OPTIMIZED OPERATION OF FLEXIBLE BIOGAS PLANTS

Results from the projects BioStrom & OptFflex

22nd EU BC &E 2014

Martin Dotzauer, DBFZ
Agenda

• Background & objectives
• Technical challenges
• Methodology of scenario screening
• Intermediate results
• Conclusions & outlook
Background

- Increase of controllable load by transformation of the electrical power system with high shares of wind and solar power
- Introduction of the „flexible premium“ within the amendment of Renewable Energy Source Act in 2012 for flexible biogas plants
- Limited potential for new biogas plants in Germany leads to the fact that existing plants are the critical element to gain flexibility
- Heterogeneous state of the art in existing biogas portfolio, referring to technical and structural conditions
- Optimal retrofitting of existing plants depends major on technical and economic frame conditions
Objectives

BioStrom
• Development of different approaches to transform existing biogas plants into controllable electricity producers via dynamic simulations
• Implementation of a concept on an existing biogas plant
• Verification of simulation and practical plant operation

OptFflex
• Identification of ideal management strategies for the flexibilisation of biogas plants based on the modelling of practical plants
• Characterise flexibilisation paths for different types of practical plants
• Suggestions for strategies how to adopt old plants to new market and system requirements
Flexible biogas plant

CHP power generation

biogas production

Source: DBFZ 2014

gas storage level

Source: DBFZ 2014
BioStrom – focus on components

- Components for storage monitoring

- Important for power shifting
- Balancing gas storage
  - Gas composition before and after gas storage
  - Incoming and outgoing flow rates
  - Standardisation of the gas storage volume
- Weather Data
  - Solar Radiation
  - Wind

Components for storage monitoring:
- Flow rate
- Gas composition
- Temperature/Pressure
- Weather station
- Water level gauge system
- Residual storage
- Digester
- Post Digester
- CHP 1
- CHP 2
- Heat
Incentives for flexible generation

• Analysis of the need for controllable electricity production

• Which Instruments define the Schedule for the Flexible Electricity Production?

• Energy only market:
  o EPEX Spot SE (Day ahead)

• Network services
  o Control power (secondary c.p.)

[Graph showing average electricity prices 2013 (hourly)]

OPTFLEX – Current stage of development

Source: DBFZ 2014, data base BNetzA 2014

Amount of the flexible premium until May 2014

Cumulated capacity [MW]

Number of plants

Source: DBFZ 2014, data base BNetzA 2014
OPTFLEX – Scenario design

- state of the art, pre-flexibility and additionally 8 scenarios
- technical adjustments (degree of flexibilisation)
  - Partial flexibility (part.)
  - Full flexibility (full)
- management adjustments (time table creation)
  - Hypothetical optimum without restrictions (free)
  - Under practical restrictions (restr.)
    - if necessary need for additional gas-, heat store in case of extension
- Target indicators are
  - Earnings on energy markets and the influence on refund
  - Costs for new capacities (CHP, gas storage)
OPTFLEX – Sample plant

• Biogas plant built up 2004, extended for flexibility in 2013
• 4 CHP: 190 kW, 2x380 kW, 250 kW (first time flexibilisation)
• 3 500 m³ gas storage, lasting for 5.4 hours of gas production
• First step: Scenarios based on state of the art
• Second step: scenarios with intended extension with additional CHP of 550 kW (marked with “+”)

Source: DBFZ 2014
OPTFLEX – Intermediate results

Source: DBFZ 2014
## OPTFLEX – Intermediate results

**Source:** DBFZ 2014

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<th>const. part.</th>
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<td>0</td>
<td>58K</td>
<td>1K</td>
<td>38K</td>
<td>-21K</td>
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</table>

**Optimization - State of the art**

- sec. control power
- flexibility-premium
- EPEX-extra
- EPEX-earning
- market-earning
- sum

![Graph showing optimization state](image-url)
OPTFLEX – Intermediate results

Source: DBFZ 2014

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### OPTFLEX – Intermediate results

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<td>8K</td>
<td>61K</td>
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Source: DBFZ 2014
### OPTFLEX – Intermediate results

**Source:** DBFZ 2014

#### Optimization - Extended

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<th>E</th>
<th>F</th>
<th>I</th>
<th>J</th>
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</thead>
<tbody>
<tr>
<td><strong>Revenue [thousand €/a]</strong></td>
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<td></td>
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<tr>
<td></td>
<td>1.70</td>
<td>1.60</td>
<td>1.50</td>
<td>1.40</td>
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<td>1.40</td>
<td>1.30</td>
<td>1.20</td>
<td>1.10</td>
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</table>

**Techn. part. + full:**

- **Free**
- **Restr.**

**CHP-rate:**

- **-66K**

**Diff. [€]:**

- **67K**

**Note:**

- sec. control power
- flexibility-premium
- EPEX-extra
- EPEX-earning
- market-premium

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<td>Free</td>
<td>Restr.</td>
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OPTFLEX – Conclusions & outlook

• Flexible power generation by biogas plants is an increasing business.
• In both projects observed plants can optimize their revenue by technical and management adaptions.
• The feasibility and the economic optimum depends on individual pre-requisites
• Decentralized biogas plants could serve an option to reduce grid stress by balancing regional intermittent feed-in
• Under the existing framework flexibilisation can be realized to met todays and also future energy system requirements
Many thanks for your attention!

**OPTFLEX**
Dotzauer, Martin
phone. +49 (0)341 2434 – 385
mail: martin.dotzauer@dbfz.de

**BioStrom**
Häring, Georg
phone. +49 (0)841 9348 – 6410
mail: georg.haering@thi.de

Project profiles:
OPTFLEX – State of the art time table

timekeeping, practical plant (7 days)

Source: DBFZ 2014
BioStrom – Intermediate results

- Concept Examples

<table>
<thead>
<tr>
<th>No additional gas storage</th>
<th>Additional gas storage</th>
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</thead>
<tbody>
<tr>
<td>2x $530 \text{kW}_{\text{el}}$</td>
<td>2x $530 \text{kW}_{\text{el}}$</td>
</tr>
<tr>
<td>max. shift of electricity production: 6 h</td>
<td>max. shift of electricity production: 12 h</td>
</tr>
<tr>
<td>feasible additional revenue at the electricity market*: 25,750 €/a</td>
<td>feasible additional revenue at the electricity market*: 24,720 €/a</td>
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</tbody>
</table>

* Feasible additional revenue at the electricity market. Assumptions: 
EPEX Spot average value 2013

An economic operation of controllable electricity production is possible without additional gas storages.
BioStrom – Intermediate results

• Modification of the biogas plant „Zellerfeld“

<table>
<thead>
<tr>
<th>Biogas plant Zellerfeld</th>
</tr>
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<tbody>
<tr>
<td>Location</td>
</tr>
<tr>
<td>Rated power</td>
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<tr>
<td>Installed power</td>
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<tr>
<td>Useable gas storage</td>
</tr>
<tr>
<td>Storage capacity</td>
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<tr>
<td>Used substrates</td>
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<td></td>
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• Daily based schedule:

![Graph showing gas storage, electrical power, and electricity price over time]