

Efficiency of the biogas process - results of a monitoring program

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Rytec- Waste technology and energy concepts

- Rytec offers a unique combination of innovative engineering and established experience in the operation of plants.
- Development, optimization, construction, retrofitting and control of process engineering systems in the energy and waste sectors.

In detail:

- Planning and Construction of Biogas plants, biological and thermal waste treatment, energy engineering as well as waste and landfill process engineering.
- Plant operations for CHP, AD plants, biomass power plants and waste water treatment plants.
- Consultancy for public and industry sector
- Emission monitoring, mitigation measures and measurement campaigns

Outline

Background

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Methodology

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Efficiency

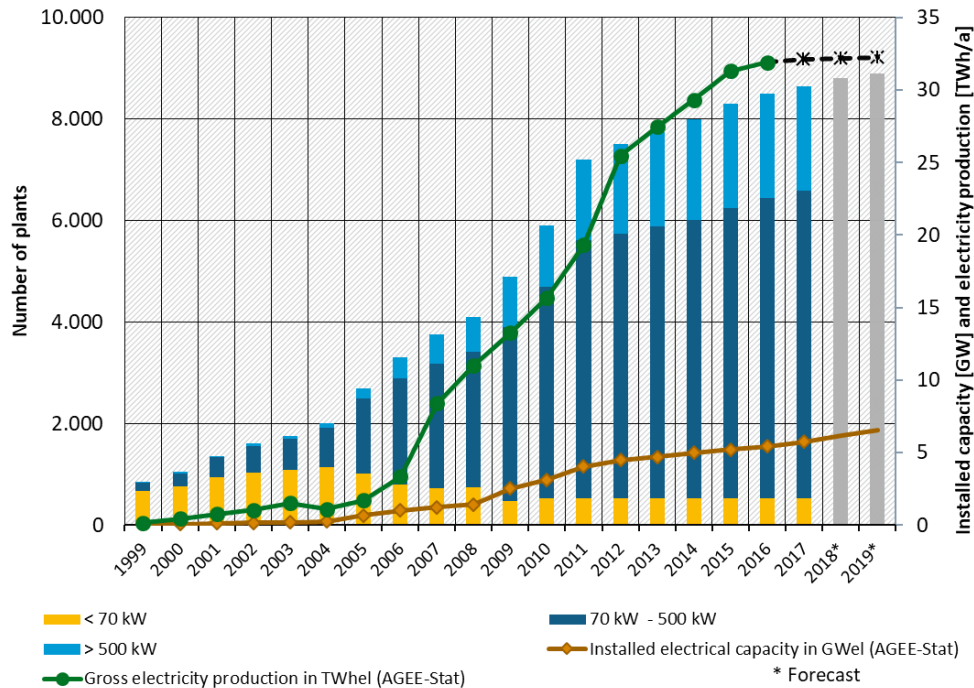
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Economics

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Conclusion

Germany State of Biogas production



- 2018: ~ 8,980 biogas production plants incl. upgrading plants for biomethane in operation
- No significant additional capacity since 2012
- **mainly flexibilisation of existing plants** (motivated by premium for flexible operation)
- New construction limited to **small scale manure plants** (< 75 kW_{el}) and few biowaste fermentation plants

Source: DBFZ,2019. Database: Distribution of biogas plants by plant size on the basis of the DBFZ plant database; installed plant capacity and electricity generation according to AGEE-Stat 2/2019 (UBA 2019), *DBFZ forecast (modified according to Lenz et al. 2019)

Biogas plant inventory

Plant type	Number of plants	Electricity production ¹⁾ [GWh/a]	Heat utilization [GWh/a]
Agriculture	8,270	27,978	12,677
Biowaste	336 (136 + 200) ²⁾	865	392
Biomethane	203	2,7	3,455
Sewage sludge	1,274 ³⁾	1,490	2,167
Landfill	468	300	122
Total	10,431	33,345	18,813

1) excluding efficiency losses;

2) Substrate input of 136 plants \geq 90% of biowaste of the whole input amount per year (acc. to § 27a EEG 2012, § 45 EEG 2014, § 43 EEG 2017); biowaste is defined as separate collected municipal waste (e.g. kitchen waste, green waste); about 200 co-fermentation plants with substrate input < 90% of biowaste including plants using agro-industrial residues.

3) Federal Statistical Office (destatis): https://www.destatis.de/DE/Presse/Pressemitteilungen/2019/09/PD19_340_433.html

Biogas in Germany – current situation

- Change to tender system in 2017
- Cap installed for maximum capacity defined until 2022 (to low for the majority for the sector)
- Low maximum bidding prices, not attractive for plant operators (not much contribution to the tender yet)
- Numerous regulations under revision, changing and mostly increasing effort for plant operators
- No perspective for the sector and no ongoing discussion/urgency within authorities noticeable (e.g. biomethane market, manure based plants)
- Age pattern within operators/owners of plants
- Lack of perspective might lead to a severe deconstruction of the sector, even within plants with sustainable concepts

Biogas-monitoring program III

- Program I monitored the beginning of the sector, program II the new energy crop based facilities (published in 2009)

Program III:

- Focus on Efficiency (biological process) and economic situation
- Connected to microbial analysis program

- Evaluation of 60 plants including small scale manure based plants and biomethane plants
- (4 Partners, 15 plants each, period of one year per plant evaluated)
- Comparison of methods for efficiency evaluation
- Transparent data acquisition and evaluation
- Ring tests between institutions to identify errors

- Duration 01.12.2015 – 30.11.2019

Biogas-monitoring program III

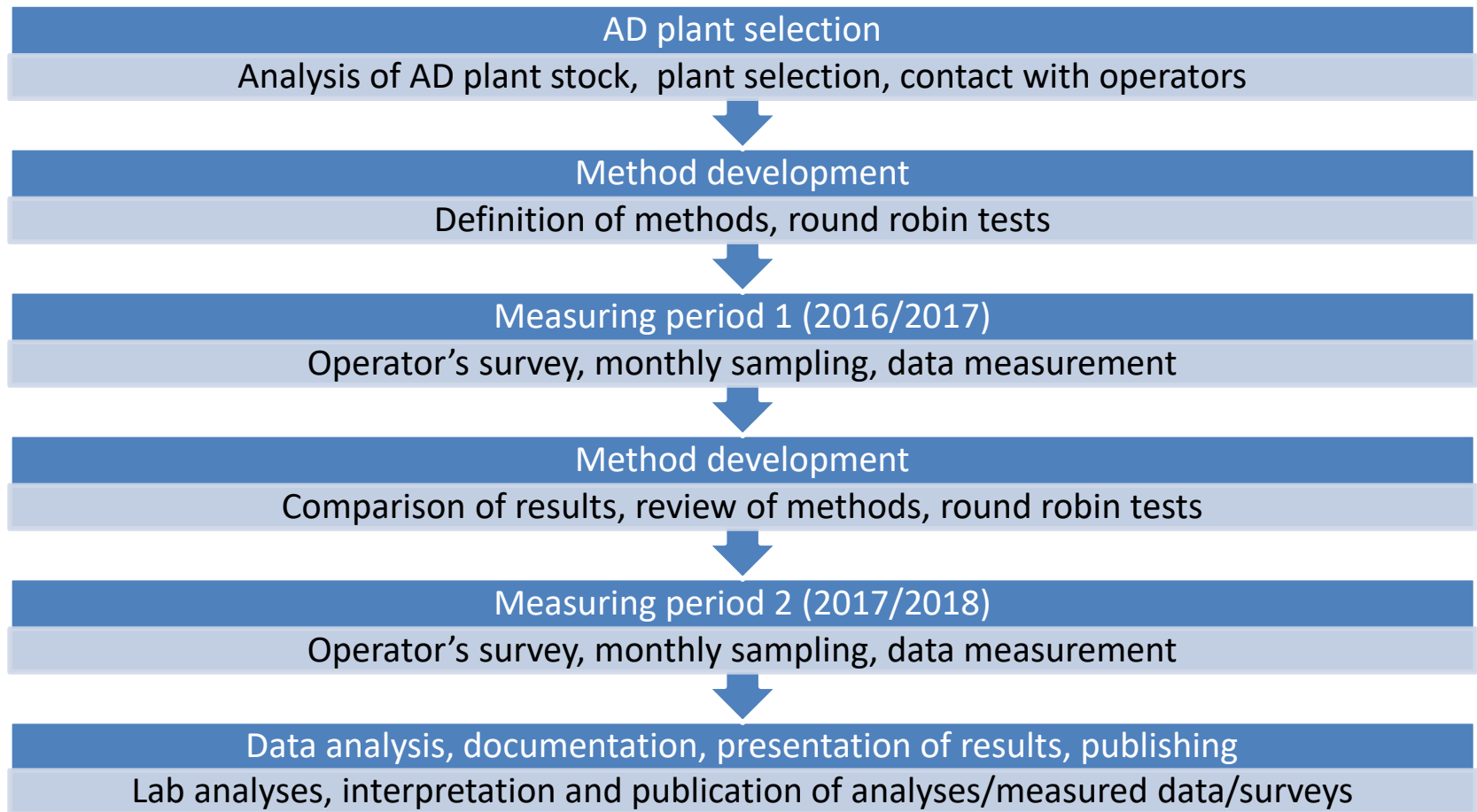
Project partner

- Deutsches Biomasseforschungszentrum (DBFZ) (Coordinator)
- Landesanstalt für Agrartechnik und Bioenergie (LAB)
- Kompetenzzentrum Erneuerbare Energien und Klimaschutz Schleswig-Holstein (EEK.SH)
- Bayerische Landesanstalt für Landwirtschaft (LfL)

Funding body:



Biogas Monitoring Programme III Methodology



Efficiency - approach

What data is required to evaluate a biogas plant resp. give performance indications?

- Mass balance of in- and output
- Energy balance of the biogas plant
- Data of the plant performance and reliability of the equipment (hours/year)
- Normative-actual value comparison

What data is needed for the mass/energy balances?

- Characterization of substrates and digestate (TS, VS, Feed value analysis for FVS, methane potential test, heating value, residual methane potential)
- Analysis and evaluation of process characteristics
- Assessment / Evaluation of the overall biogas plant concept

Efficiency - approach



Potential
(average specific methane potential)



Yield
(specific methane yield)

Substrate type; mass; TS; VS

VS based standard values
(KTBL) → Standard KTBL



„Weissbach method“ for energy
crops based on Ash, raw fiber,
for selected substrates:
standard values (KTBL) → FVS



VS, methane potential
test → Batch



Heating value, (plus
digestate mass, TS and
heating value) → Energy



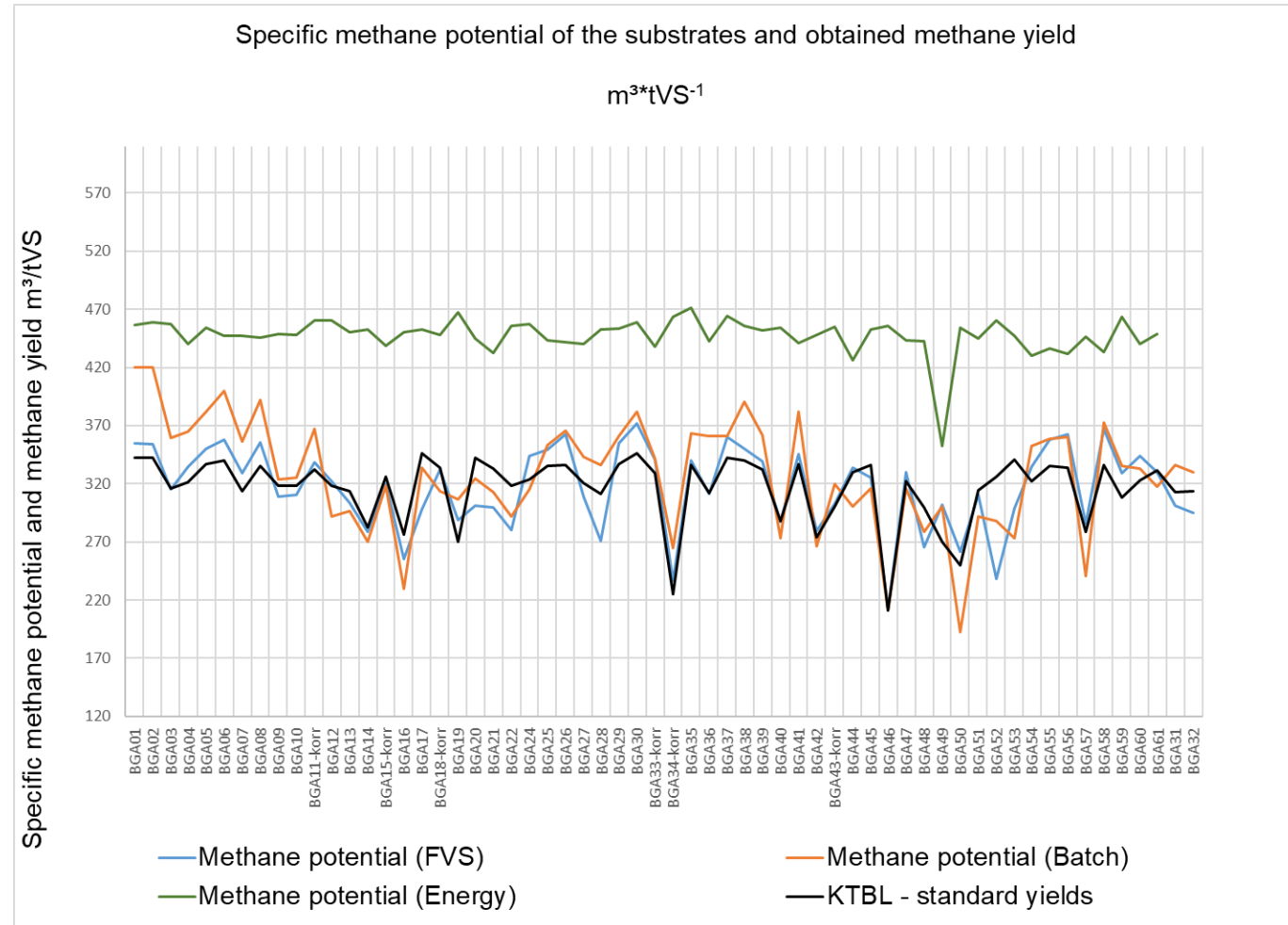
Grid kWh fed in
→ Factor transformer
→ Factor efficiency CHP
→ Heating value methane
→ methane mass flow into engine

Efficiency - results

Basis of masses is VS
to be able to compare
results directly

Batch, FVS, Standard
Values show similar
tendency, but also quite
differing results

Heating value much
higher and different
trend



Source: Jan Liebetrau, based on data from BMP 3 project team

Efficiency - results

KTBL values known to underestimate slightly; still:

Masses need to be checked

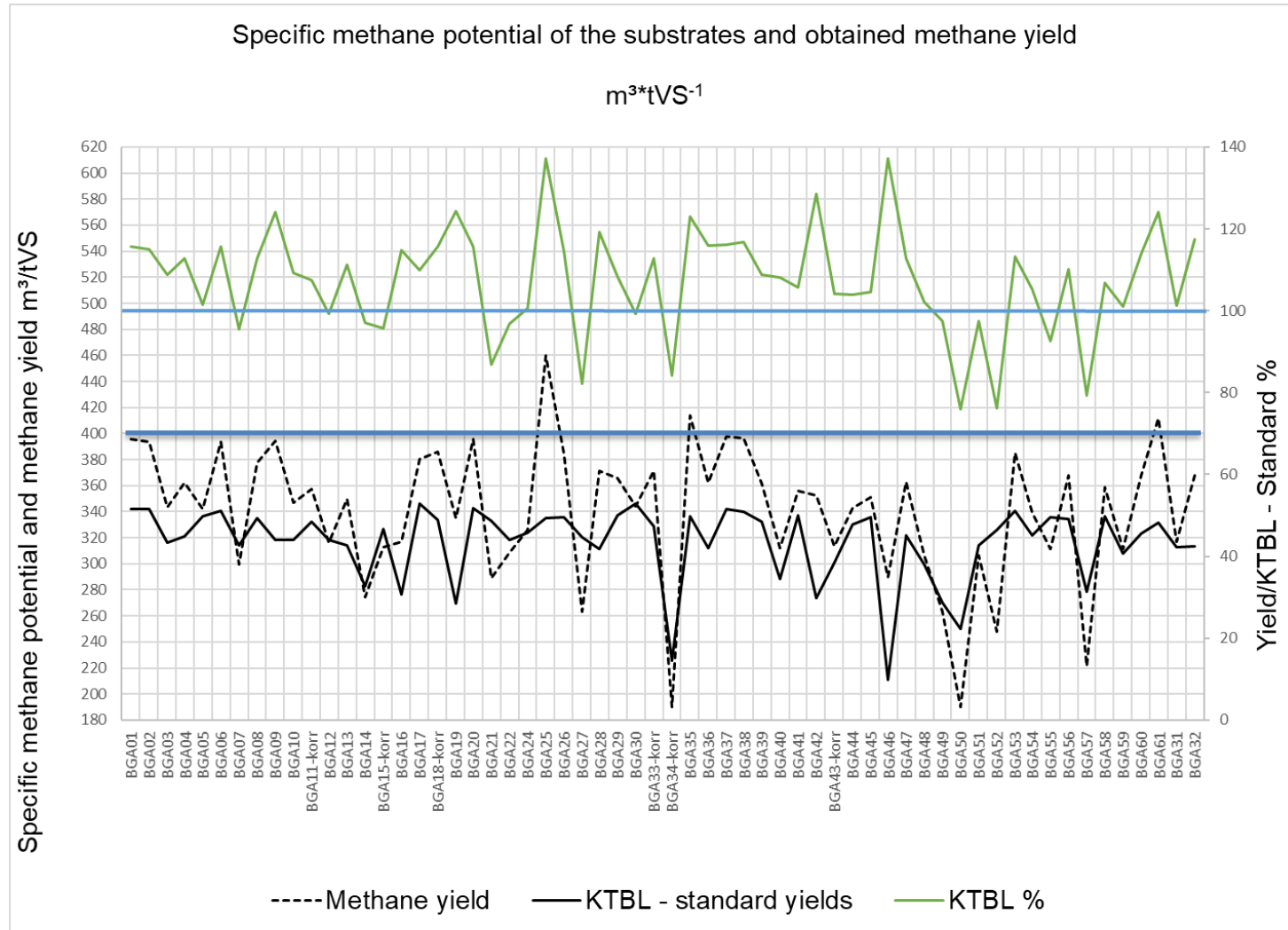
Representative samples (?)

Errors likely in all areas:

- Masses
- Representative Sampling
- Potential determination

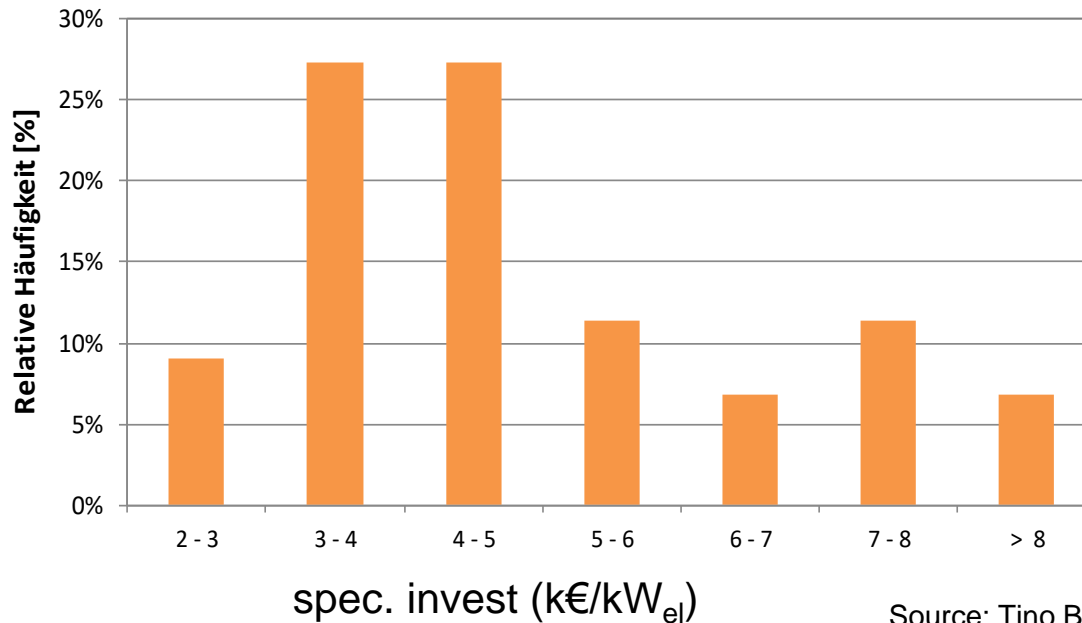


every plant has to be checked in detail



Source: Jan Liebetrau, based on data from BMP 3 project team

Economy - results

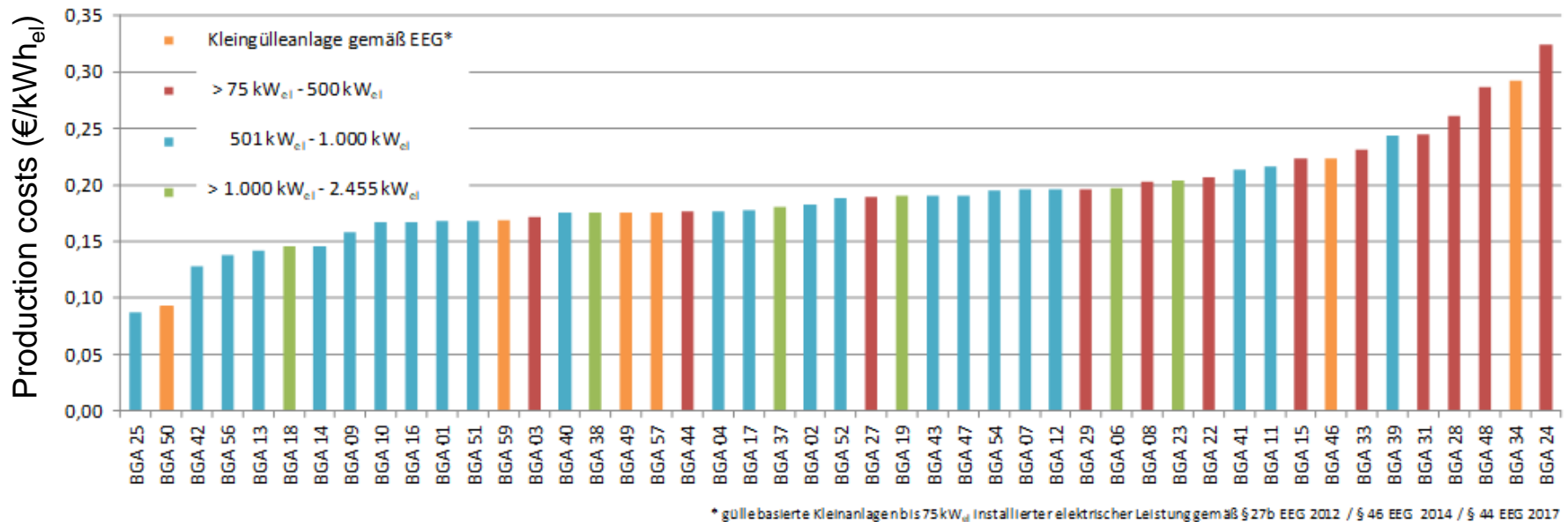


Source: Tino Barchmann; DBFZ

- Participation of rather better plants
- Economic evaluation based on one year (reinvests have large impact)
- Basic information not easy to collect (e.g. costs for labour at small scale plants integrated in agriculture operation)

Economy - results

Production costs (€/kWh_{el})



* gültig basierte Kleinanlagen bis 75 kW_{el} installierter elektrischer Leistung gemäß § 27b EEG 2012 / § 46 EEG 2014 / § 44 EEG 2017

Source: Tino Barchmann; DBFZ

High operational hours help, but expensive substrates, breakdown, or high reinvestments can ruin the balance

Present maximum bid in the tendering system: 0.1639 €/kWh

Conclusions

- Mass balance as a critical point
 - Actual mode of operation and key figures of AD plants often poorly measured
 - Analytical (lab) errors insignificant in comparison to errors made on site/during sampling
 - Different methods for potential analysis can vary to large extend
 - In particular input masses seem to be questionable
- Recommended procedure for plant evaluation
 - First check procedure with standard values to identify uncertainties
 - In case of plausible data, proceed with more detailed, precise analysis
- Economics
 - Even without plausible mass balance the plants can be cost efficient
 - Large variation in production costs (tender system should level that out(?))
 - No clear correlation of a single parameter to profitable business
 - Most plants have production costs higher than future tariffs allow
 - Investigated plants have a positive balance due to high tariffs in the past

Thanks to all participants and contributions to the project in general and the presentation in particular -

and thank you for listening.

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