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Exploring Biogas from Common Reed

The rapid expansion of reed growth, combined with changes in livestock management, poses environmental challenges. However, if reeds can sustainably contribute to increased biogas production in Ostrobothnia and similar regions, they may also present an opportunity. The City of Vasa and Stormossen Oy have initiated an investigation into harvesting reeds for biogas production, including nutrient extraction from the plants. The study also considers the associated quantities, costs, and sustainability implications. Patiwat Snickars, a student and employee at the City of Vasa, participated in biogas tests at Novia UAS and wrote a thesis on the topic of biogas from reed. The Boost Nordic Biogas project wanted to highlight this work and the potential of reed-based biogas in this info sheet.

Practical work and experiments

Patwin's thesis explores the potential of common reed (*phragmites australis*) for biogas production, focusing on the entire process; from harvesting to production. The study investigates the economic and production aspects of converting common reed into biogas, with aim to provide insights into its feasibility and sustainability.

Perhaps the largest challenge with utilizing reed is harvesting. Efficient harvesting of common reed involves using specialized machinery like harvesters and tub grinders to optimize the process. There are many different types of these harvesters and grinders with varying cost. In the study, several suppliers of harvesters were contacted about cost and functionality, and study visits were conducted to learn more about the processes.



A challenge with utilizing reed is how to harvest it.

Laboratory work utilized the AMPTS II system setup on lab-scale, designed for conducting anaerobic digestion tests. Researchers analyzed the Biochemical Methane Potential of various biomass substrates, evaluating the capacity of different organic materials to produce methane through anaerobic digestion.

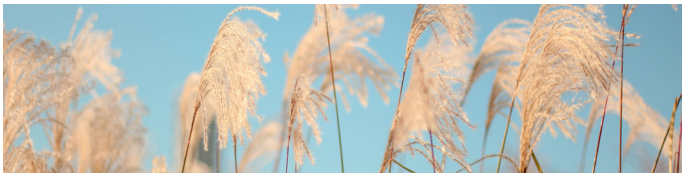
Seasonal variations

Seasonal variations in methane production from common reed are analyzed through tests on harvests from winter, summer, and autumn. It gives valuable insights to optimal harvesting time for maximizing biogas yield (figure 1).



Figure 1. Reed harvested in summer and winter, milled in the laboratory.

In addition, the reed was mixed with either sludge from wastewater treatment or biowaste. Stormossen has two separate reactors for those substrates which operate at different temperatures (55°C and 42°C). The reed was also digested on its own at those different temperatures and inoculum from those reactors. Based on discussions about reactor feeding, it was decided to test two different mixing ratios for those co-digestion tests.



Common reed can be used for biogas production but more reserach is needed..

Results

The thesis includes a comprehensive cost analysis spanning the entire process, from the harvest of common reed to biogas production. It takes into account various factors, including machinery expenses, labor costs, and transportation logistics, to evaluate the economic viability of leveraging common reed for biogas.

Notably, the costs associated with the biogas plant itself are not incorporated in the analysis (see Table 1).

Table 1. Payback period analysis, for two different scales winter harvest.

Description	15 hectares	30 hectares	Comment
Total Fixed Costs (EUR)	74 763 €	74 763 €	Investment for equipment and infrastructure
Total Variable Costs (EUR)	43 946 €	87 891 €	Variable Costs/ha multiplied by hectares
Total Revenue (EUR)	56 410 €	112 820 €	Revenue from biogas sales
Net Cash Flow (EUR)	12 465 €	24 929 €	Total Revenue minus Total Variable Costs
Payback Period (Years)	**6,00**	**3,00**	Fixed Costs/Net Cash flow

Logistics is often an important factor in the profitability of biogas plants, and when it comes to reed, truck transportation may be difficult in some areas. Wet weather may further complicate this. Cold winters might ease the situation with transportation, which is another argument for winter harvest.

However, in situations regarding winter harvest, proper storage is needed, if not readily available. You can read more about this in the thesis, which contains a SWOT-analysis (identifing strengths, weaknesses, opportunities and threats) of using bunker silos and/or baling for common reed. Bunker silos is commonly used on farms to store bulk feed, and baling is the process of compressing and binding hay, straw, or sil-age into bales for easier handling, transport, and storage.



Reed can be stored in bunker silages.

Recommendations

The thesis highlights the potential of common reed for biogas production, emphasizing the importance of efficient harvesting and pre-treatment.

Harvesting in winter appears to be the most attractive option, with significantly more biogas produced per ton of reed (figure 2). However, this leaves part of the plant under the ice, and proper storage of the reed also affects biogas production which might lead to increased costs.

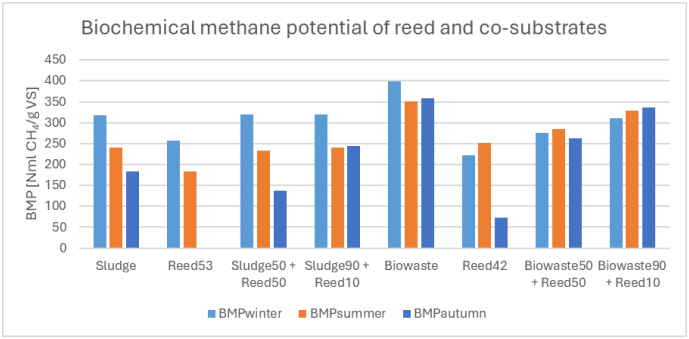


Figure 2. Results from the biogas tests on reed harvested in different seasons.

In the experiments, the reed that was milled in full-scale and stored for a couple of months showed especially low potential for biogas production, hinting at poor sample quality. The sample also contained impurities such as stones, which may cause problems at a biogas plant.



In the study winter tests were used.

Mixing reed with other substrates

Sludge can be a more suitable co-substrate than biowaste in this case. The reason why sludge is better might be the visible difference in mixing properties during the winter tests. When reed was mixed with biowaste the material floated on the reactor surface to a larger extent than in samples mixed with sludge. Floating material can lead to issues in the reactor, but also decreases reactor efficiency. In order to determine the amount of nutrients removed, a supplement analysis of the nutrient content of the plant harvested in different seasons should be performed.

The reduced outcomes observed in certain cases appear to be influenced by the diminished quality of the inoculum, likely stemming from process instabilities encountered during that period. It is advisable to retest these samples, ideally alongside a control sample like microcrystalline cellulose, to validate the findings.

Conclusion

Common reed can be a valuable source in producing biogas, particularly when harvested in winter for increased yields. However, effective harvesting and storage methods are needed to reduce costs, as well as further reserach.

More information

Text written by Andreas Willfors, Novia. Based on: Snickars, Patiwat (2024). Common Reed's Methane Potential Through Anaerobic Digestion – Cost Analysis from Harvesting Biomass to Biogas Production (clickable link).

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