

Factors influencing prices for heat from biogas plants

Rome, November 2017

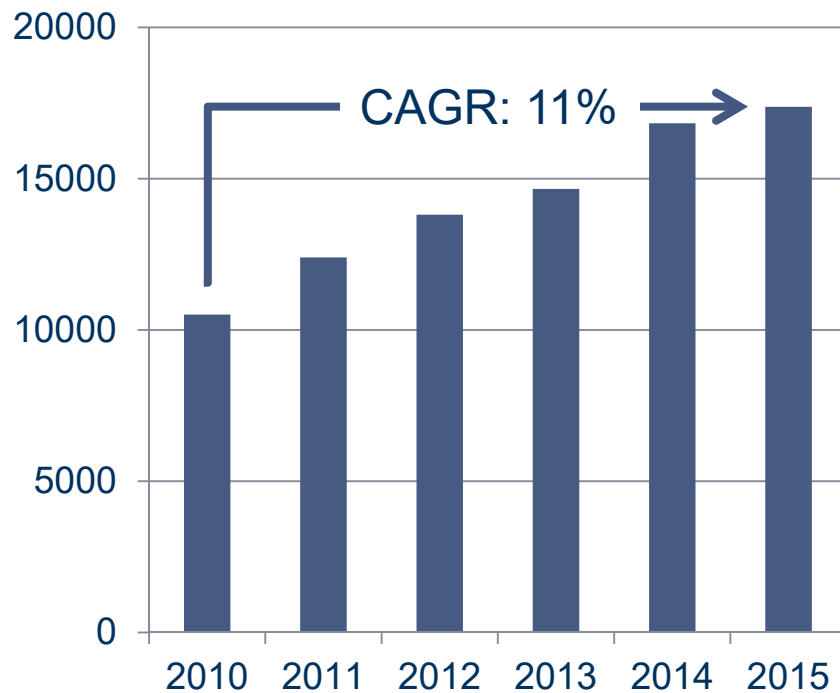
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Agenda

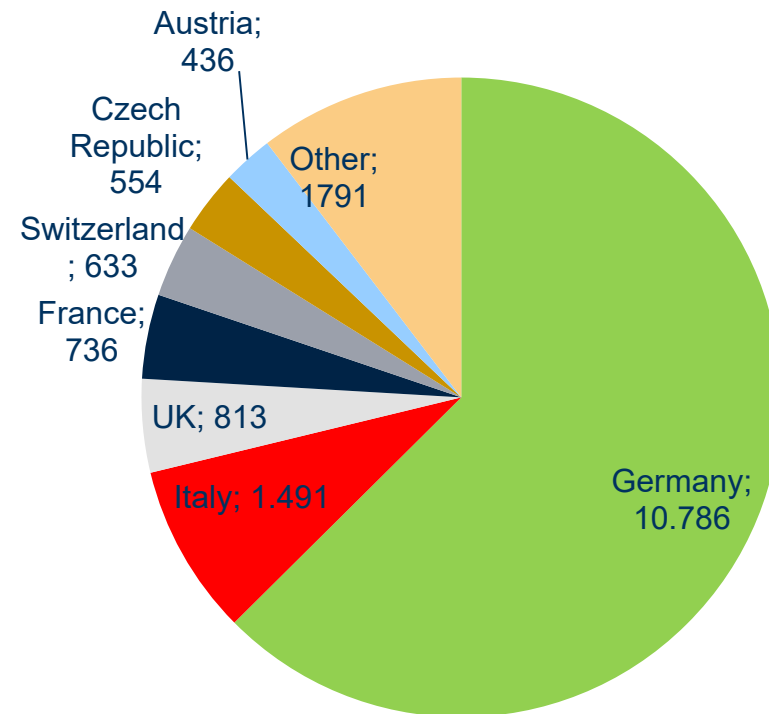
- Introduction
- Research question and hypotheses
- Methods
- Results
- Discussion and implications

Biogas plants in Europe by country 2015

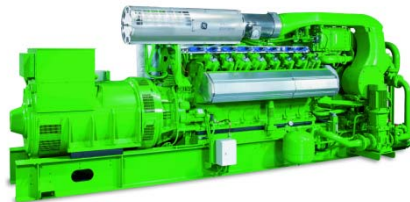
Development of the number of biogas plants in Europe 2010 - 2015



Distribution of biogas plants by country per end of 2014; total: 17.240



Using heat: large financial and ecological effects



Electricity: ca. 40%
Heat: ca. 45%

Financial perspective

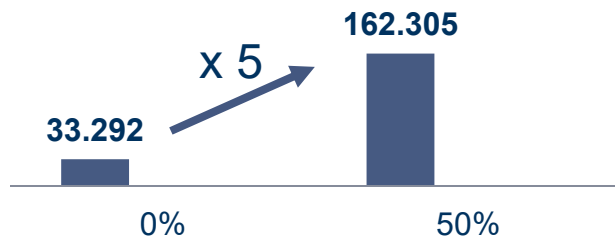
Significant profit increase through income from selling heat

Ecological perspective

Reducing GHG emissions by replacing fossil fuels

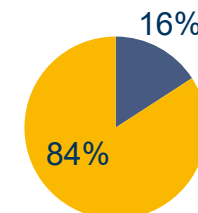
Utilizing biogas heat from a CHP unit

Profit of a 500 kW biogas plant depending on heat utilization [EUR/a]



(Nakazi et al. 2009)

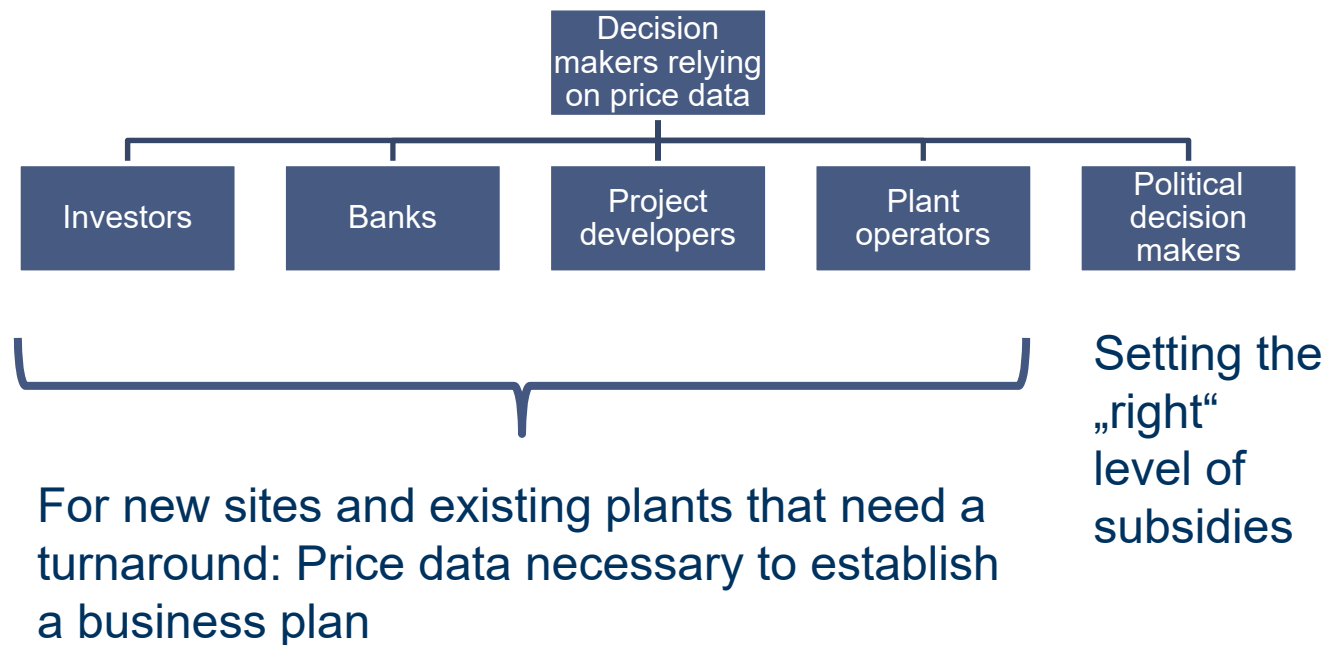
GHG reduction [CO₂ eq./MJ] of a 2.000 kW biogas plant, 50% heat utilization



(Lansche and Müller 2012)

Why do we need price data?

- Income from heat sales depends crucially on price
- BUT: no reliable data on heat prices

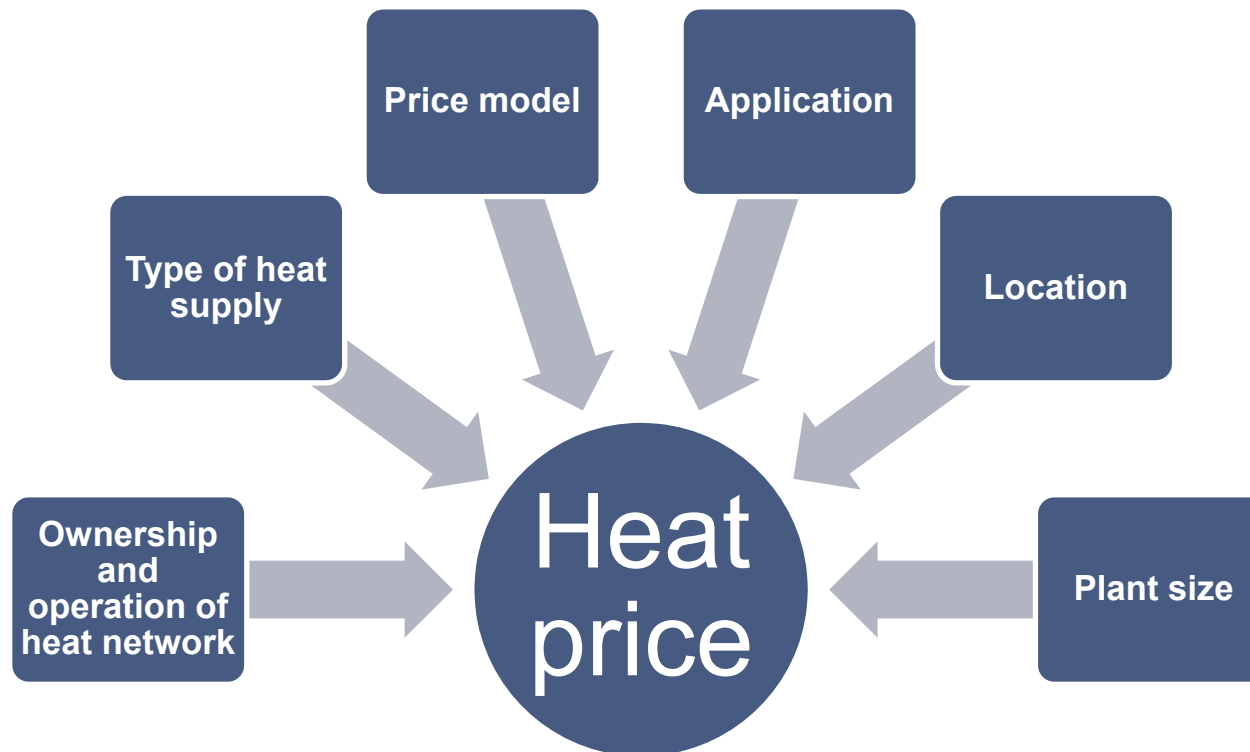


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Research question and hypotheses

Research question: “Which prices do biogas plant operators obtain for heat sold to third parties and which variables influence the prices?”



Hypotheses (1/3)

1. Heat network and supply type

- Hypothesis 1.1: Prices are higher if a biogas plant owns the network compared to a situation where it does not
- Hypothesis 1.2: Prices are higher if a biogas plant operates the network compared to a situation where it does not
- Hypothesis 1.3: Prices are higher if a biogas plant guarantees full supply compared to a situation where it does not

2. Price model

- Hypothesis 2: Prices are higher if the contract stipulates a fixed price as compared to a contract containing an annual price increase.

Hypotheses (2/3)

3. Application

- Hypothesis 3: There are significant price differences between applications

4. Location

- Hypothesis 4.1: The higher the population density (persons per square kilometer) in a region is, the higher the prices are that biogas plants can obtain.
- Hypothesis 4.2: The higher the GDP per capita (€/person) in a region is, the higher the prices are that biogas plants can obtain.

Hypotheses (3/3)

4. Location (continued)

- Hypothesis 4.3: The higher the GDP per square kilometer (€/sqkm) in a region is, the higher the prices are that biogas plants can obtain.
- Hypothesis 4.4: The higher the gross value added of the manufacturing sector per square kilometer (€/sqkm) in a region is, the higher the prices are that biogas plants can obtain.

5. Plant size

- Hypothesis 5: Larger plants (kWel) obtain higher prices

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Material and methods

- Sample: 2,724 biogas plant operators in the German Biogas Association (total ca. 9.000 plants in Germany)
- Online questionnaire, extensive pre-testing
- Fielding period: June 1st to September 8th 2016, two reminders, incentives for first participants
- Net sample size of 602 plants with 1.035 supplies: response rate of 22.1 % (AAPOR RR 2)

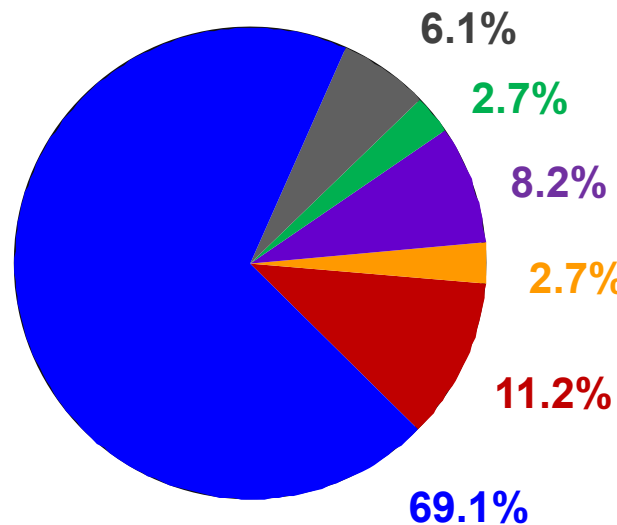
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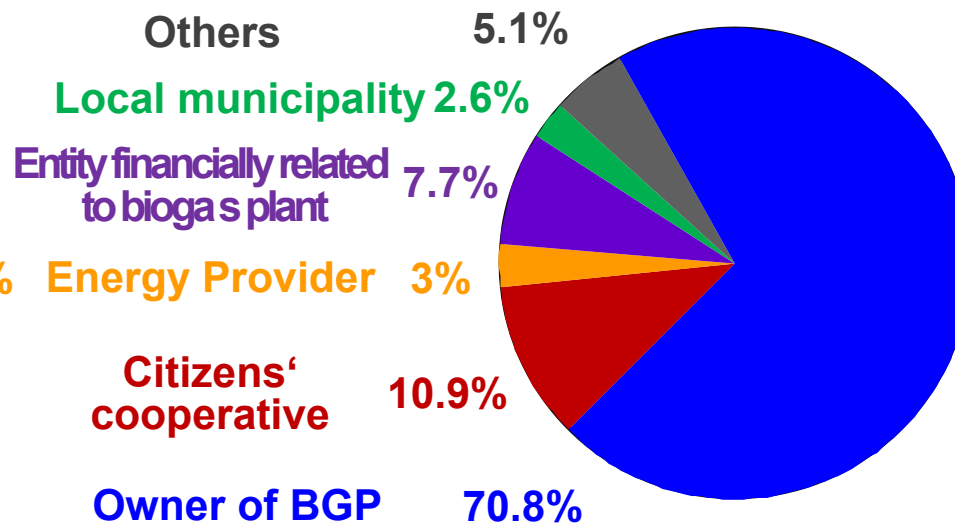
Results - Overview (1/2)

- Structure of Owner and Operator

Owner of Heat Network (n=525)



Operator of Heat Network (n=469)



Results - Overview (2/2)

- Structure of different usage types

| Usage of heat | Number of plants have this usage | Share of supplies with heat supply contract [%] | Average share of usage of plants' total heat volume [%]* | Share of supplies with security of supply [%] | Share of supplies with fixed prices [%] |
|------------------------|----------------------------------|---|--|---|---|
| Residential Building | 300 | 77 | 19 (28) | 32 | 49 |
| School or kindergarten | 66 | 94 | 3 (18) | 45 | 35 |
| Other public buildings | 89 | 87 | 2 (11) | 46 | 47 |
| Company buildings | 161 | 86 | 6 (17) | 35 | 36 |
| Grain drying | 137 | 23 | 3 (10) | 11 | 57 |
| Wood drying | 173 | 12 | 9 (22) | 5 | 76 |

* Not all plants supply into all usages. The number in parentheses give the share of each application only for those plants that supply into this application.

Results - Hypotheses (1/4)

- H 1.1: Prices are higher if a biogas plant owns the network compared to a situation where it does not
 - Biogas plant owner and financially related **vs.** other owners (2-Sample t-Test)
 - Plant owners receive **on average 1 Cent more** than others
 - Hypothesis 1.1 is supported (n=525 plants, $p \ll 0.001$)
- H 1.2: Prices are higher if a biogas plant operates the network compared to a situation where it does not
 - Biogas plant owner and financially related **vs.** other owners (2-Sample t-Test)
 - Plant owners receive **on average 1 Cent more** than others
 - Hypothesis 1.2 is supported (n=466 plants, $p \ll 0.001$)

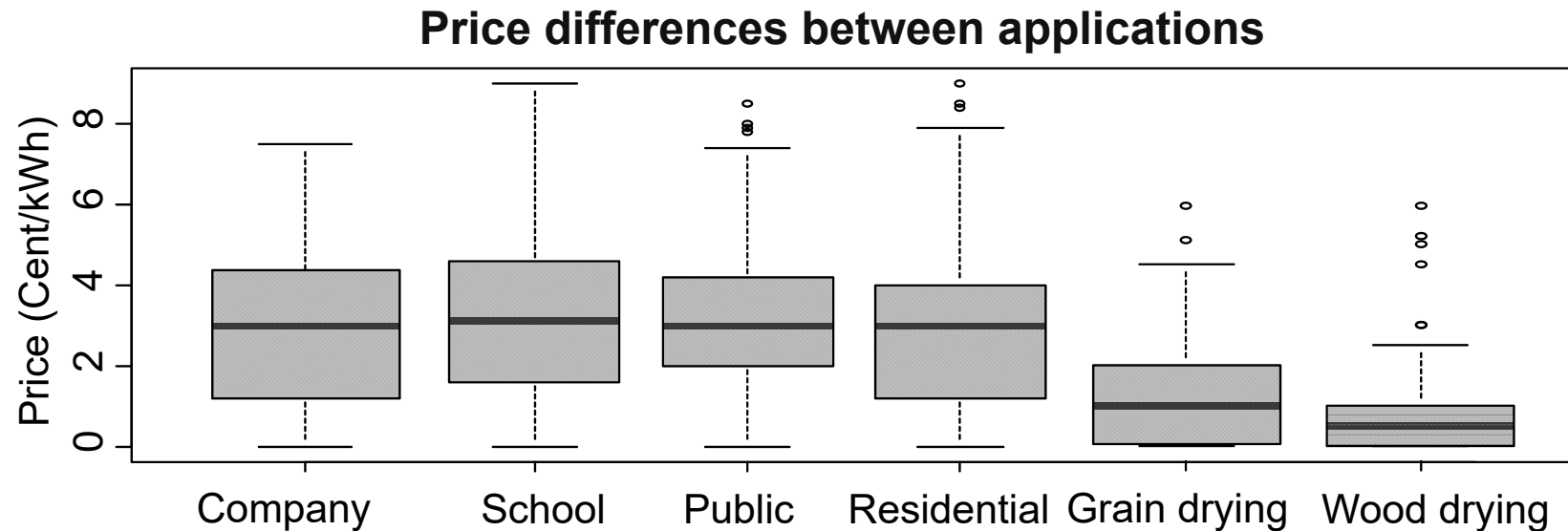
Results - Hypotheses (2/4)

- **H 1.3: Prices are higher if a biogas plant guarantees full supply compared to a situation where it does not**
 - Full supply guarantee **vs.** no guarantee
(2-Sample t-Test)
 - Supply guarantee obtains **on average 1.6 Cent** more than others
 - Hypothesis 1.3 is supported (n=968 contracts, $p \ll 0.001$)

- **H 2: Prices are higher if the contract stipulates a fixed price as compared to a contract containing an annual price increase**
 - Fixed prices **vs.** non-fixed prices
 - (2-Sample t-Test)
 - Fixed prices obtain **on average 1.4 Cent less** than non-fixed
 - Hypothesis 2.1 is not supported (n=946 contracts, $p \ll 0.001$)

Results - Hypotheses (3/4)

- **H 3: There are significant price differences between applications**



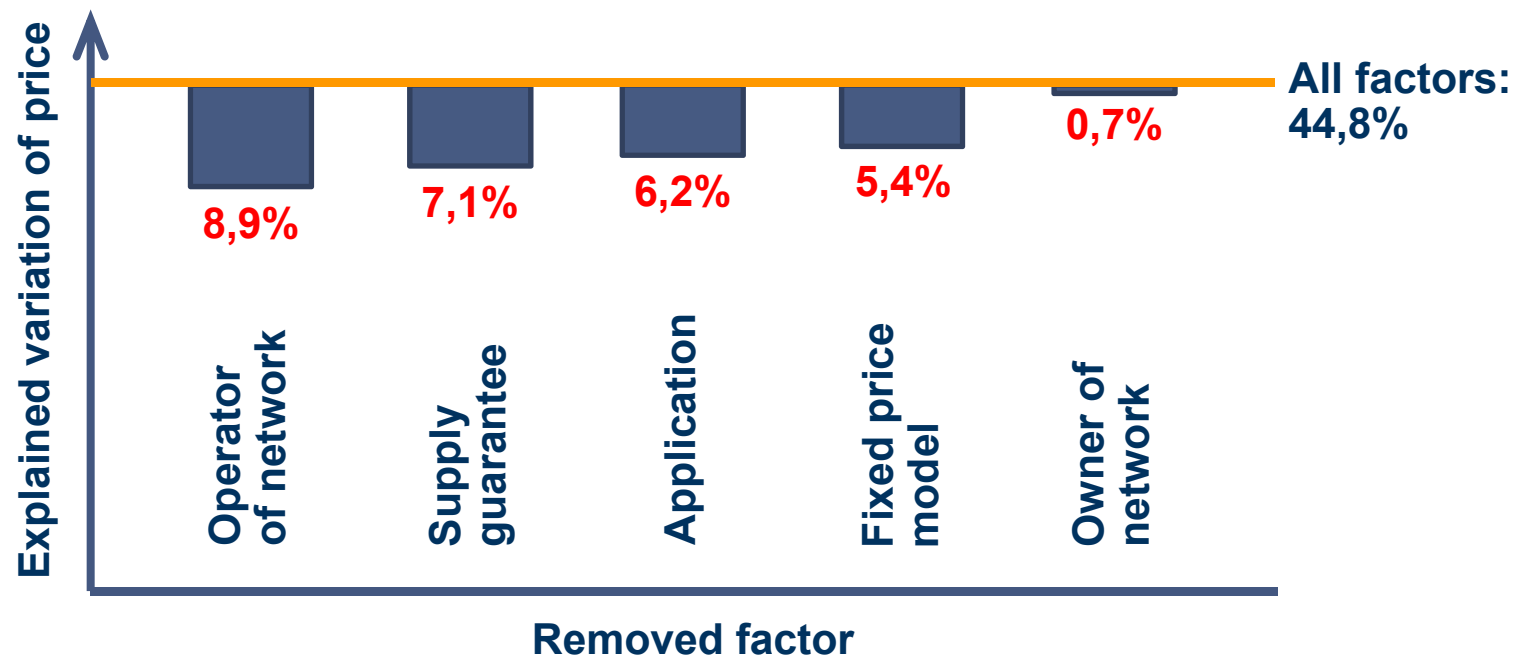
- Hypothesis 3 is supported (n=975 contracts, $p < 0.001$) (One-way ANOVA)
- Effect because of drying prices relative to other applications

Results - Hypotheses (4/4)

- **H 5: Larger plants (kWel) obtain higher prices**
 - Relation between plant size **and** received price (Regression Analysis)
 - Average price increases **only by 0.03 Cent** per 100 kWel
 - Hypothesis 5 is supported (n=586 plants, p=0.011)(very small effect)
- **The following hypotheses were not supported:**
(Regression Analysis)
 - H 4.1: The higher the **population density** (persons per square kilometer) in a region is, the higher the prices are that biogas plants can obtain
 - H 4.2 to H 4.4: The higher the **GDP per capita** (€/person), the higher the **GDP per square kilometer** (€/sqkm) or the higher the **gross value added** of the manufacturing sector per square kilometer (€/sqkm) in a region is, the higher the prices are that biogas plants can obtain

Results - Importance of factors

- Which factor is responsible for price variations?
 - Regression model with 5 factors (n=815 contracts, $p \ll 0.001$)
 - 44,8% of the variation (variance) of the prices can be explained
 - Importance by reduction of explanation when removing a factor



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Discussion and implications (1/2)

- Prices vary widely, site-specific factors on a micro-level seem to have a large influence on price distribution
- This implies a considerable risk lying in heat price estimations for business plans
- Implication for project developers, investors etc. for both new plants and existing plants they want to turn around: project planning has to be more advanced than for other parts of the project; preliminary negotiations with customers are necessary to narrow down the range of potential price points

Discussion and implications (2/2)

- Implication for political decision makers: there is no „right“ level of subsidies that ensures biogas growth without over-subsidization of some plants
- Devising a uniform feed-in-tariff for electricity produced by biogas plants of a certain type, e.g. size or input material, invariably means over-subsidizing some projects while preventing others from being built
- But: for the first time, there are reliable price data to estimate the effect of setting subsidy levels on the profitability of biogas plants