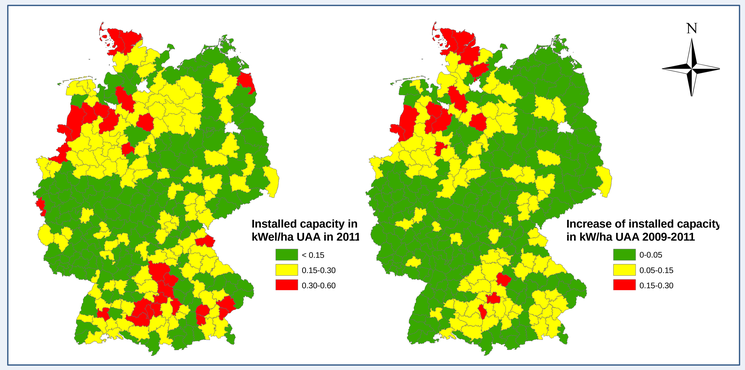
- The dynamic expansion of biogas production in Germany within the last decade was mainly driven by the economic-support-schemes provide by the Renewable-Energy-Source-Act (EEG).




- The amendments of the EEG in 2004 and 2009 triggered a boom in the development of biogas production in Germany.
- A further amendment of the EEG in 2012 and the accompany change of economic-support-schemes decelerated the dynamic development.

## Spatial distribution of biogas production

- Even though the economic-frame-conditions provided by the EEG are homogeneous among the German counties, a heterogeneous distribution and development of biogas production can be observed.



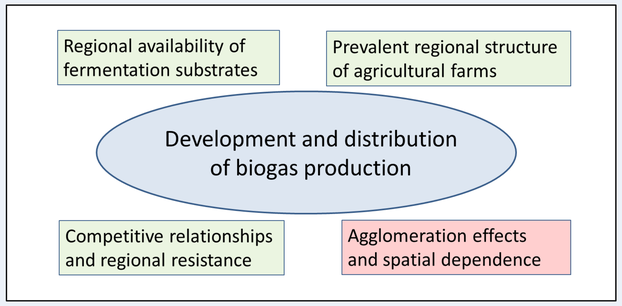

## Research Questions

- Why is the regional distribution and the development of biogas production not homogeneuos among the german counties even though governemental economic-support-schemes of biogas production provided by the EEG are?
- Can we explain the distribution and the dynamic development of biogas production in Germany by the concept of spatial dependence and heterogeneity?

## Methodological approach

- An econometric model that estimates the increase of installed capacity in $kW_{el}$/ha UAA (Utilized Agricultural Area) between 2009-2011 on the county level is used in order to answer the research questions.
- We hypothesis that heterogeneous location factors as well as spatial interactions between neighbouring counties influence the distribution and development of biogas production in Germany.
- If necessary, spatial effects will be incorporated in the econometric model in order to get unbiased and efficent estimates.

## Potential drivers of the development and distribution of biogas production




- For the potential drivers of the spatial distribution and development of biogas production proxy variables are identified.
- In a first step, a linear regression model using all proxy variables is estimated by the OLS-method (N=301).
- Diagnostic tests for spatial dependence suggest the incorporation of spatial effects in the regression analysis.
- Based on robust LM-tests, we choose a spatial-lag-model in order to express and test for spatial dependencies.

## Diagnostic tests for spatial dependence

| Test statistic | $\sqrt{y}$ |
|---|---|
| Moran's I (Transformed dependent variable) | 0.42 *** |
| LM (spatial error) | 2.86 * |
| Robust LM (spatial error) | 8.97 ** |
| LM (spatial lag) | 16.10 *** |
| Robust LM (spatial lag) | 22.22 *** |

Source: Own calculations $\sqrt{y}$= transformed dependent variable installed capacity in $kW_{el}$ / ha UAA;
First-order queen-contiguity neighbourhood matrix was used. ***,** indicates statistical significance at p< 0.001, 0.01, 0.1

## Estimation of the increase of installed capacity in $kW_{el}$/ha UAA (2009-2011)

| Variable | Estimate OLS-model | Estimate spatial-lag-model |
|---|---|---|
| Constant | 0.55 *** | -1.54 *** |
| Share of set aside-area (% of total UAA), 2003 | 0.12 n.s. | 0.08 n.s. |
| Silage maize to wheat yield-ratio, 2003-2008 | -0,02 ** | -0.02 * |
| Share of managers 45+ (total farm), 2010 | -0.42 ** | -0.31 ** |
| Installted capacity ($kW_{el}$/ha UAA), 2008 | 0.37 *** | 0.32 *** |
| Share of silage maize (ha UAA), 2003 | 0.12 n.s. | -0.05 n.s. |
| Share of grassland (ha UAA), 2007 | -0.11 *** | -0.08 * |
| Number of poultry (ha UAA), 2007 | 0.01 n.s. | -0.01 n.s |
| Number of cattle (ha UAA), 2007 | 0.07 *** | 0.06 *** |
| Number of pigs (ha UAA), 2007 | 0.01 * | 0.01* |
| Population density ($km^2$) | 0.01 n.s. | 0.01 n.s. |
| Spatial dependence ρ | / | 0.30 *** |
| Likelihood ratio $\chi^2$ | / | 16.31 |
| Prob. > $\chi^2$ | / | 0.00 |
| $R^2$ | 0.43 | 0.50 |
| AIC | -644.90 | -660.12 |
| BIC | -596.70 | -608.46 |

Source: Own calculations $\sqrt{y}$= transformed dependent variable installed capacity in $kW_{el}$ / ha UAA;
First-order queen-contiguity neighbourhood matrix was used. ***,** indicates statistical significance at p< 0.001, 0.01, 0.1

## Conclusions

- Heterogeneous location factors as well as the existence of spatial interactions between neighbouring counties can explain the spatial distribution and development of biogas production to a certain extent.
- Ignoring the existence of spatial dependencies leads to an overestimation of the impact of heterogeneous location factors on the distribution and development of biogas production in Germany.
- Possible explanation for the spatial dependencies observed might be knowledge-spill-over between operators of biogas plants as well as the activities of local consulting companies.
- On the policy level, the further development of the EEG should focus on the promotion of biogas production based on animal manure.

## Further information

Please contact lscholz@atb-potsdam.de for more information. The results shown are preliminary, please do not cite without permission.
We greatly thank and acknowlegde the financial support by the German Academic Exchange Service (DAAD).

**Leibniz-Institut für Agrartechnik Potsdam-Bornim e.V. (ATB)**
Max-Eyth-Allee 100 | 14469 Potsdam | Germany | atb@atb-potsdam.de | www.atb-potsdam.de