HOCHSCHULE OSNABRÜCK
UNIVERSITY OF APPLIED SCIENCES

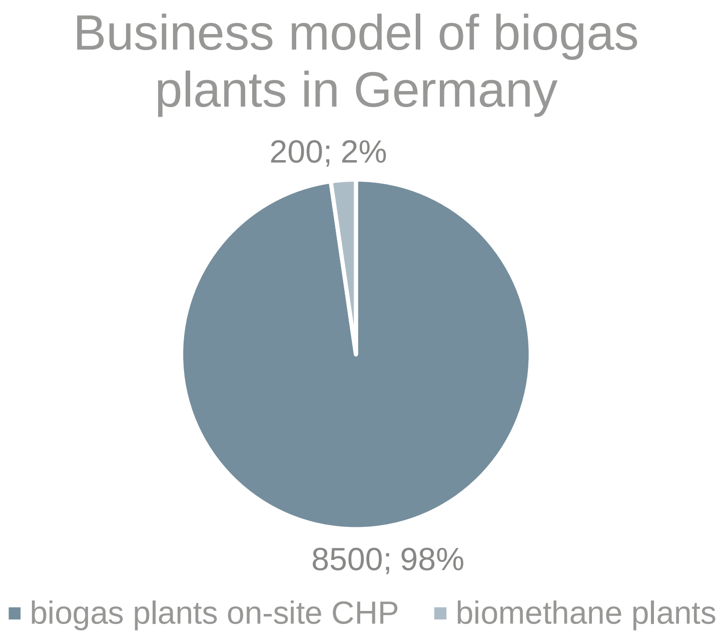
EXPLOITING POTENTIAL FOR ECONOMIES OF SCALE IN BIOGAS PURIFICATION INFRASTRUCTURE

A. Mertins, T. Wawer

Source: Natascha - stock.adobe.com

Framework

- Current business model:
  combined on-site heat and power generation
- Changes in regulation in Germany and coupling of sectors
  → new business models required
- Approach:
  biogas purification and injection into the natural gas grid



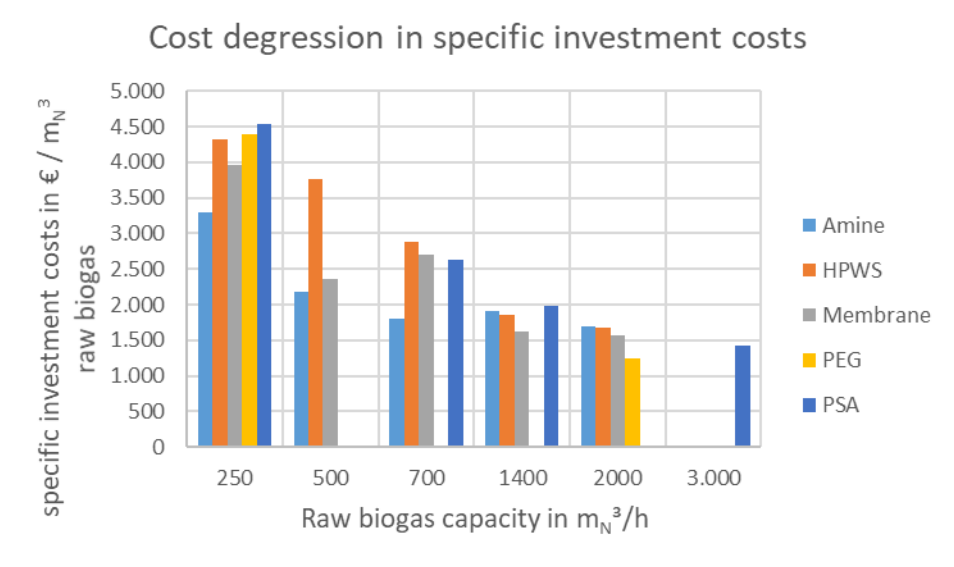
Source: Daniel-Gromke et al. (2017)

Advantages of biomethane

- New business models for existing biogas plants
- Greenhouse gas savings
- Flexible and universal applicability
  - Off-site CHP generation
  - Fuel replacement in mobility sector
  - Heat market
- Use of an existing infrastructure

Synergy effects

- Degression in investment costs for purification plants
- Smallest size (250 m_N^3) exceeds average production of biogas plants in Germany (180 m_N^3) and the research region (150 m_N^3)



Source: Beil et al. (2019)

Approach

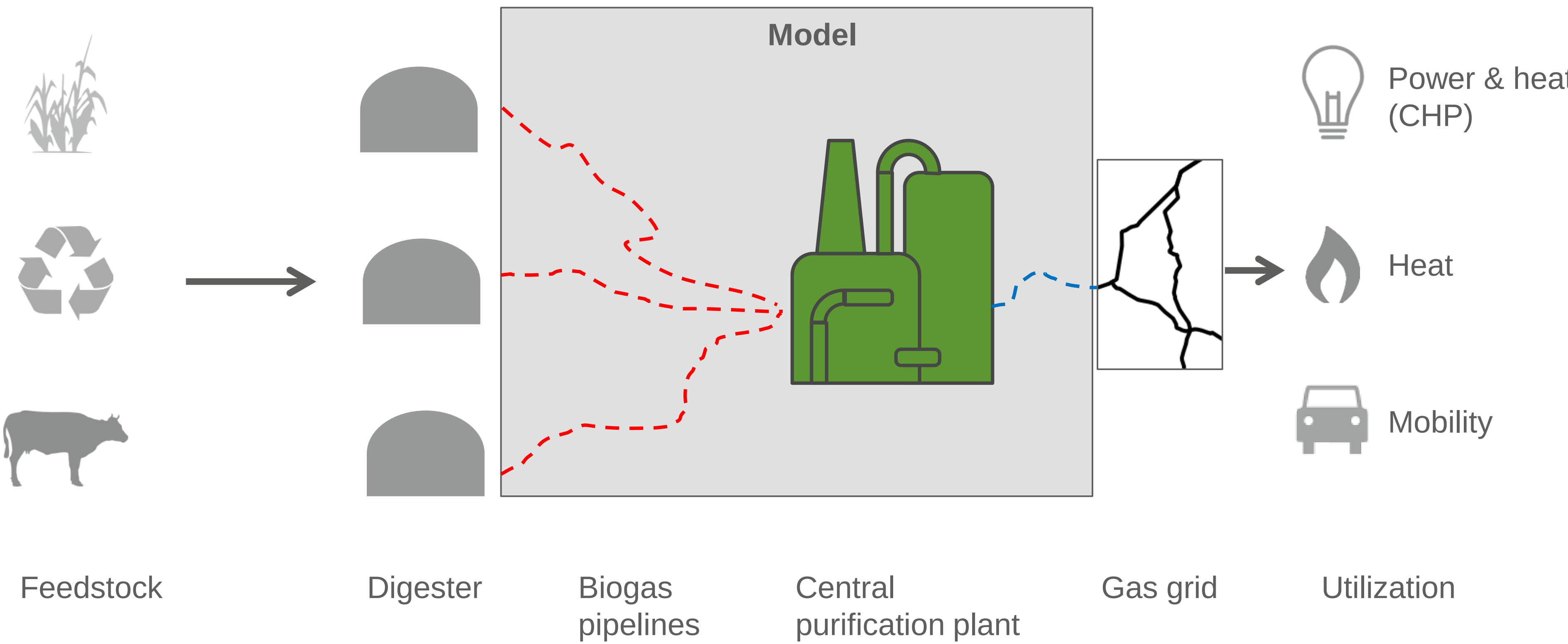
- Purification and distribution infrastructure is needed
- Different impurities
  - desulphurization and dewatering
  - removal of carbon dioxide
- Minimize system costs for biogas purification by cooperation
  - Costs for upgrading plants (investment costs and annual expenditure)
  - Costs for pipelines (investment costs)

Research hypothesis:
Construction of a joint purification plant including biogas pipelines is economically advantageous compared to individual on-site purification infrastructure

Biogas
Methane concentration: ~ 54 %

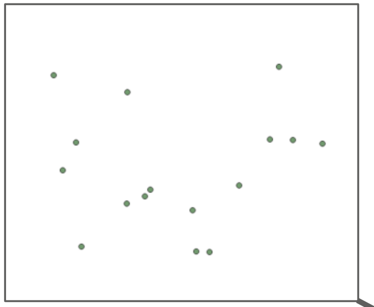
→

Biomethane
Methane concentration: ~ 95 %

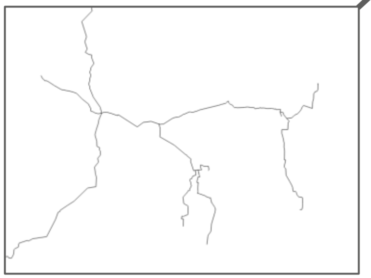


Regionalperspektive BIOGAS

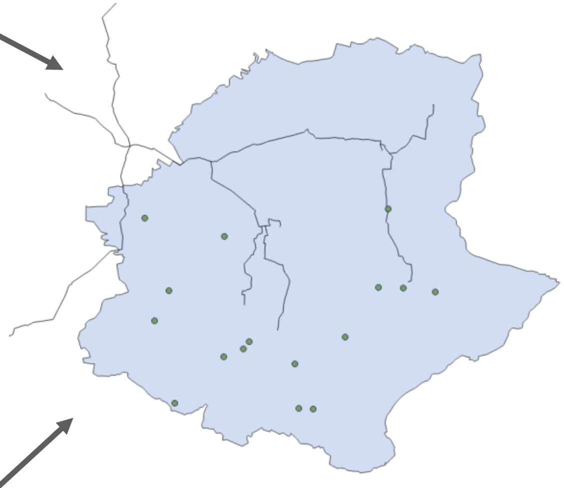
HOCHSCHULE OSNABRÜCK
UNIVERSITY OF APPLIED SCIENCES



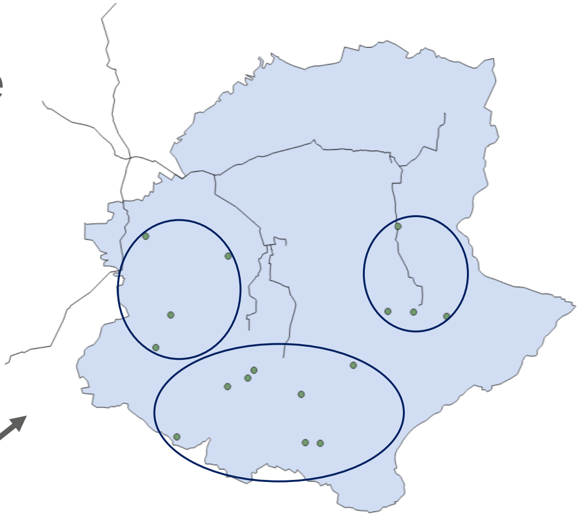
Existing biogas plants

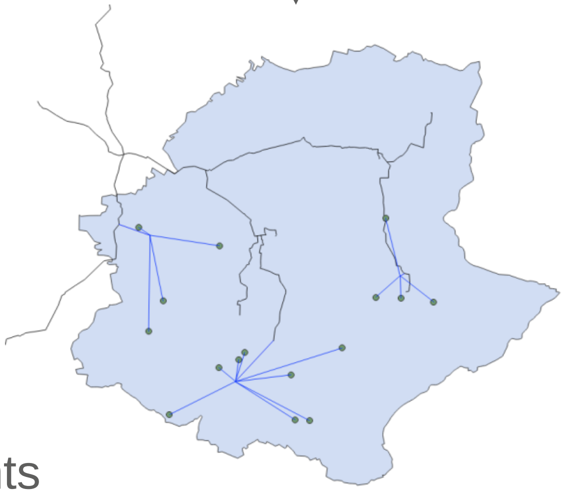


Existing gas grid



Clusters are created by K-means algorithm



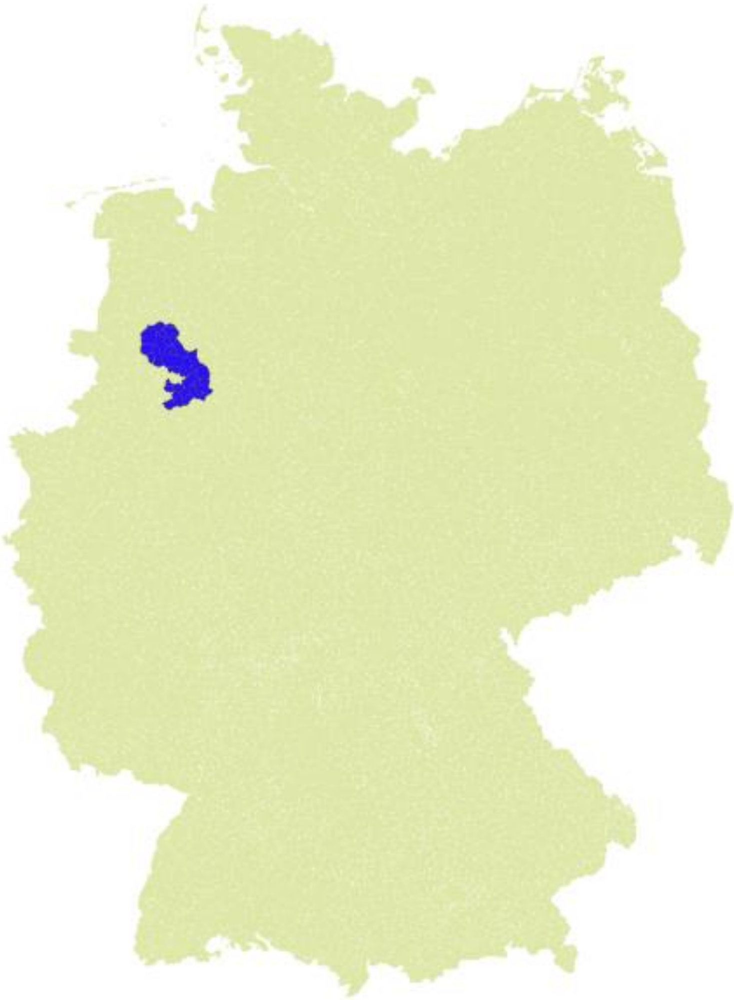


Solution:

- Pipeline
- Purification plants

Case study

- Reference region: administrative district of Osnabrück county
- 90 biogas plants in the region
- Average biogas plant size
  - Raw biogas volume: 150 m_N^3/h
  - Installed capacity: 560 kW_{el}
- No existing biogas purification to biomethane

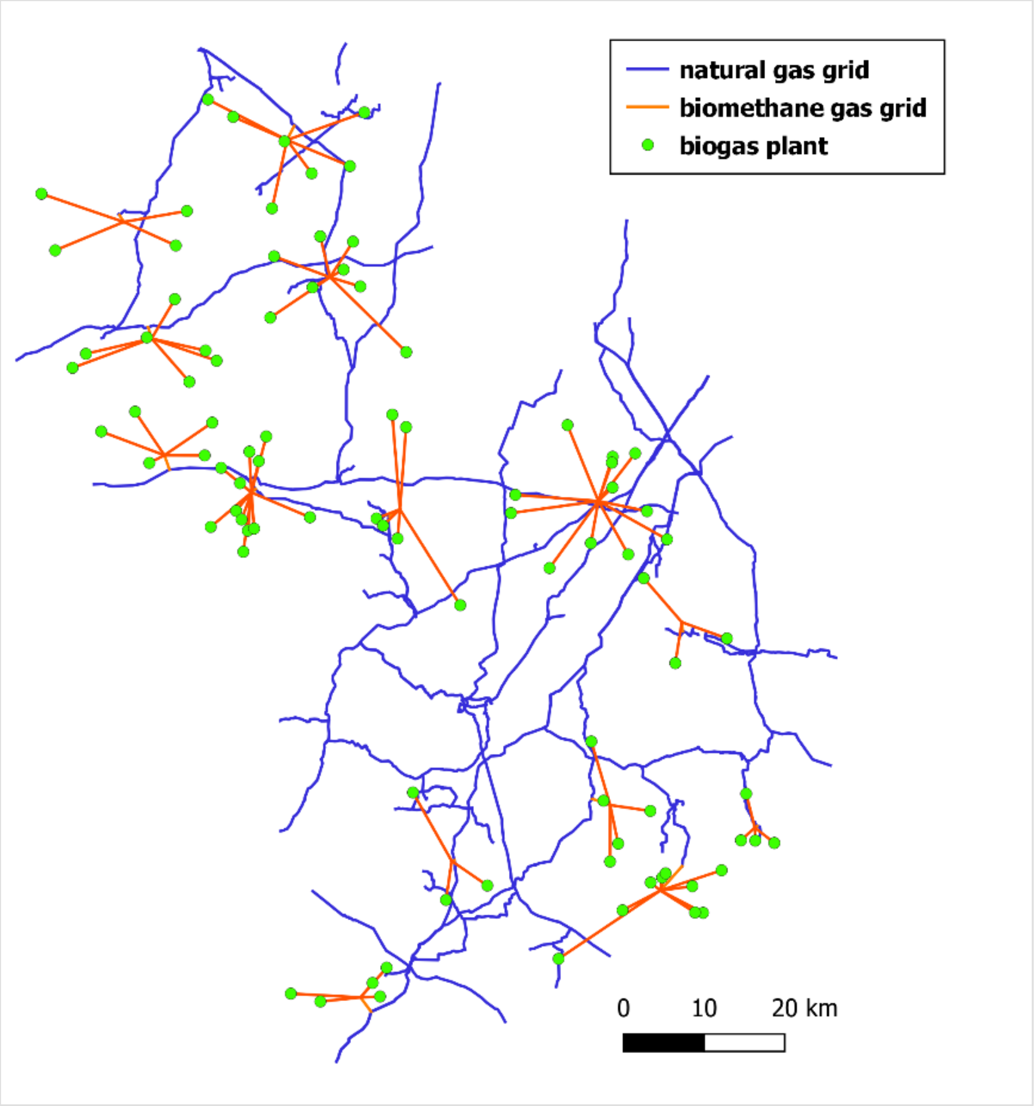


Regionalperspektive BIOGAS

HOCHSCHULE OSNABRÜCK
UNIVERSITY OF APPLIED SCIENCES

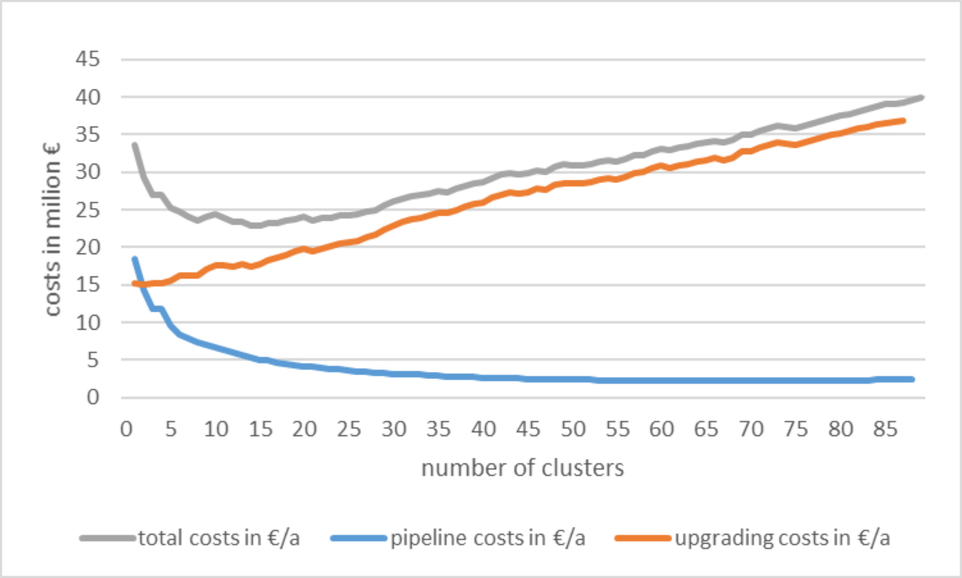
Results

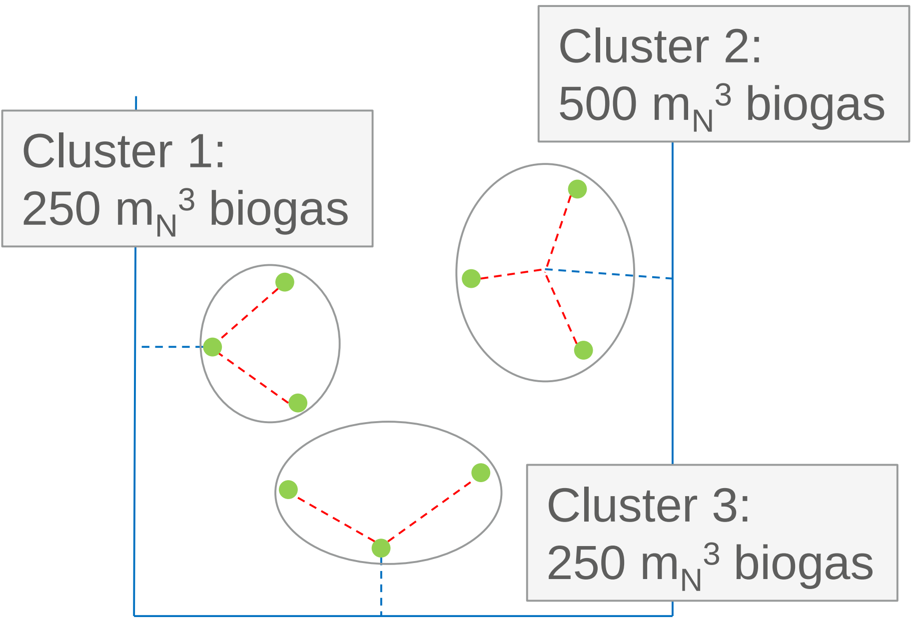
- Individual purification:
  - Annual system costs: 39.87 million euros
  - Even the smallest purification plants are significantly overdimensioned
- Joint purification:
  - 14 clusters (3 -12 biogas plants)
  - Annual system costs: 22.82 million euros
  - Cost savings: 43 %

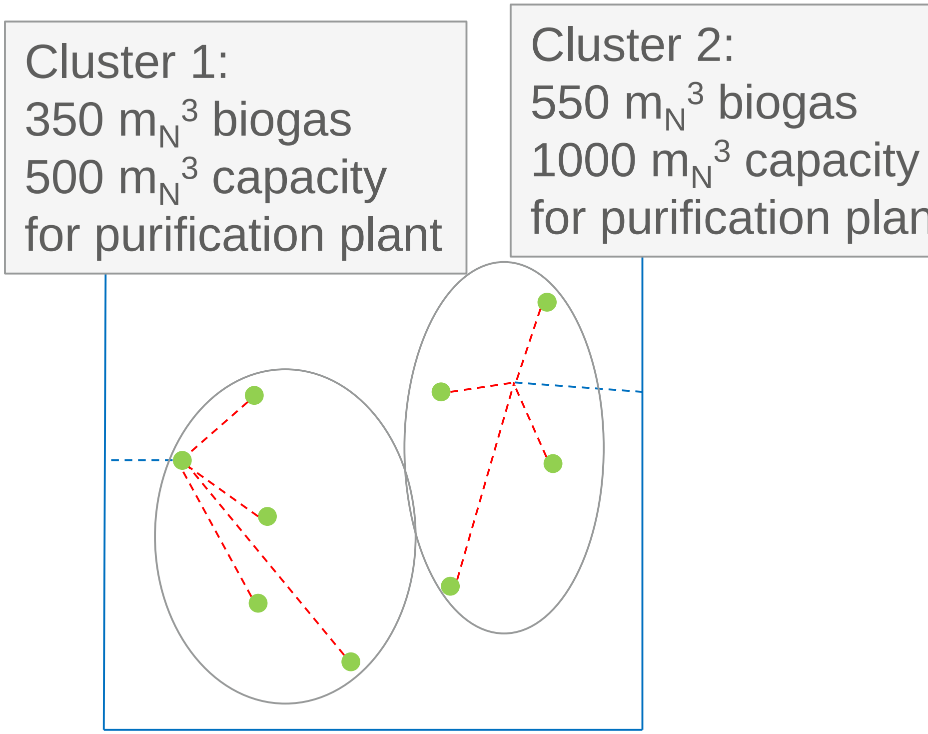


Results

- Purification costs in individual facilities significantly higher
- Pipeline costs for fewer clusters higher
- Make use of spatial proximity of biogas plants
    - Cooperation
    - Exploitation of cost degression







3 Clusters:
System costs: 261,113 € per year
Capacity optimally used

2 Clusters:
System costs: 275,425 € per year
Worse utilization of capacity leads to higher costs

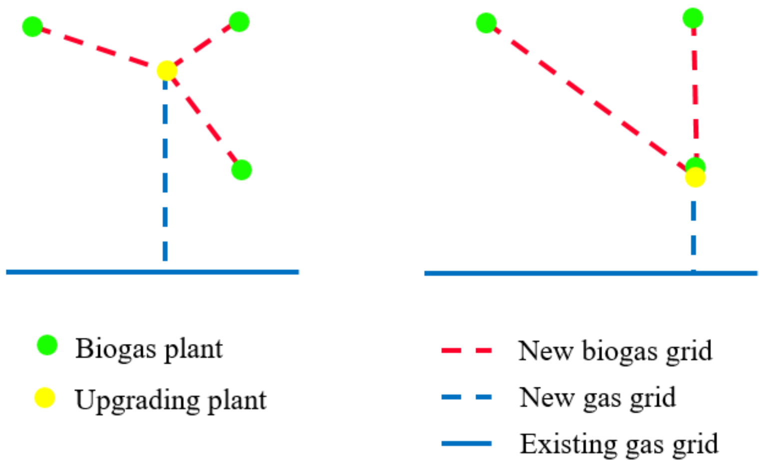
Regionalperspektive BIOGAS

HOCHSCHULE OSNABRÜCK
UNIVERSITY OF APPLIED SCIENCES

Variation of upgrading plant location

- NP-hard optimization problem
- Two possible locations for purification plants are provided

- First approach:
  purification plant is placed at the center of the cluster
- Second approach:
  purification plant is placed next to the biogas plant closest to the gas grid
- Cost-optimal option is selected by model



Conclusions and policy recommendation

- System costs are almost reduced by 50 % using joint purification
- Economics depend on
  - Availability of gas infrastructure
  - Options of cooperation
- Verified with real data
  - Highly relevant for further infrastructure development
  - Flexible adaptation to local requirements of other regions
- Next steps
  - Examination of the economic efficiency in detail
  - Feasibility depends on various framework conditions (e.g. acceptance of biogas plant operators)

Regionalperspektive BIOGAS

HOCHSCHULE OSNABRÜCK
UNIVERSITY OF APPLIED SCIENCES

Thank you for your attention!

Contact:

Anica Mertins
+49 (0) 541 969 2333
anica.mertins@hs-osnabrueck.de

Anica Mertins, M.Sc.