Deutsches Biomasseforschungszentrum
gemeinnützige GmbH

DBFZ

Economics of manure digestion in Germany

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What awaits you

Content of the presentation

1. General aspects of the economics of manure utilization and biogas production
2. Aspects of the economics of manure utilization in Germany
3. Conclusion

1. General aspects of the economics of manure utilization and biogas production

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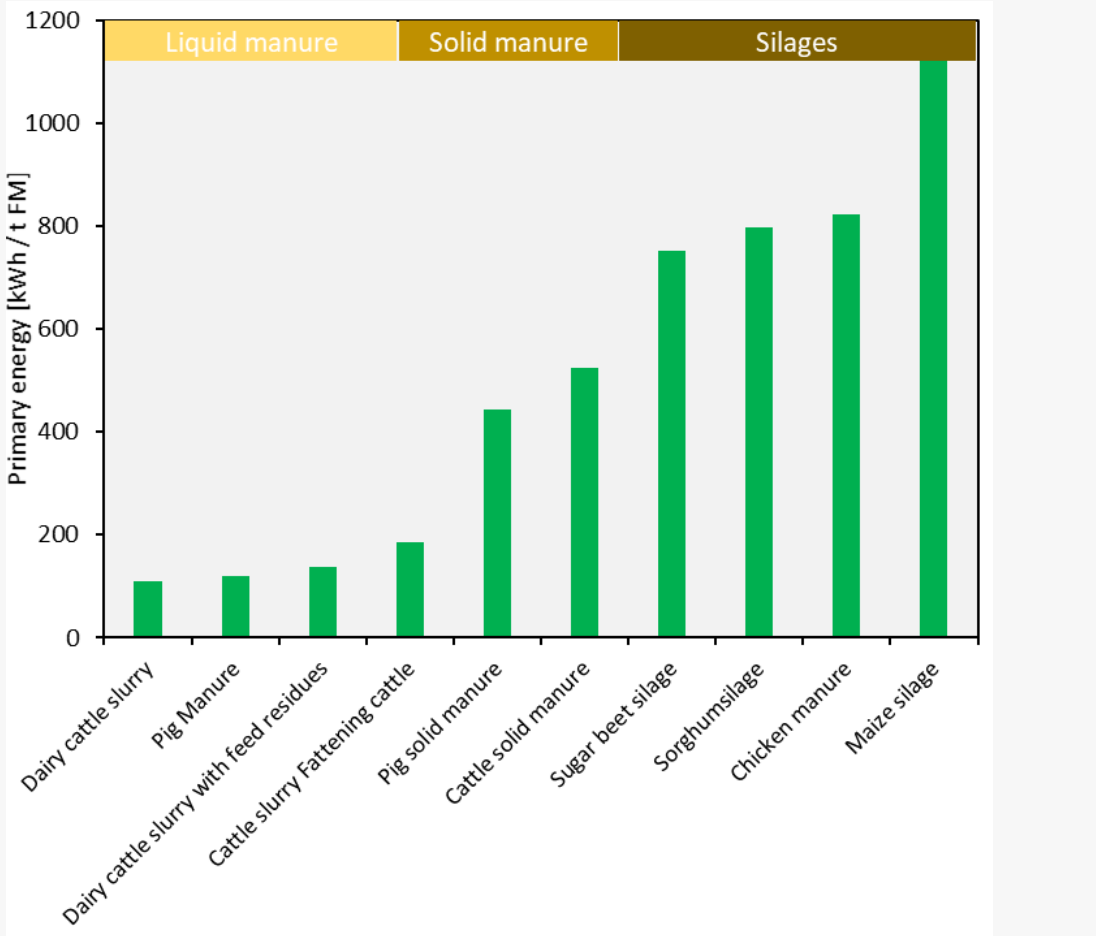
Influences of technical parameters on economics

Physical parameters of different feedstock

	TM-content [%]	VS-content [%]	CH_4-content [%]	Methane yield [m^3 CH_4/t FM]	Primary energy [kWh /t FM]	Primary combustion power [kW / t FM]
Types of Liquid manure						
Cattle slurry Fattening cattle	0,10	0,85	0,55	18,70	186	0,02
Dairy cattle slurry	0,09	0,85	0,55	11,13	111	0,01
Dairy cattle slurry with feed residues	0,09	0,85	0,55	13,91	139	0,02
Pig Manure	0,06	0,80	0,60	12,10	121	0,01
Types of Solid manure						
Cattle solid manure	0,25	0,85	0,55	52,59	524	0,06
Pig solid manure	0,225	0,825	0,6	44,55	444	0,05
Chicken manure	0,4	0,75	0,55	82,50	823	0,09
Types Agricultural silages						
Maize silage	0,35	0,95	0,52	112,39	1120	0,13
Sorghumsilage	0,28	0,9	0,52	79,93	797	0,09
Sugar beet silage	0,23	0,9	0,52	75,35	751	0,09

Source: KTBL



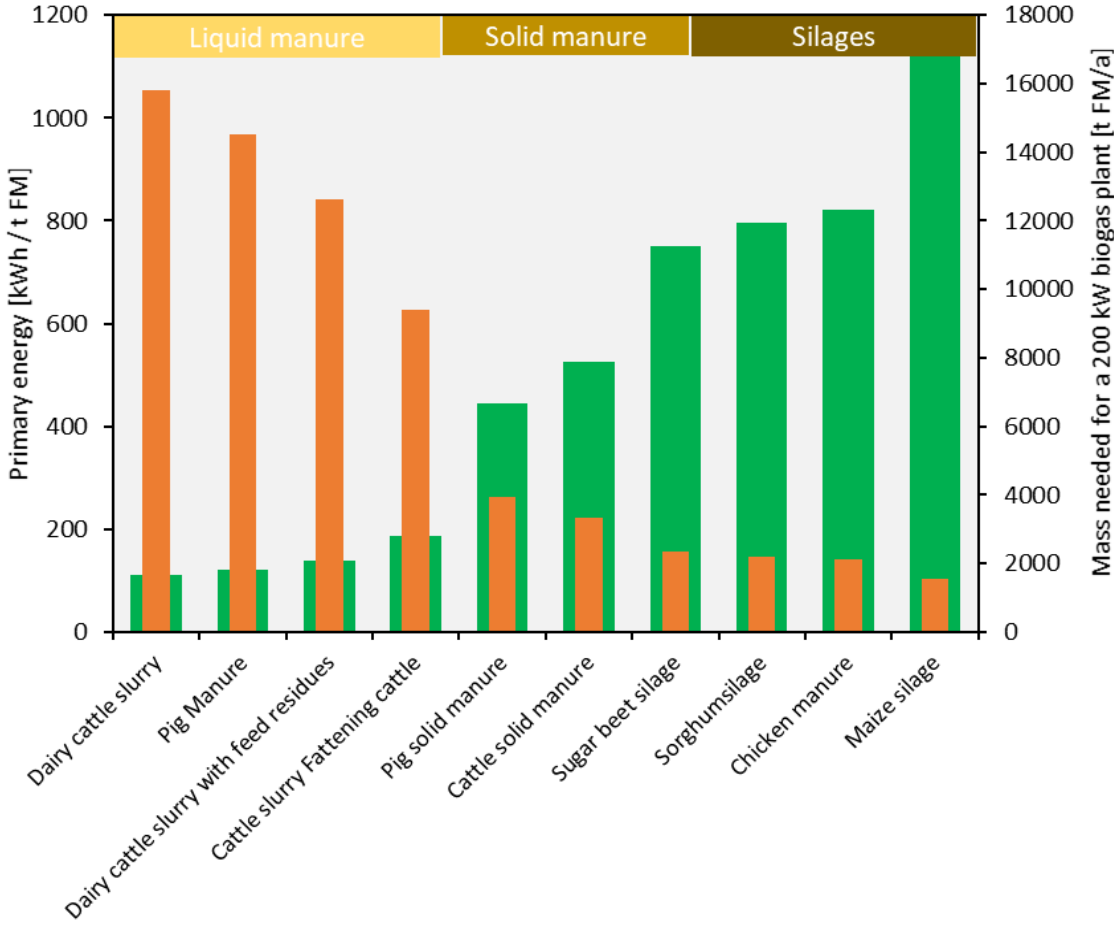
1. General aspects of the economics of manure utilization and biogas production

Influences of technical parameters on economics

Physical parameters of different feedstock

Manure is a high massflow/low energy feedstock

- >90 % water content
- High logistical effort (transport, storage etc.)
- Compared to silage, more slurry must be used to produce the same energy
- Implications for costs (construction, transport and operation)



1. General aspects of the economics of manure utilization and biogas production

Influences of technical parameters on economics

Influence of the feedstock on the capital expenditure

Capital expenditure highly depends on the feedstock

- Because of high water and low energy content, manure needs larger digester and digestate storage to produce the same energy
- Capital expenditures for manure-only plants are relatively high

		Cattle manure only (200 kW)	Maize silage only (200 kW)
Technical parameters			
Retention time	[d]	50	100
Digester volume	[m^3]	3.735	1.710
Digestate storage volume	[m^3]	17.862	1.975
Capital expenditure			
CHP	[€]	230.786	230.786
Processcontrol and flare	[€]	67.938	67.938
Pumpstation	[€]	58.478	34.628
Digester	[€]	450.170	246.255
Digistate storage	[€]	818.278	149.888
Digestate storage cover	[€]	188.529	46.600
Sum	**[€]**	**1.814.180**	**776.096**

Source: Own calculation

1. General aspects of the economics of manure utilization and biogas production

Influences of technical parameters on economics

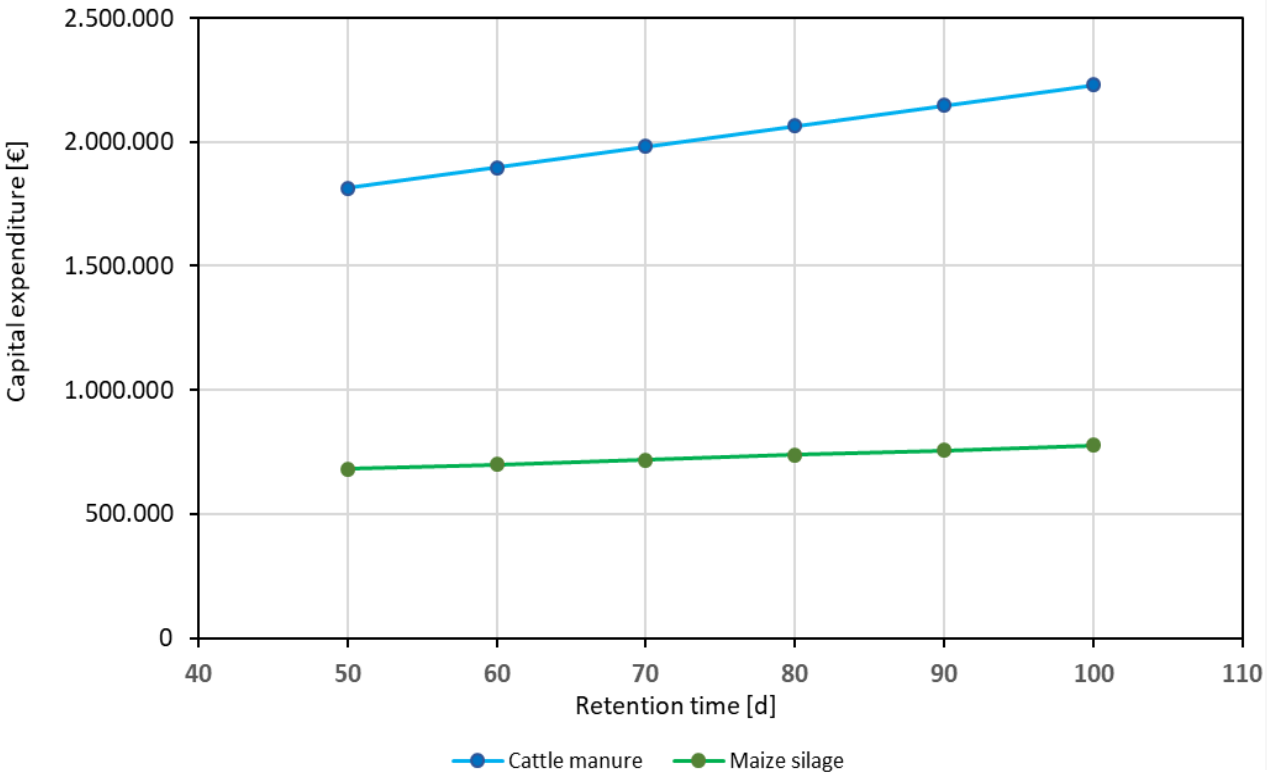
Influence of the retention time on the capital expenditure

The retention time has an influence on the investment

- If the retention time is changed, the construction costs change
- The effect differs for the different feedstocks
- The higher the water content, the higher the effect on the costs when the retention time is changed
- The 200 kW biogas plant is used as an example

- Because of low dry matter content liquid manure requires less retention time, but high digester volume (less time for digestion needed)
- Because of high dry matter content silages requires more retention time, but less digester volume (more time for digestion needed)

Influence of the retention time on the capital expenditure (Example: 200 kW baseload biogas plant)



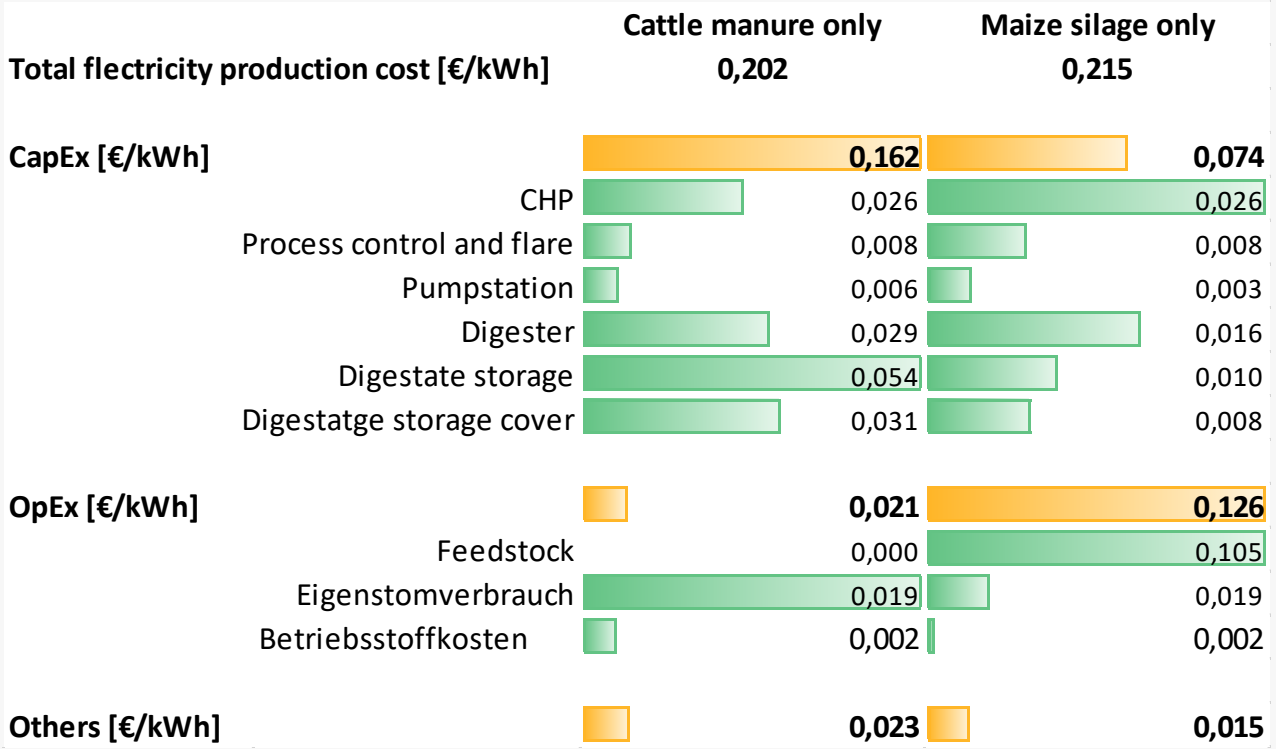
1. General aspects of the economics of manure utilization and biogas production

Influences of technical parameters on economics

Influence of the feedstock on the production cost

Production costs are infuenced by several aspects

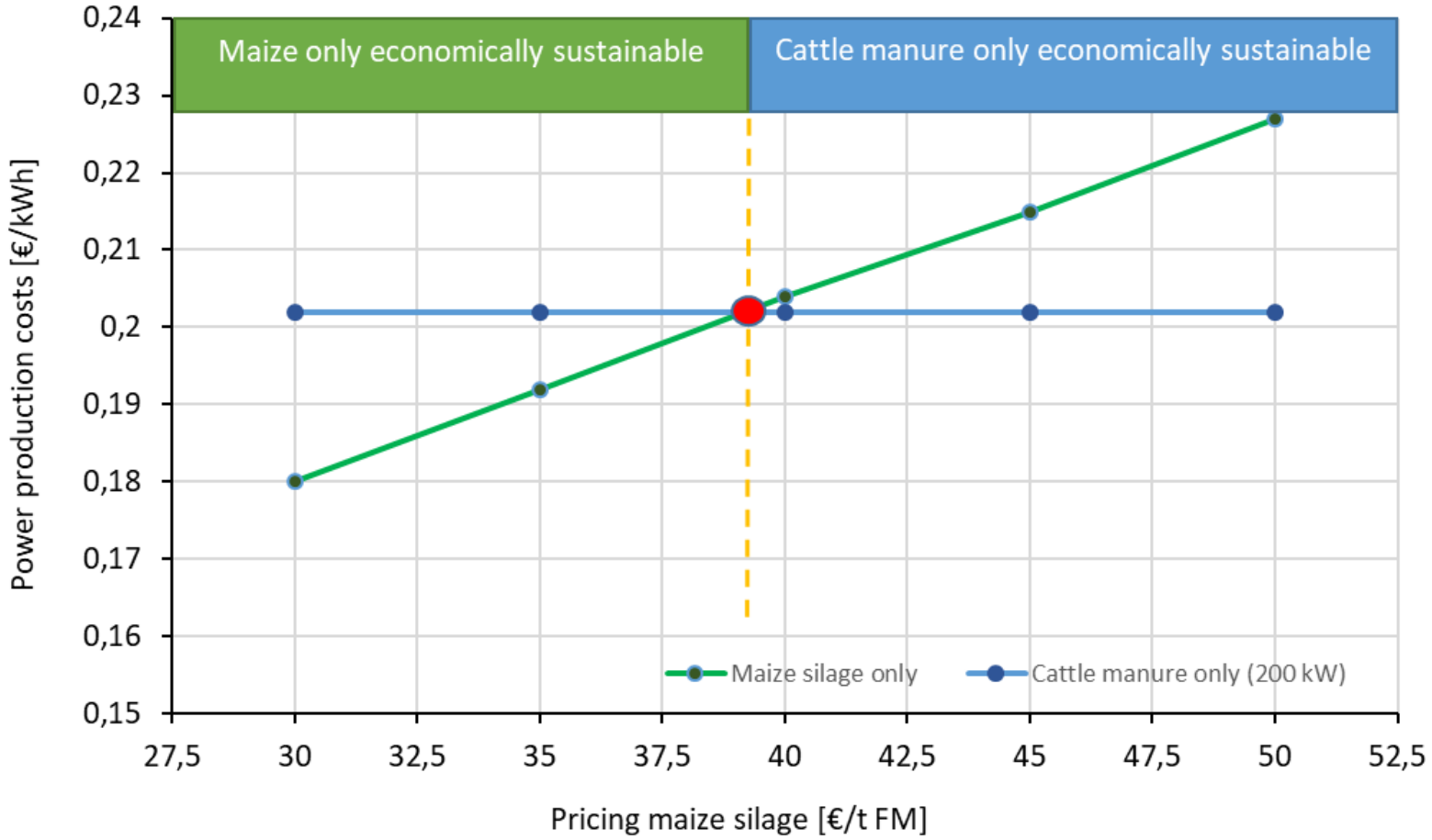
- CapEx (Invest, reinvest)
- OpEX (Feedstock, power consumption)
- For manure we can assume feedstock costs of 0 € / t FM, because manure is a byproduct of livestock farming
- For maize silage we can assume costs of 45 € / t FM, because silage production cost need to be taken into account
- Price formation can vary substantially in different regions
- Manure plants = Low OpEx but high CapEx
- Silage plants = High OpEx but Low CapEx
- The pricing of feedstock influences production costs



1. General aspects of the economics of manure utilization and biogas production

Influences of technical parameters on economics

Economic viability of manure use depending on maize silage prices



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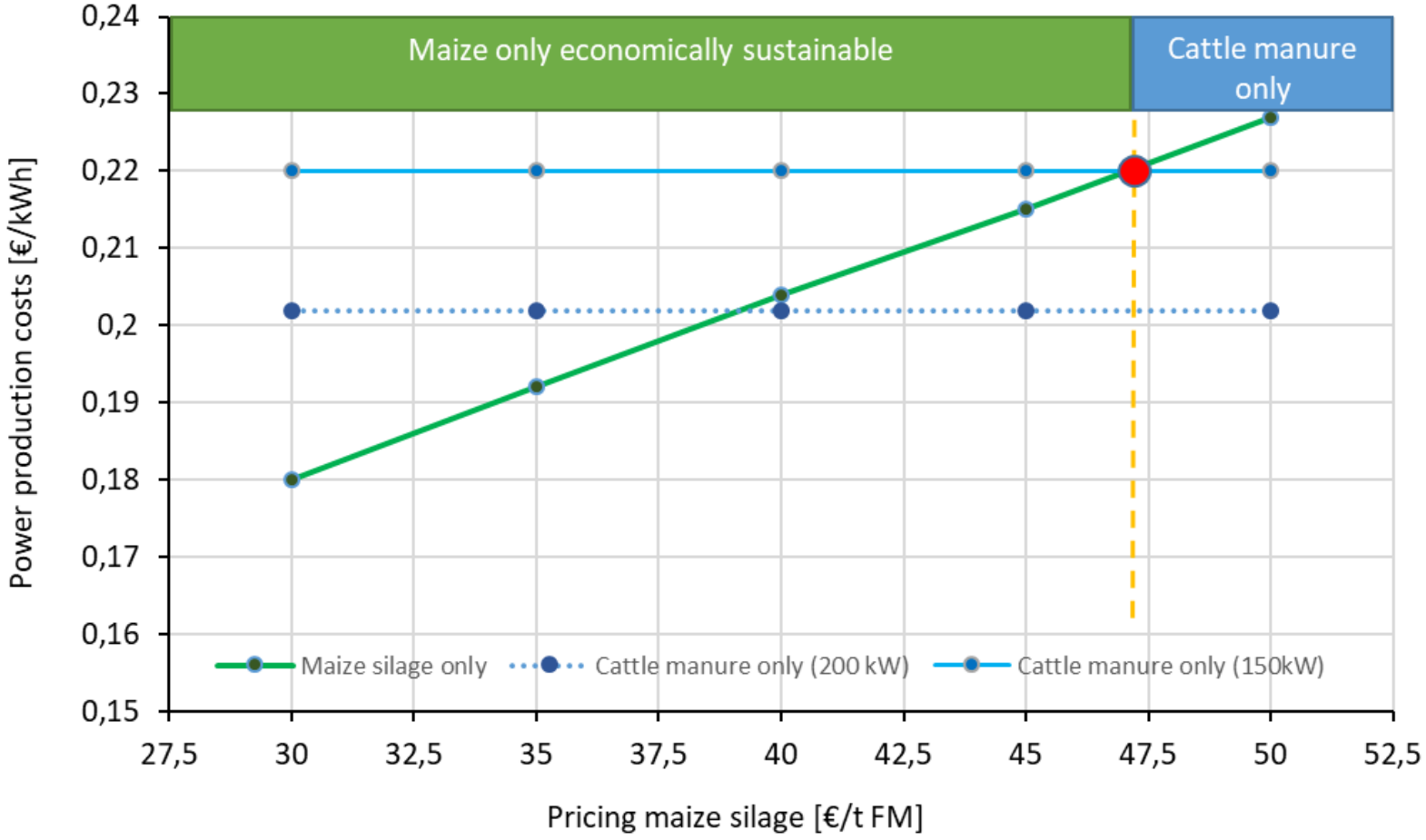

Production costs are influenced by several aspects

- Smaller manure plants are less economically sustainable in comparison to larger silage only plants (economy of scale)

2. Aspects of the economics of manure utilization in Germany

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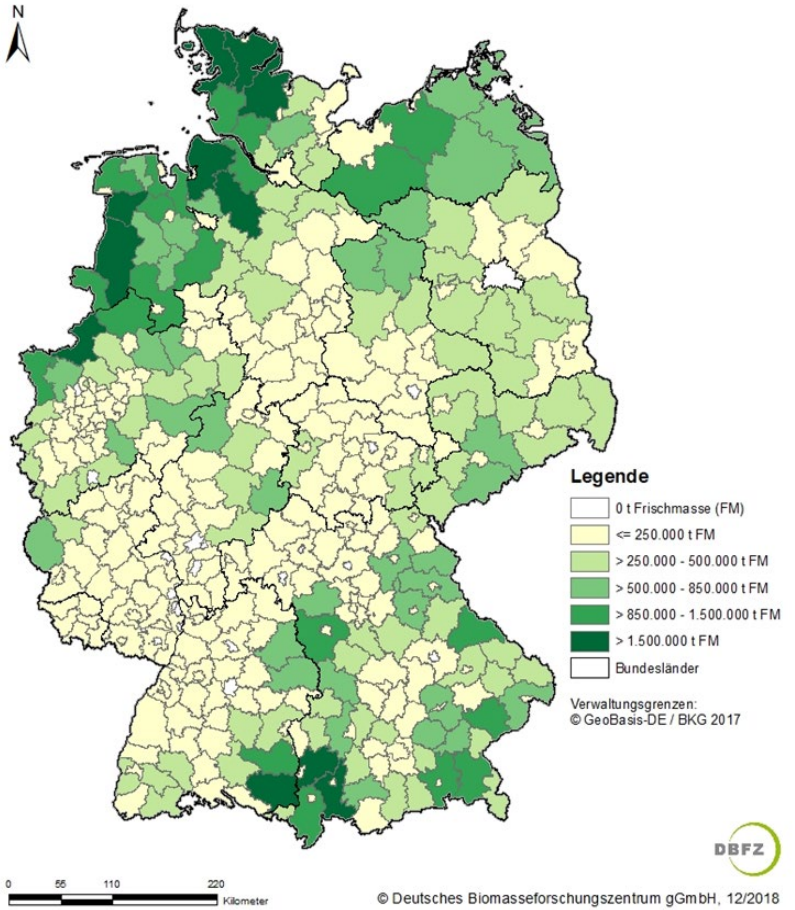
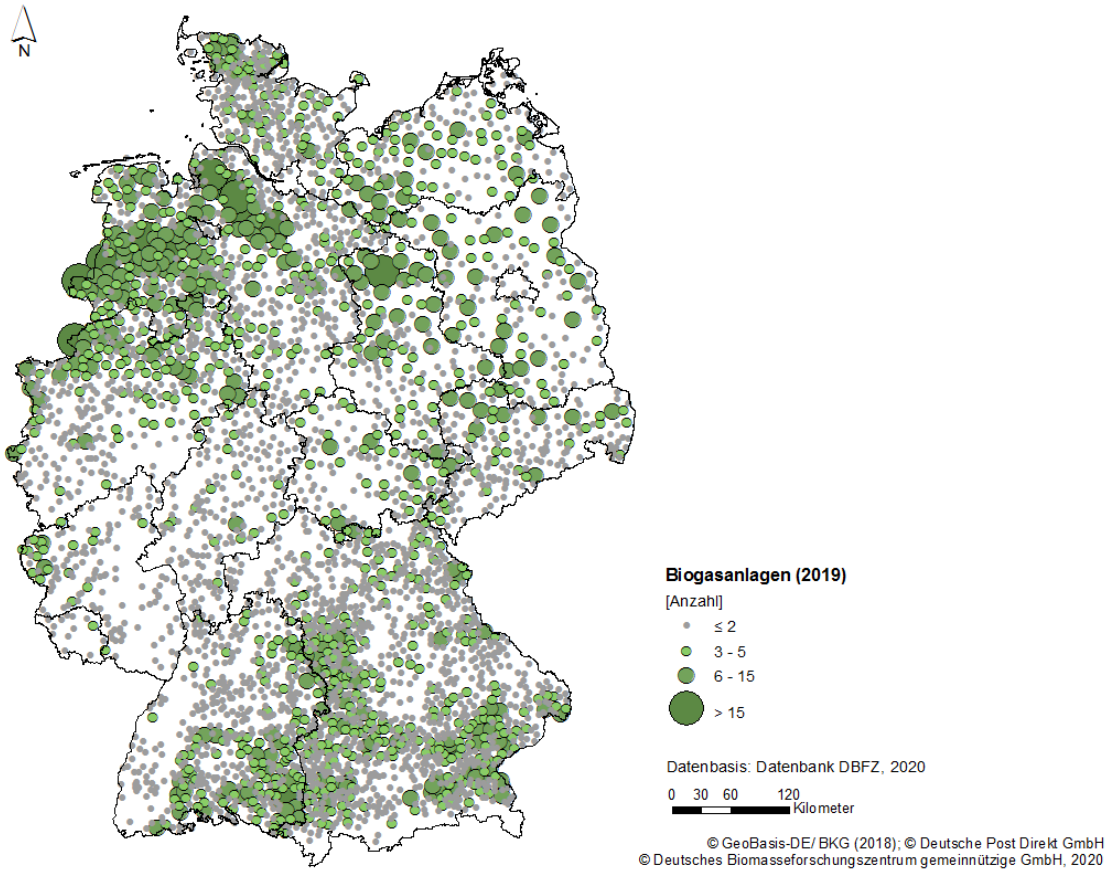
Economic-geographical aspects of biogas plants

Spatial distribution of cattle manure potentials



Spatial distribution of biogas plants



Quelle: Majer et al. (2019)

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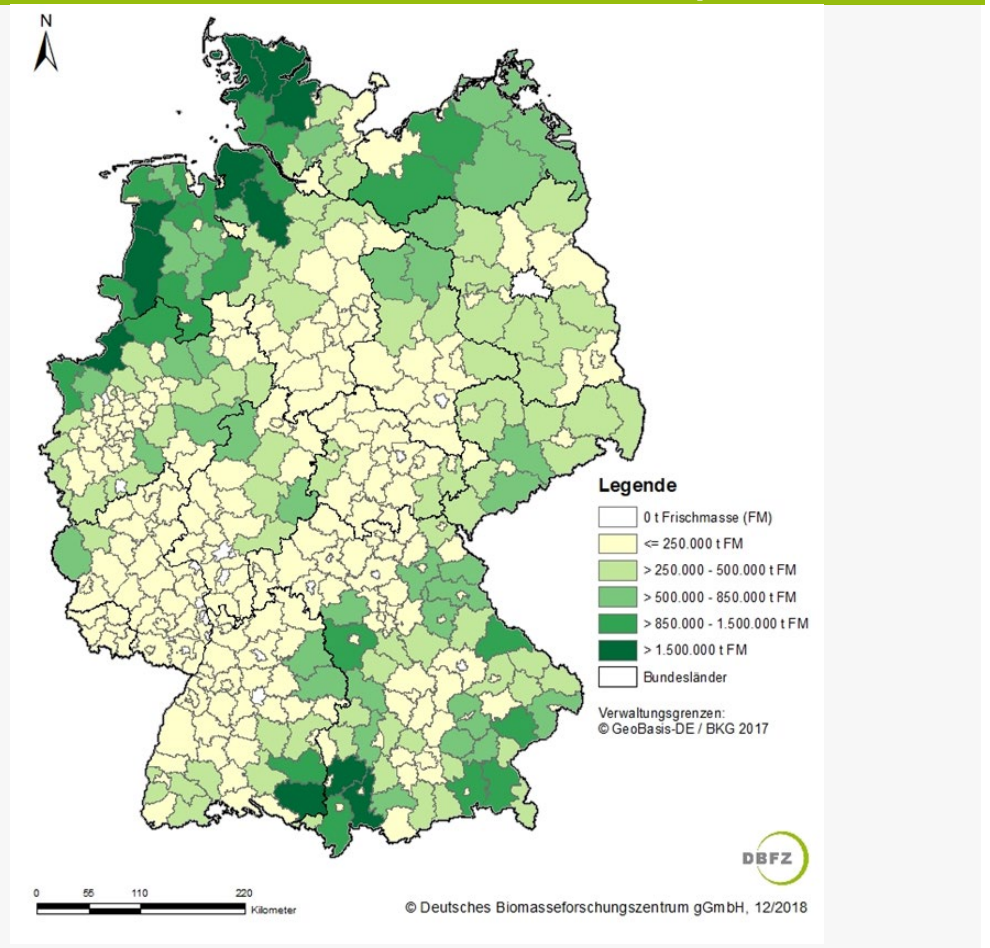
Economic-geographical aspects of biogas plants

Spatial distribution of cattle manure potentials



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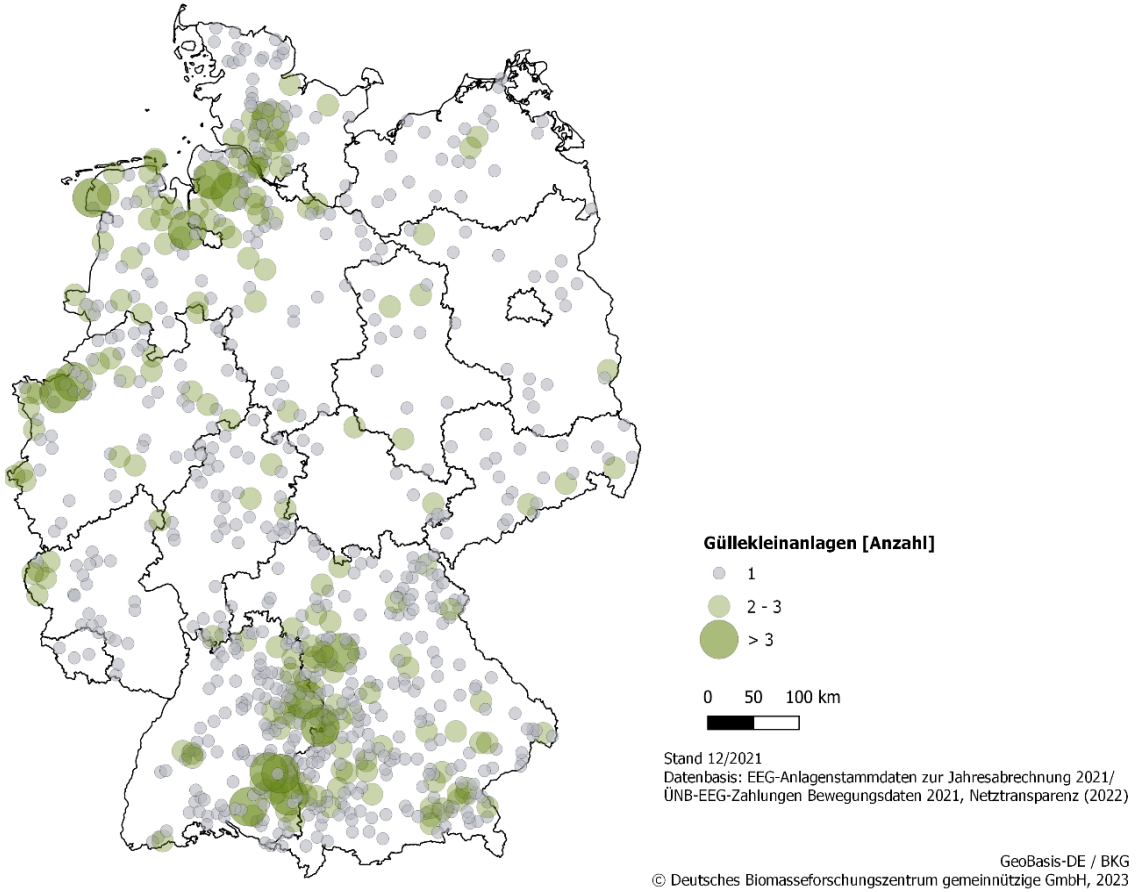
Spatial distribution of biogas plants



Quelle: DBFZ (2023)

2. Aspects of the economics of manure utilization in Germany

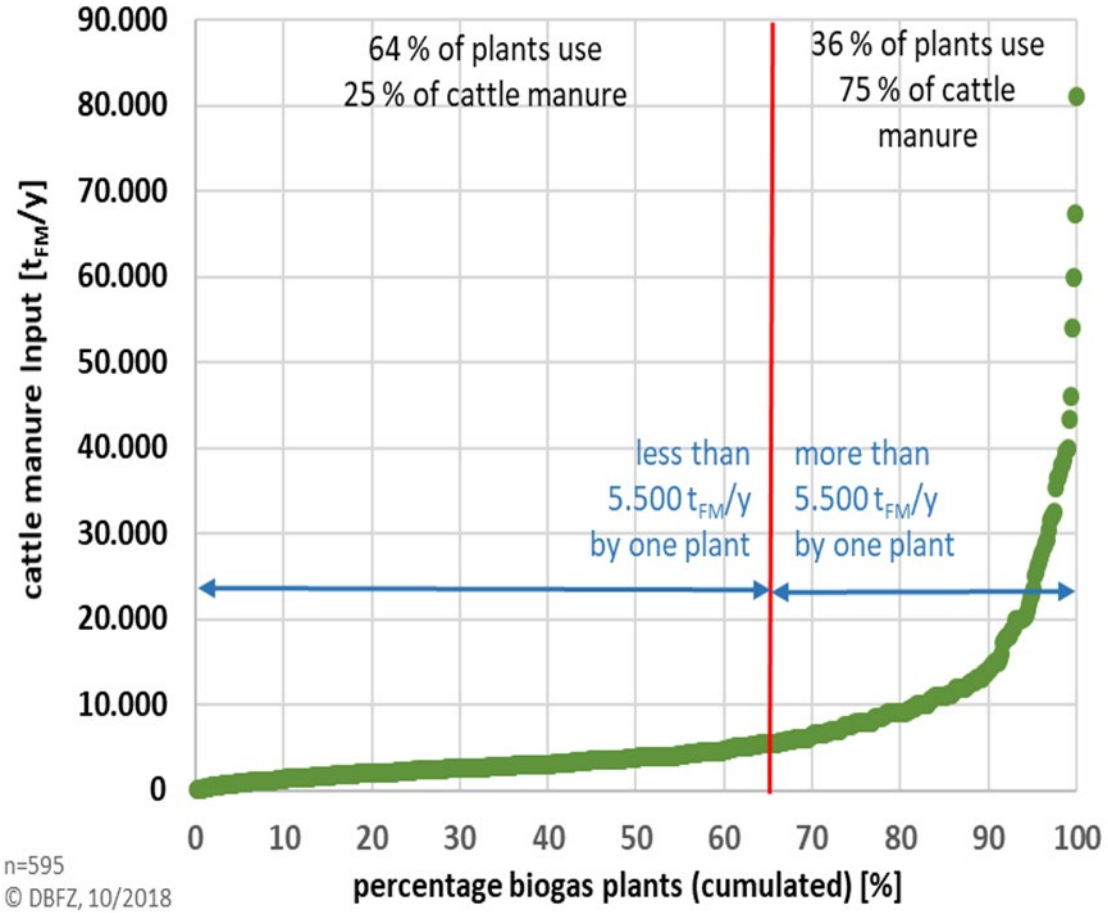
Biogas plants and manure as feedstock

General setting of manure utilization

1. **Liquid manure distribution (example: cattle manure)**
   - 36 % of the plants use 75 % of cattle manure.
   - 64 % of the plants use 25 % of cattle manure.
   - 64 % of the plants use below 5.500 t FM/year (approximately 39 kW electrical power)

2. **Significance in the context of manure use**
   - The removal of fewer biogas plants with high manure utilization has a greater effect than the removal of many with low manure utilization
   - If the focus is set on 36 % of the biogas plants, 75 % of the cattle manure can be kept in use

Cattle manure utilization in biogas plants (mass)



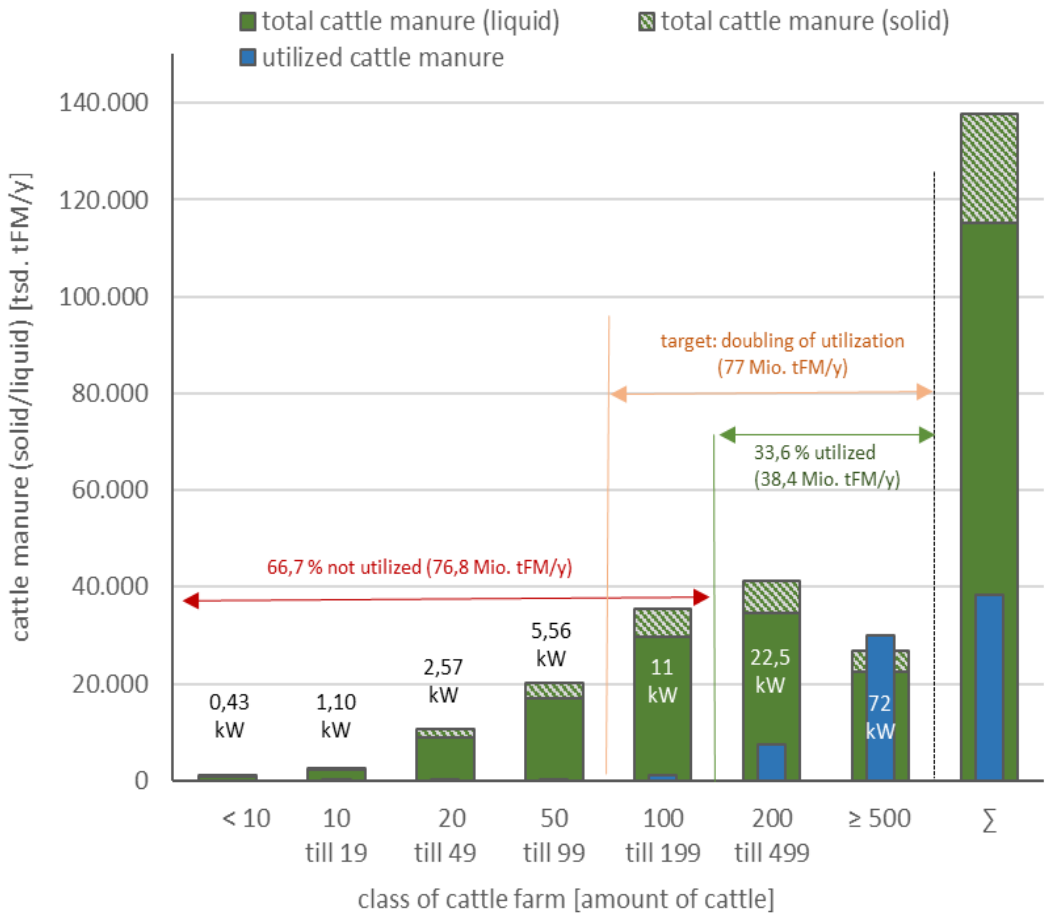
2. Aspects of the economics of manure utilization in Germany

Manure potential and current utilization

Potential analyses

- A total of about 60 million t FM of animal excrements are currently in use
  - about 40.7 million t FM of cattle slurry
  - about 6.9 million t FM of solid cattle manure
  - about 6.1 million t FM pig slurry
  - approx. 0.4 million t FM solid pig manure
  - approx. 5.9 million t FM of unspecified excrement, poultry manure and cloven-hoofed manure

Manure utilization: Example cattle manure

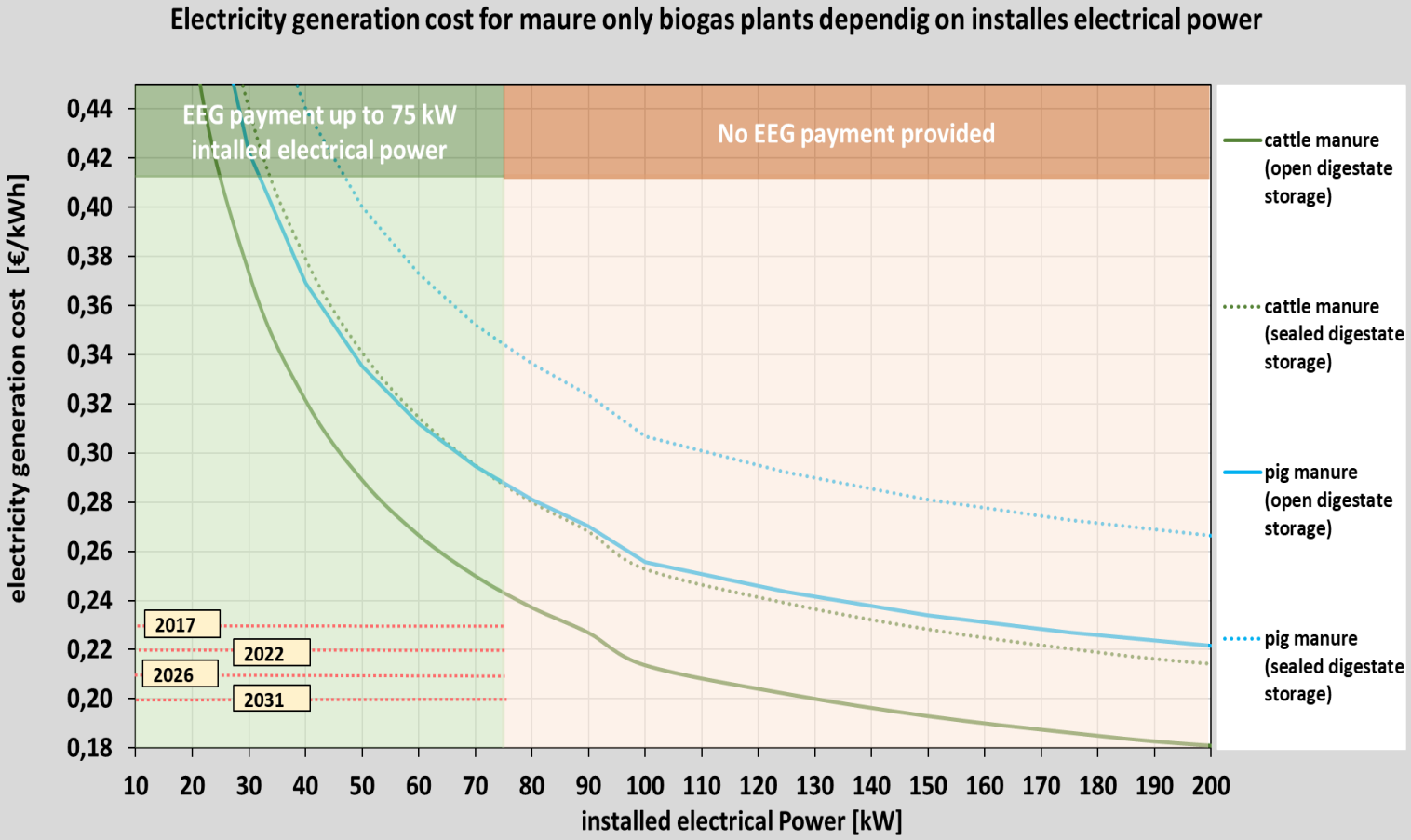


2. Aspects of the economics of manure utilization in Germany

Cost at plant level

Economies of scale for biogas plants (Manure only)

1. **Economies of scale for manure only biogas plants**
   - Strong economies of scale in electricity generation costs as a function of installed capacity
   - Pig manure has higher electricity production costs than cattle manure
   - Sealing of digestate storage means higher cost
2. **EEG-payment manure only plants**
   - EEG payment not cost-covering and only applicable up to 75 kW
   - EEG payment degression makes the utilization of small amounts of liquid manure even less attractive

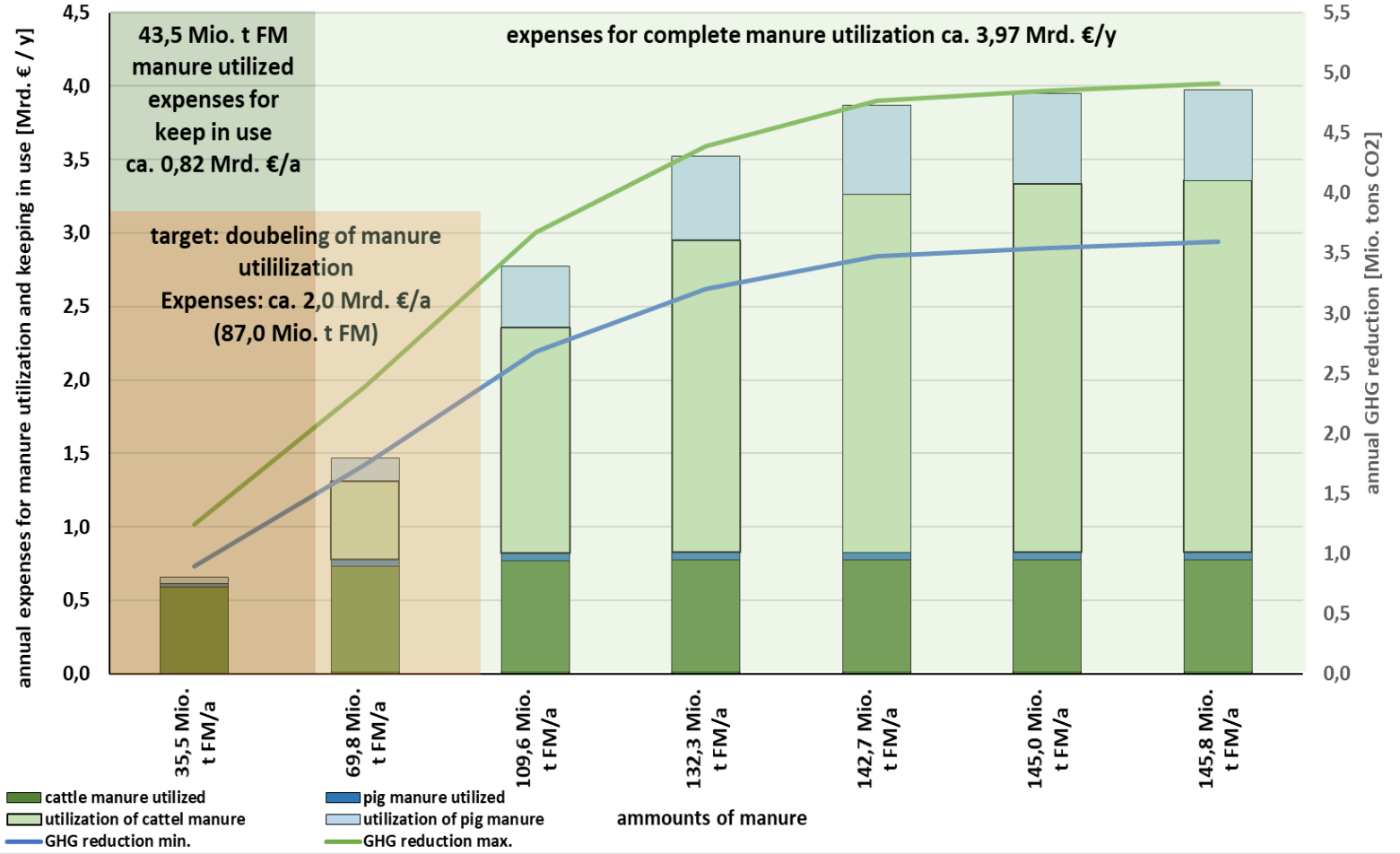


2. Aspects of the economics of manure utilization in Germany

Costs for keeping manure in utilization and utilize additional amounts of manure

Keeping and expansion of energetic manure utilization

1. **Costs**
   - Keeping energetic manure utilization: ca. 0,82 Mrd. €/y
   - Doubling energetic manure utilization ca. 2 Mrd. €/y
   - Complete utilization ca. 3,97 Mrd. €/y
2. **Cost of GHG reduction**
   - Ca. 1,2 Mio. t CO_2-Aq. for 0,82 Mrd. €/y
   - Ca. 3 Mio. t CO_2-Aq. for ca. 2 Mrd. €/y
   - Ca. 6 Mio. t CO_2-Aq. for ca. 9,97 Mrd. €/a



3. Conclusion

Conclusion and main statements

Main statements for German manure utilization

1. **In the already existing biogas plant stock liquid manure is used on a large scale. The use of these liquid manure quantities must be further secured for GHG savings.**
   - The liquid manure quantities utilized so far are mainly located at sites with large quantities of liquid manure or liquid manure is transported to these plant sites.
   - Cattle manure has higher potential and is cheaper to utilize than pig manure.
2. **Two thirds of the existing liquid manure potentials have not yet been utilized.**
   - If these quantities are to be utilized, this must be done through new concepts for existing plants and through new plant construction.
3. **Liquid manure potentials of small animal stocks with unfavorable infrastructural conditions can only be achieved with high specific costs for energetic use. Other options should also be considered.**
   - If no technical option and funding is given, untreated manure contributes further to GHG emissions.
   - Covering digestate storage in combination with flaring the storage gases can be a more cost-effective alternative to GHG avoidance. But in this case the renunciation of energetic use and GHG reduction in energy sector must be accepted.

3. Conclusion

Conclusion and main statements

Main statements in general

1. **Liquid manure is a high massflow/low energy feedstock compared to silages**
2. **High livestock amounts are needed for using economies of scale for manure only plants**
3. **Liquid manure is a cheap feedstock, which needs high capital expenditure to get into utilization**

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Smart Bioenergy – Innovations for a sustainable future

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