Deutsches Biomasseforschungszentrum
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Possibilities for biogas in electricity grid balancing

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IEA Bioenergy Conference 2015, Berlin October 2015

Outline

Introduction

Demand oriented operation – technical options on biogas plants

Feed in management for optimized flexibility options

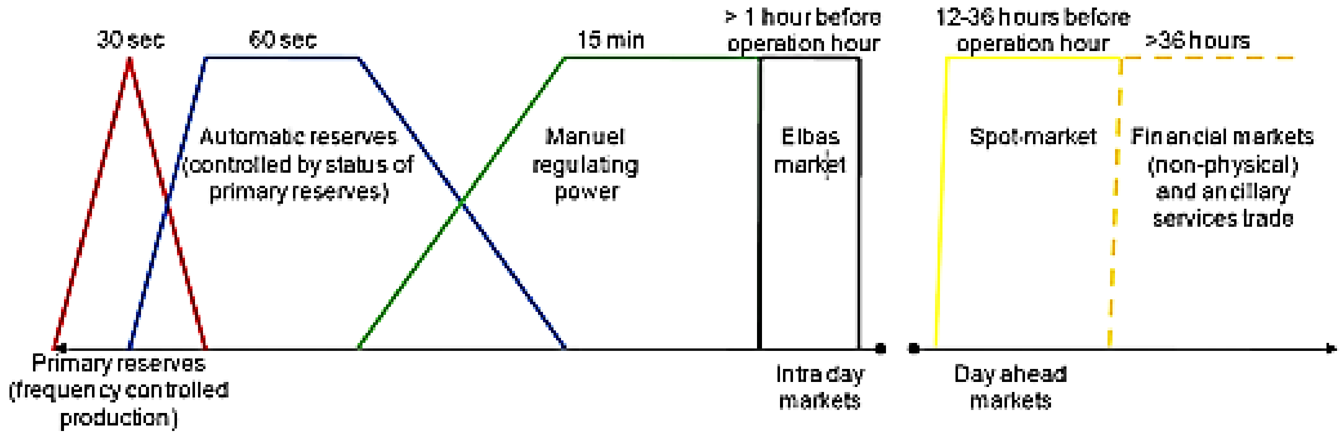
Power to gas

Conclusion

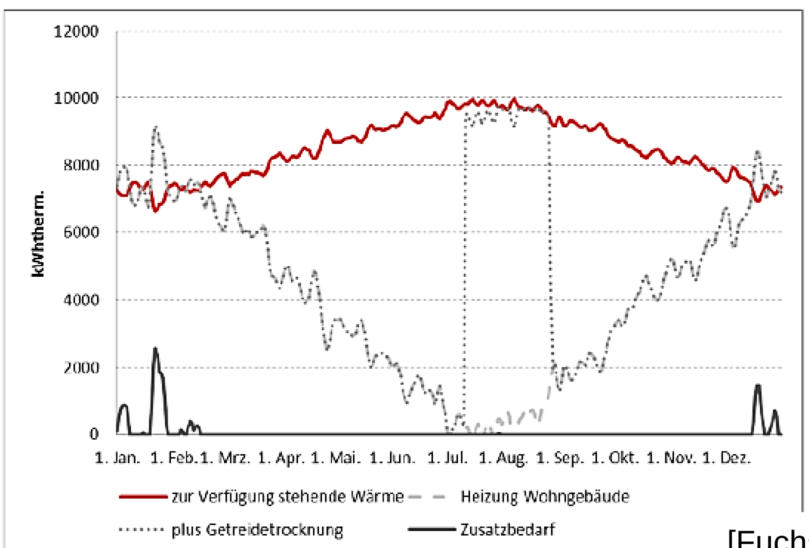
Reasons for demand oriented operation

- **Biogas based electricity as an facilitator for increasing share of fluctuating renewables on different grid levels**
  - Market (price) oriented operation
  - Grid stabilisation services
- **Biogas as a potential link between electricity and gas grid (storage and distribution option)**
- **Increasing efficiency – degree of utilization**
- **Integrated biogas plants on site of industrial facilities**
- **Areas with instable grid situation**

Conditions for flexible operation



[Matthiesen 2008]

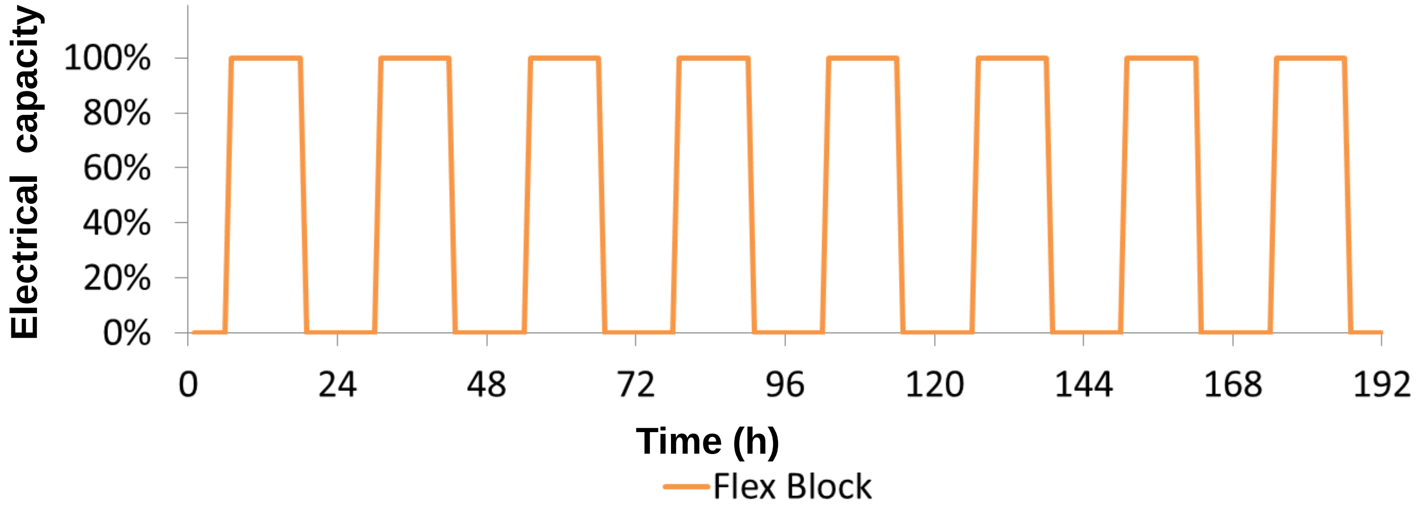


[Fuchs 2012]

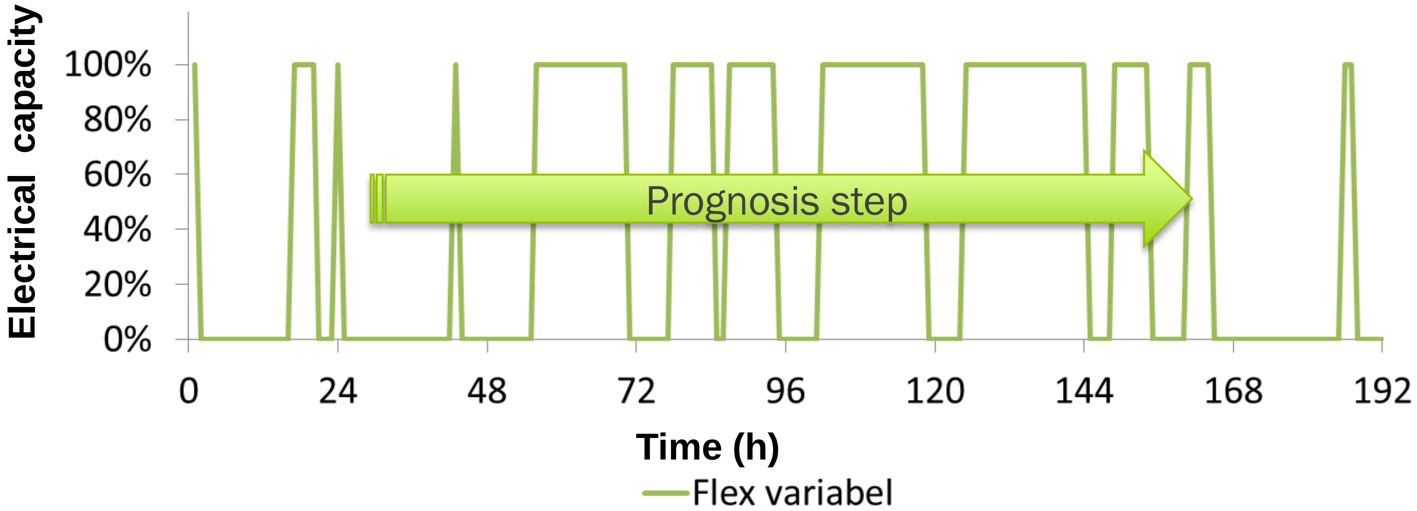
Different market options with different requirements for participation

Biogas plants have individual constructive and operational design which define the limits of flexibility

Quality of flexibility



Limited flexibility



Flexibility
on demand

Technical options for flexibility on site

- Increase of CHP capacity - in case of constant annual energy output
- Increase of gas storage capacity
- Control of biogas production rate
  (controlled feeding, storage of intermediates)

- Power to heat
- Biomethane
- Power to gas

Case study –

control of biogas production rate

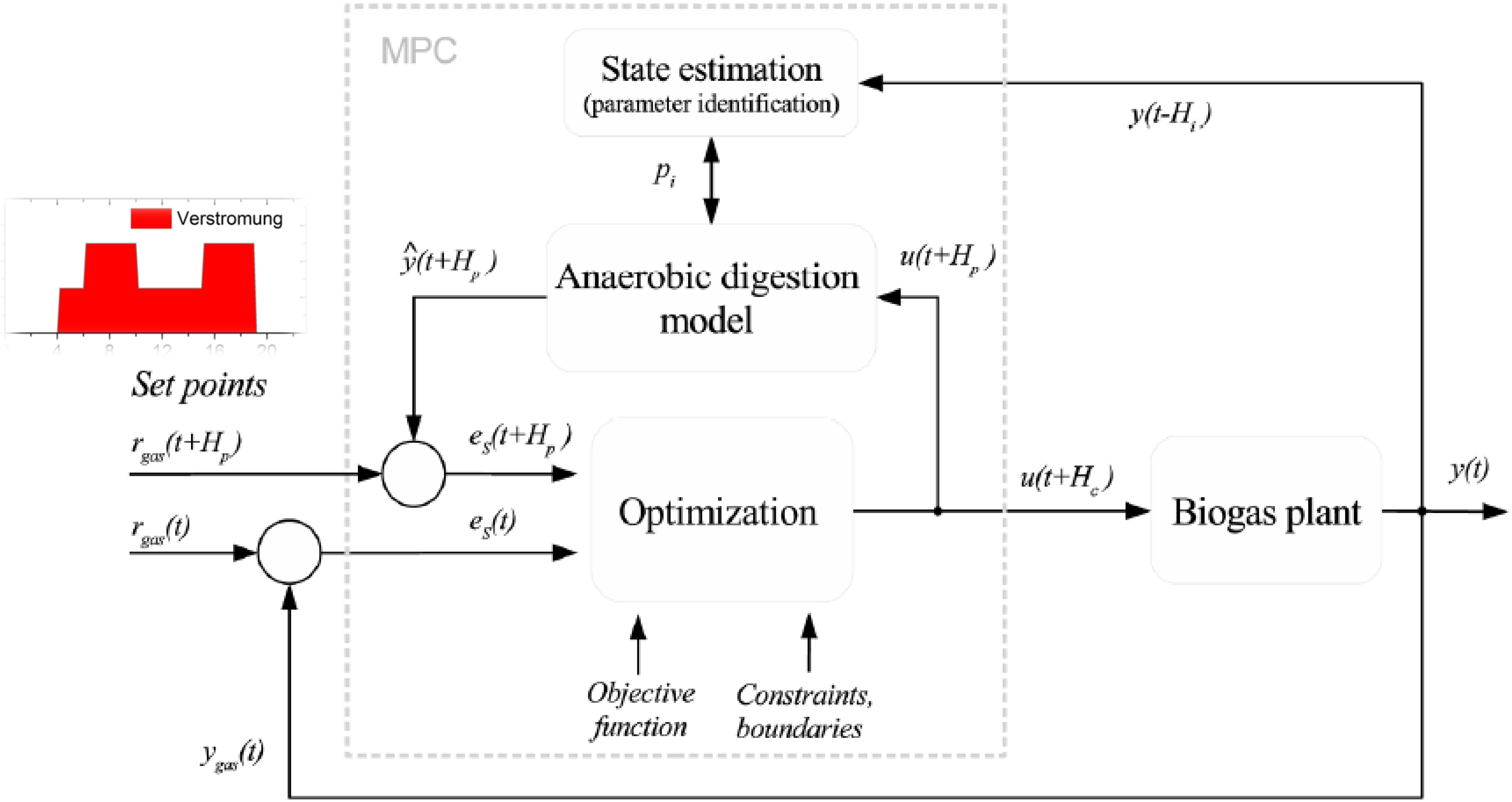
Gas storage - technical challenges

- Most common are flexible membrane roofs
- Monitoring devices for determination of filling level imprecise, in particular between extremums
- Flexibility of membranes limited
- Gas transportation needs to be able to handle varying flows
- Adequate gas management necessary for minimisation of losses

- Limited gas storage capacity available

- App. 4 hours of storage capacity in average in German biogas plants

Process control



(Mauky et al, subm.)

Set variable: substrate and feeding amount

Controlled process variable: gas storage filling level

Demonstration test

DBFZ- Pilot plant facility

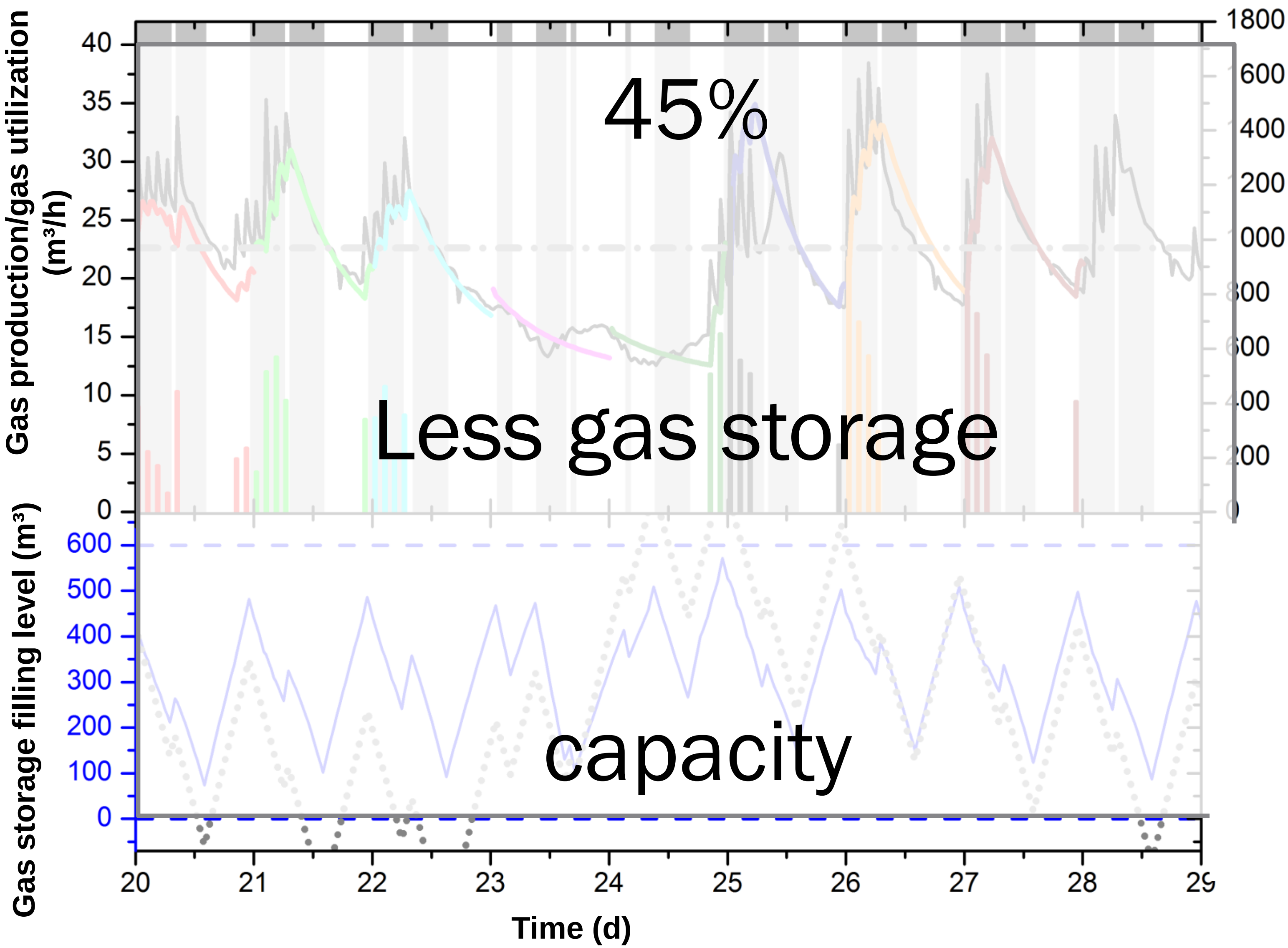
Source: DBFZ

Main digester:
190 m^3 (165 m^3 reaction volume)

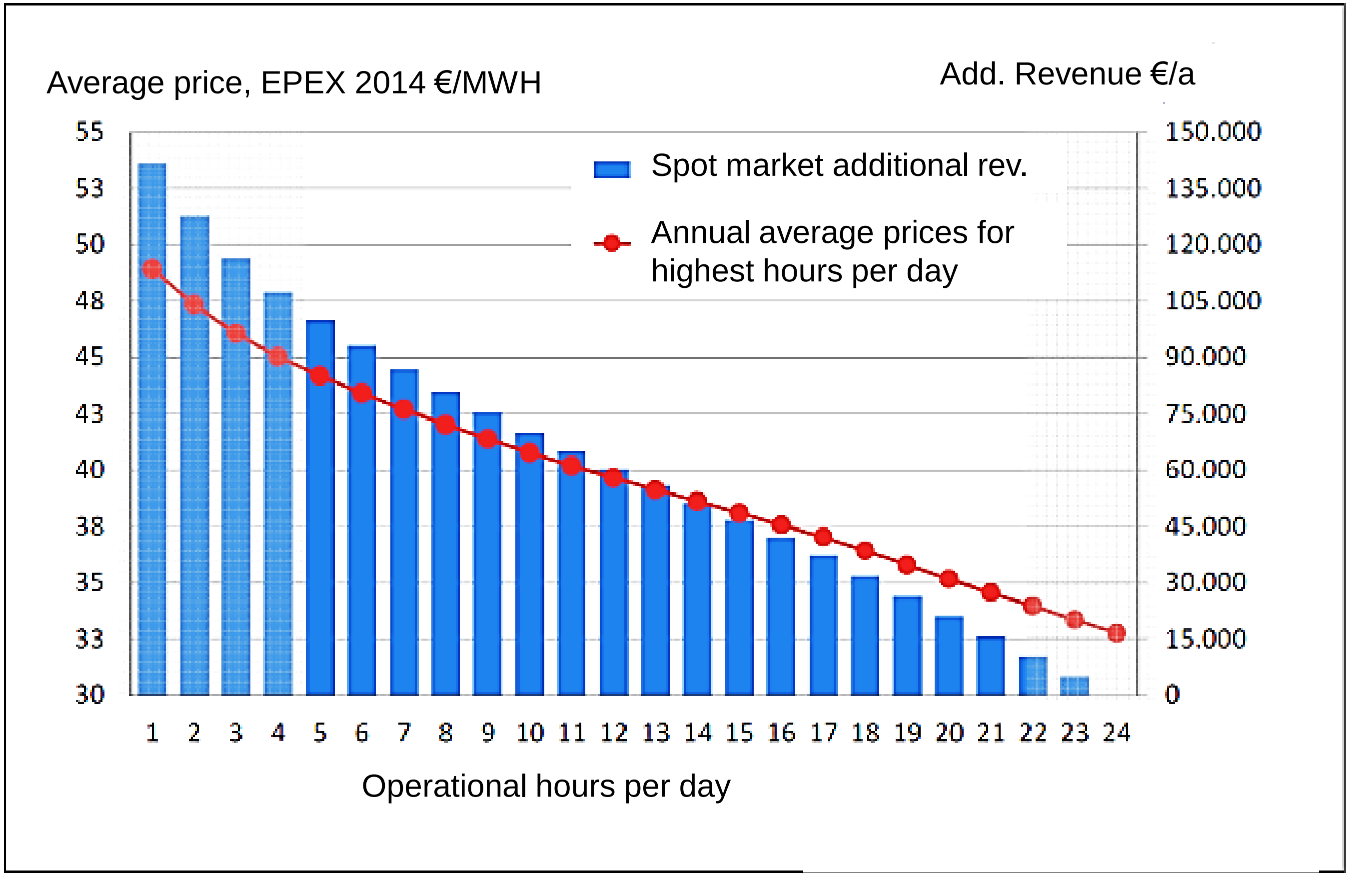
Substrates:

- Corn silage,
- Cow manure,
- Sugar beet silage

Controlled biogas production



Economy



Possible additional revenues and average stock market electricity price for a 1 MW plant in relation to operational hours to realise design energy output

Source: Cube Engineering

Power to gas

Power to gas on biogas plants

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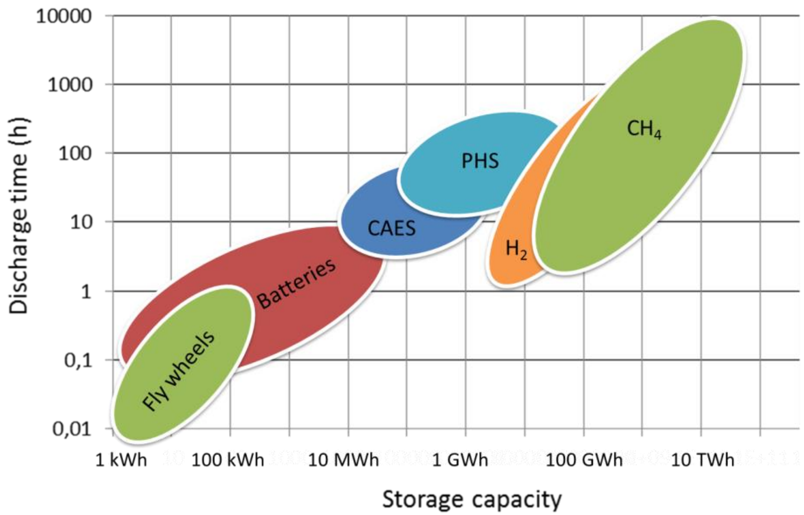
- **Using excess electricity to store energy**
- **Virtual electricity transportation by using the gas grid**
- **Biogas plants offer a CO_2 source for methanation**
- **Given grid connection**

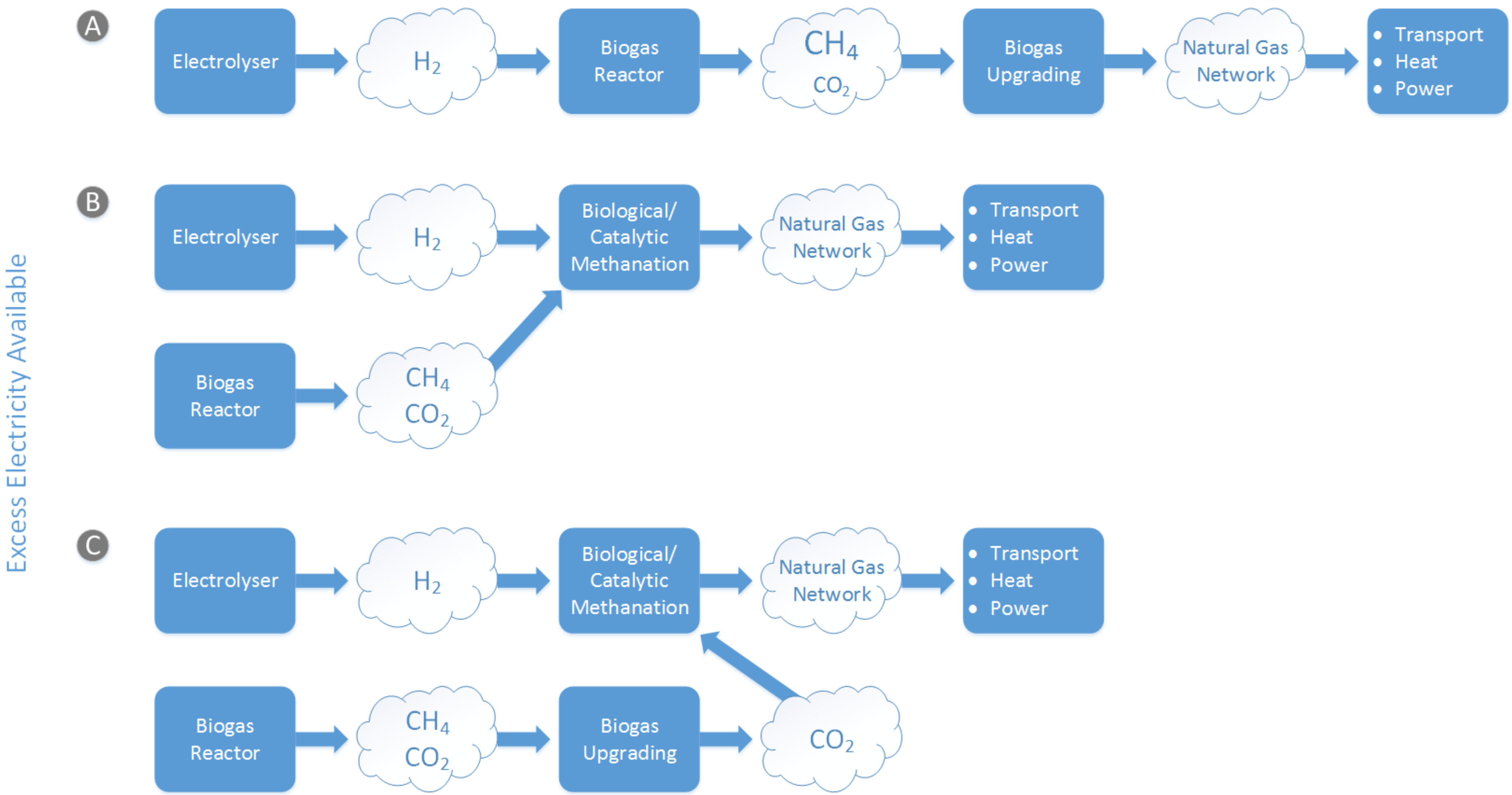
But:

- **High costs (limited operational hours)**
- **Limited efficiency**



Comparison of various energy storage systems with respect to discharge time and storage capacity (modified from Specht et al., 2011). [Baxter et al.]

Power to gas



[Baxter et al]

Aspects of methanation

<u>Biological methanation</u>

in situ vs. external

Insensitive to trace pollutants within the gas, similar process to conventional biogas production

CO_2 partial pressure, H_2 dissolution (increased pressure and insertion via hollow fibre)

<u>Catalytic methanation</u>

Higher effort for gas cleaning,

well known process,

smaller reaction volume, adequate for large scale application

Study on costs

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Efficiency? Costs? Integration of upgrading process?

Pilot phase (e.g. MicrobEnergy, Krajete)

3000 h full load operation per year,

electricity costs at 5 ct/kWh

17-29 ct/kWh (SNG) (2,5-110 MW)

1-6 ct/kWh (Methanation)
[Graf et al]


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Abschlussbericht
Techno-ökonomische Studie zur biologischen Methanisierung bei Power-to-Gas-Konzepten

Oktober 2014

Dr. Frank Graf
DVGW-Forschungsstelle am Engler-Bunte-Institut des Karlsruher Instituts für Technologie (KIT), Karlsruhe

Dr. Alexander Krajete
Krajete GmbH, Linz, Österreich

Ulrich Schmack
MicrobEnergy GmbH, Schwandorf

KRAJETE
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Efficiency PtGtP 19-45 % [Baxter et al]

Conclusion

- Different energy markets require different qualities of flexibility
- Whole production chain defines limitations of flexibility
- Model based control and feeding management can substitute gas storage capacity
- Uncertainty: development of electricity market – prices, fluctuations, other users of surplus energy
- Flexible plants get more complex –revenue from system integration needs to pay off for that

Bioenergy needs to provide a new quality – smart energy grids require smart, integrated plants

Publications

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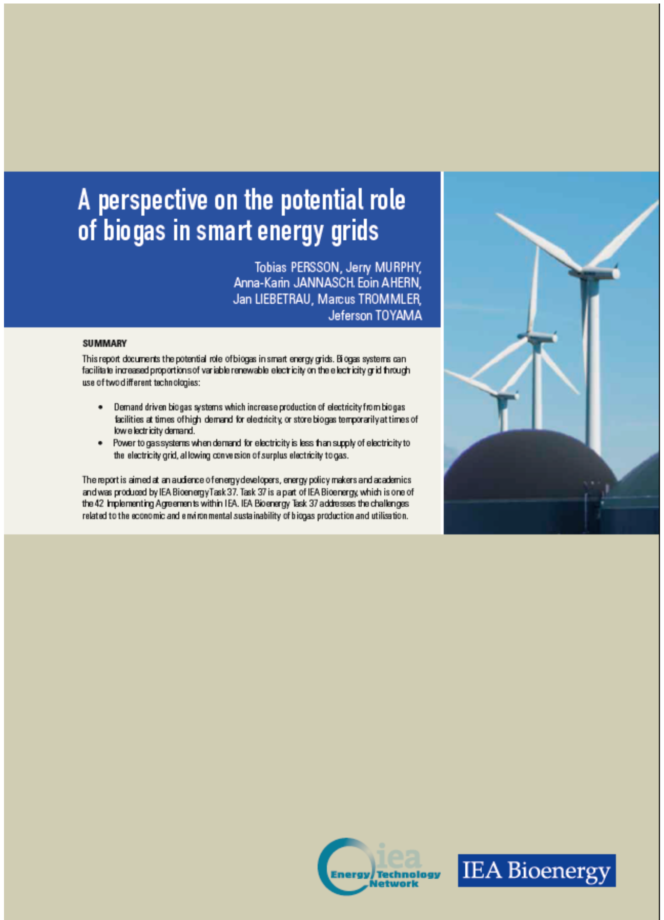

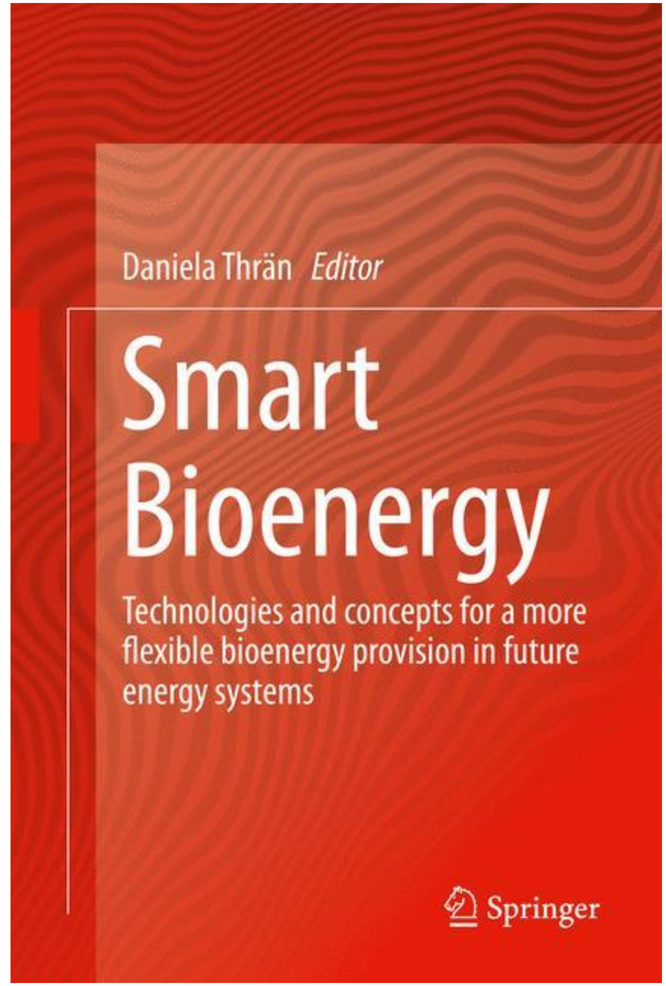

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Smart bioenergy – innovations for a sustainable future

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