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Potential analysis of agricultural residues as a source of renewable energy

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Content

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Motivation

- Over the past few decades Austria has seen a steady decline of agricultural farms.
- Grassland in Austria from 1950 to 2010: reduction of 1,000,000 ha of grassland.
- The traditional grassland utilization is for agricultural production (milk, meat)
- The reduced management of extensively used grassland areas (e.g. natural protected areas) subsequently enhances forestation.
- This process of succession has numerous negative effects on different sectors, including tourism.
- In the absence of agricultural farming, alternative management concepts are required in order to preserve an open countryside.

Adapted land utilization concepts

– Utilization of grass biomass, agricultural residues and municipal waste for biogas production would be a suitable alternative

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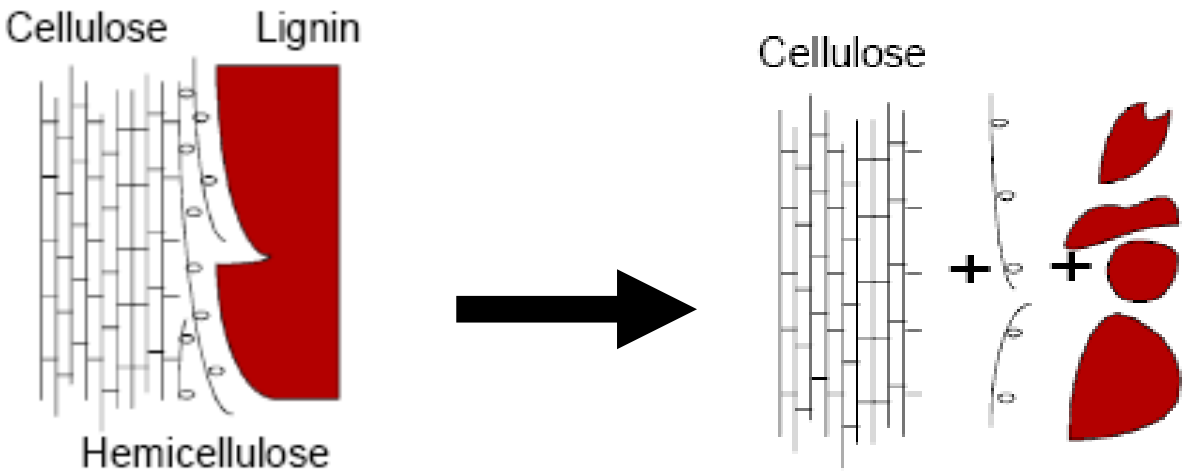
- Problem using such materials
  - high content of lignocellulosic complexes



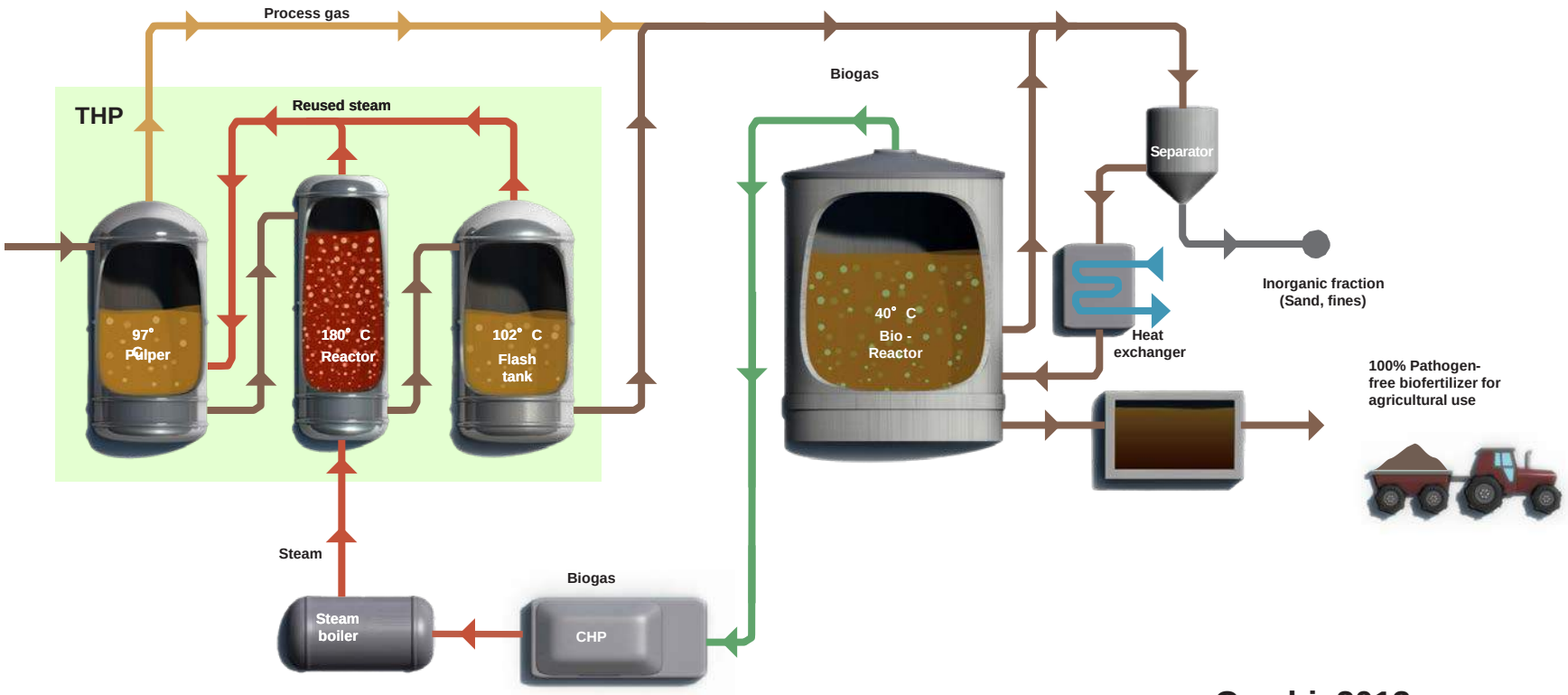
Source: Wich et al. (s.a)

Adapted land utilization concepts

- Utilization of grass biomass, agricultural residues and municipal waste for biogas production would be a suitable alternative
- Problem using such materials
  - high content of lignocellulosic complexes
  - **Pathogens → sanitation**

→ Pre-treatment is necessary

Steam explosion pre-treatment



Cambi, 2013.

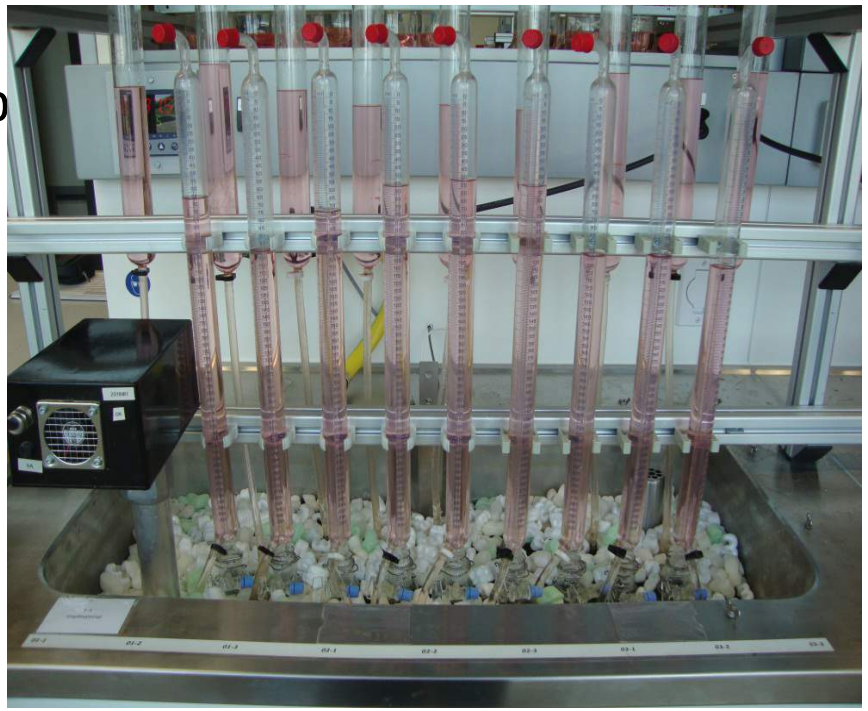
Material and Methodes

Pretreatment of biomasses

- Treatment with high temperatures and pressure over a certain time
- 8 combinatios of temperature and time
- 160 – 220° C for 15min

Analysis of untreated and pretreated materials:

- Electron-scan microscope
- DM, VS (→ as b
  methane yield)
- Cellulose,
  Lignin (Van Soest)
- Methane potential in
  (→ biogas and methane formation)

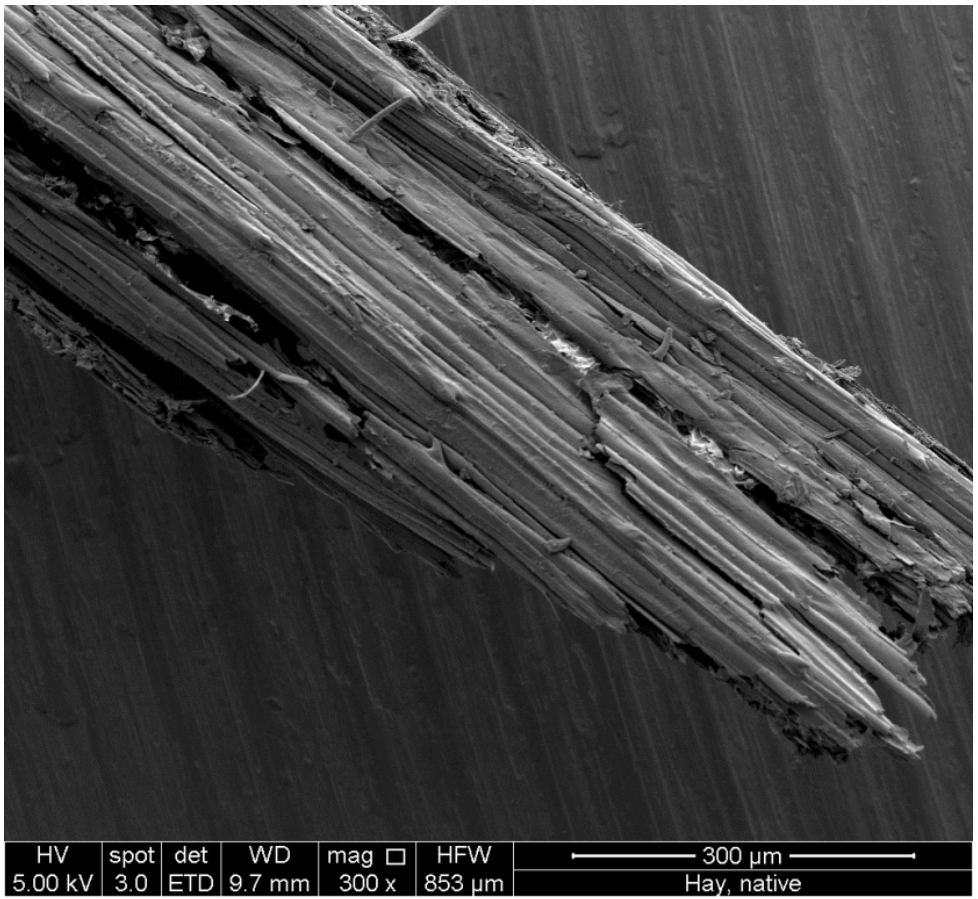


Model region

- Area: 192 km2
- Population 3.400
- Input materials for the biogas production
  - Hay from unused grassland, manure, biowaste, other agricultural residues
- 60 % of the biomass yields
- Additionally, 5 % losses emerge due to the conservation
- The theoretical potential of animal excrements is reduced by the duration of the free-range grazing period.

Results

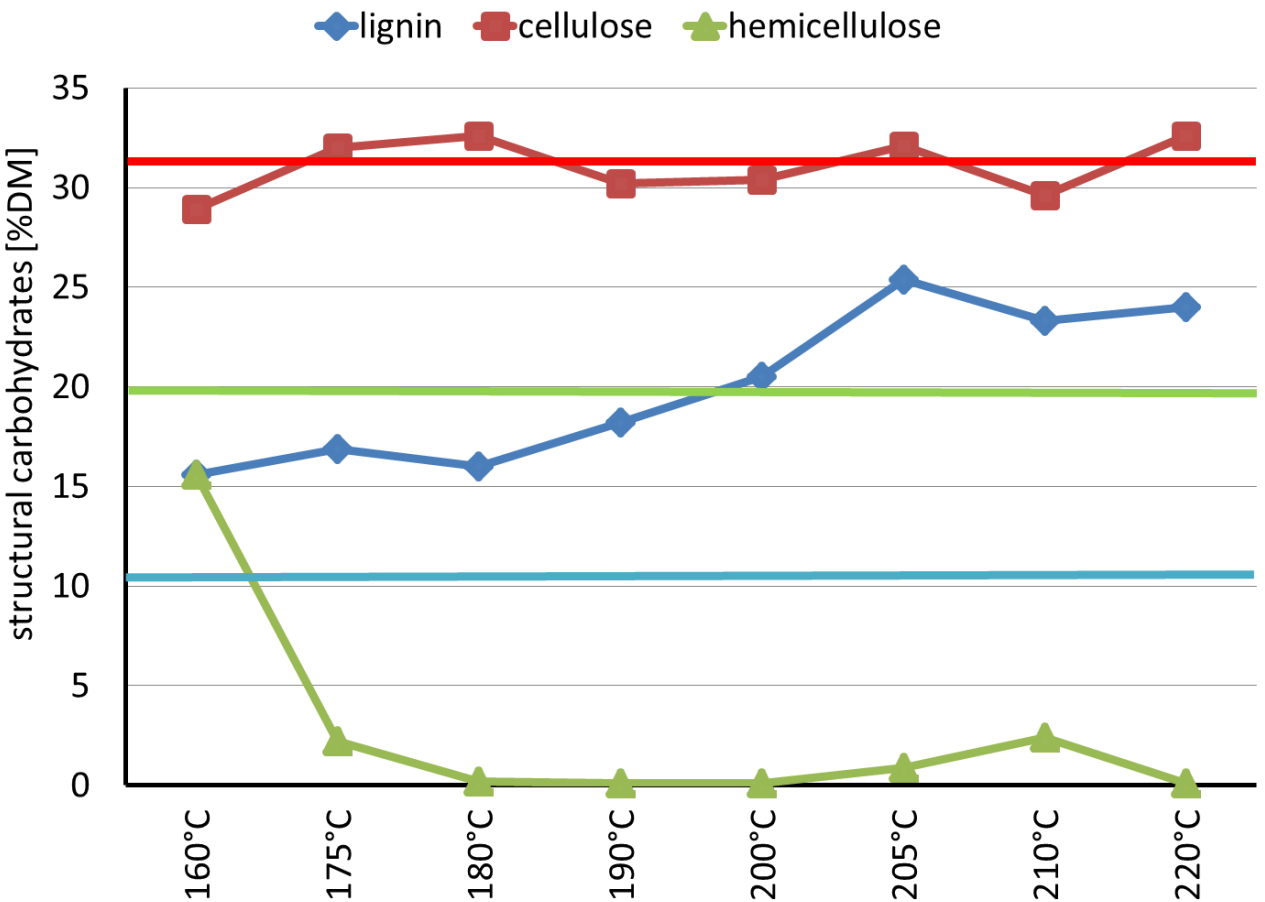
Electron-scan microscope
Hay, native



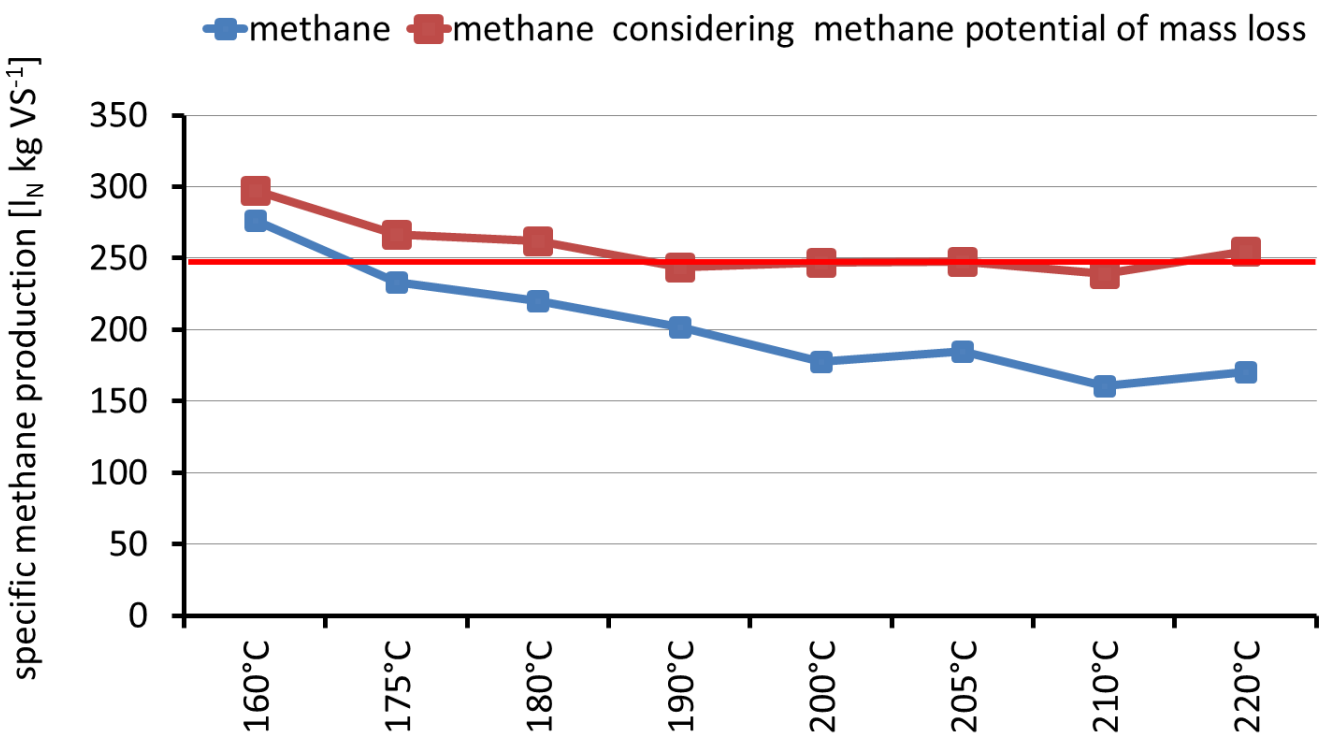
Electron-scan microscope
Hay 180°, 10 min

Electron-scan microscope
Hay, 190° C, 10 min

Chemical composition: Van Soest



Batch experiments: Specific methane yields



Biogas yields

	Yield of Biogas [Nm^3 t VS^{-1}]	Content of CH_4 [%]
Steam exploded hay	468	59
Manure solid/liquid	300 - 450	55 - 65
Steam exploded Kitchen scraps	600	65
Frying oil	1,000	68

Model region

- Area: 192 km2
- Population 3.400
- Input materials for the biogas production
  - Hay from 180 ha grassland
  - Manure (2,850 cattle, 970 other roughage eaters, 130 pigs, 1,300 chickens
- No waste from household and municipal waste

Technical Potential (2010)

	Input [t DM/year]	Methanyield [Nm^3/year]	Energy [kWh/year]
Hay, steam exploded	557	153,800	1,500,000
Manure	6,000	1,163,400	11,500,000
Total		1,217,200	13,000,000

Power CHP

electrical: 670 kW

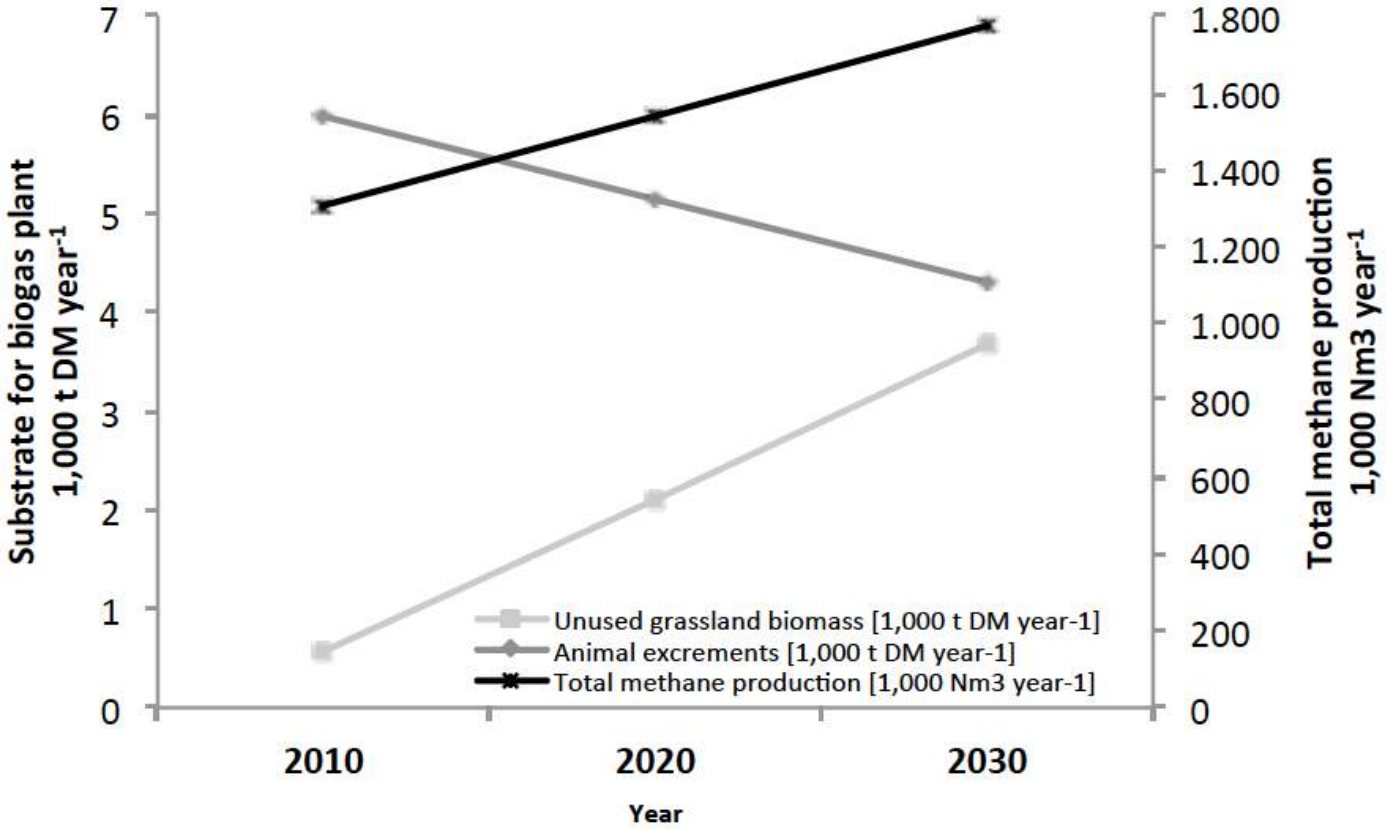
thermal: 740 kW

Produced (own consumption removed)

Electricity, 4,5 GWh, heat, 4,4 GWh

→ Corresponds 29% of the consumption of electricity

Technical potential of biogas substrates 2010, 2020 and 2030 for the model region



Conclusions and Outlook

- Steam explosion increase the specific methane yield
- Mass loss during the pretreatment important factor, Strong Influence of inhibitors → Detailed analysis of inhibitors
- Biogas potential of agricultural product and agricultural residues is high
- Combination of grass biomass, agricultural residues and municipal waste for biogas production would be a suitable alternative

Thank you!

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