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SIMPLY Project

Biomass feedstock potential

Report

Revision History

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1 Introduction

This report documents activities conducted as part of the SIMPLY-project, work package 1.1: *Map and characterize suited biomass resources in Denmark incl. quantity, quality, cost and competition. Assessment of economical and practical feasibility of biomass pyrolysis under various circumstances.*

On 24 of June 2024 the Danish Government presented “Aftale om et grønt Danmark” [1]. This agreement mentions pyrolysis of biomass as an important technology to deliver on the GHG-reduction emission targets. The agreement includes a tax on GHG emissions from biological processes.

Also, the government has announced a specific strategy on pyrolysis of biomass which is expected to be released in Q3 2024.

1.1 Reference

This report forms part of the delivery of information as part of the SIMPLY-project.

1.2 Scope of Report

The report focuses on mapping the biomass potential in Denmark relevant for carbon capture and storage through biochar produced by pyrolysis of agricultural biomass residues.

2 Biomass feedstock potential

Denmark has a strong hold regarding data on agriculture fields. Leveraging this information the biomass potential can be quantified in much detail.

Early 2024, the CIP Foundation has published the results of a thorough assessment of the potential for pyrolysis of biomass in Denmark. Stiesdal has contributed to the work done by the CIP Foundation. The assessment includes a mapping of potential biomass resources in Denmark [2].

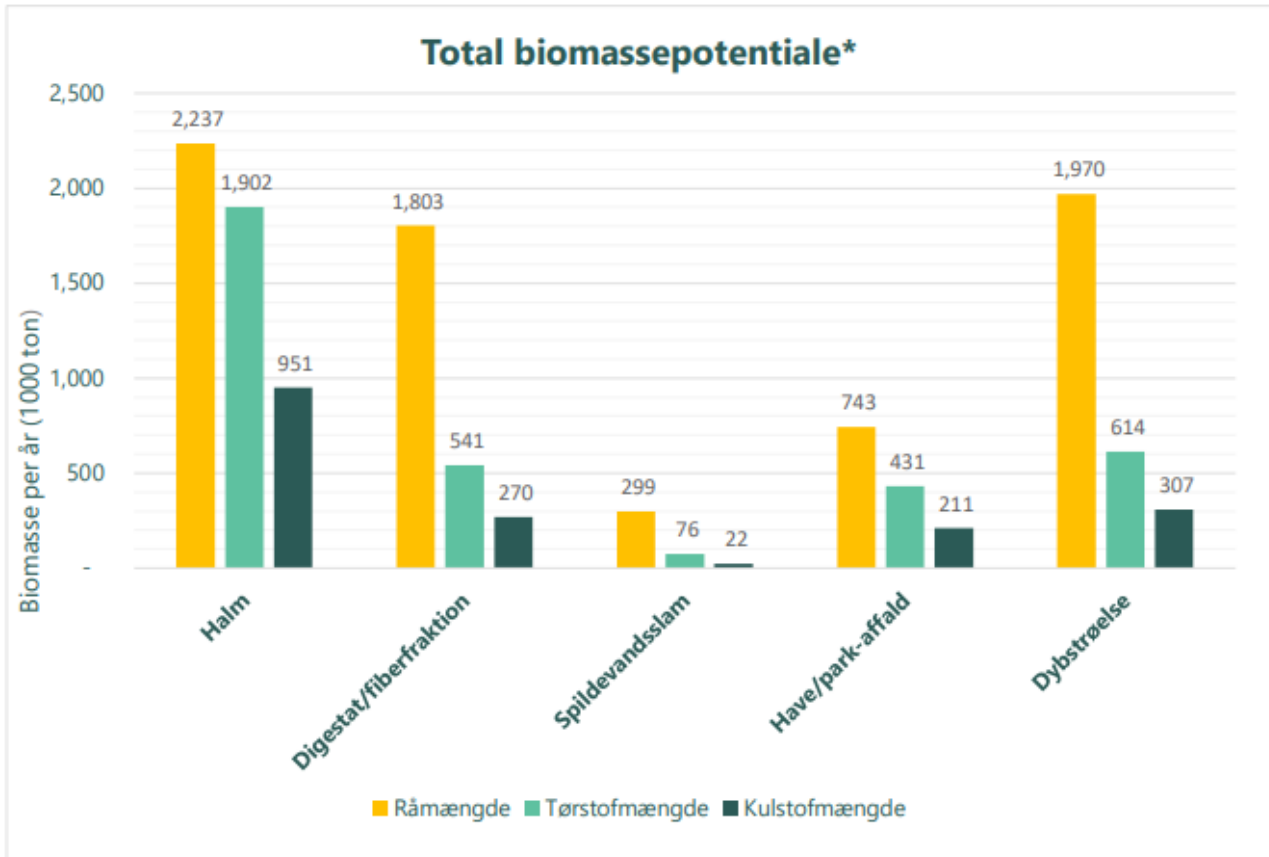


Figure 1 Estimate on the total biomass potential in Denmark.

In total, the estimated biomass potential amounts to 7,052 Mio. Ton of biomass corresponding to 3,564 Mio. ton of dry matter or 1,762 Mio. ton of carbon.

The study also maps the potential biomass resources on geographical locations.

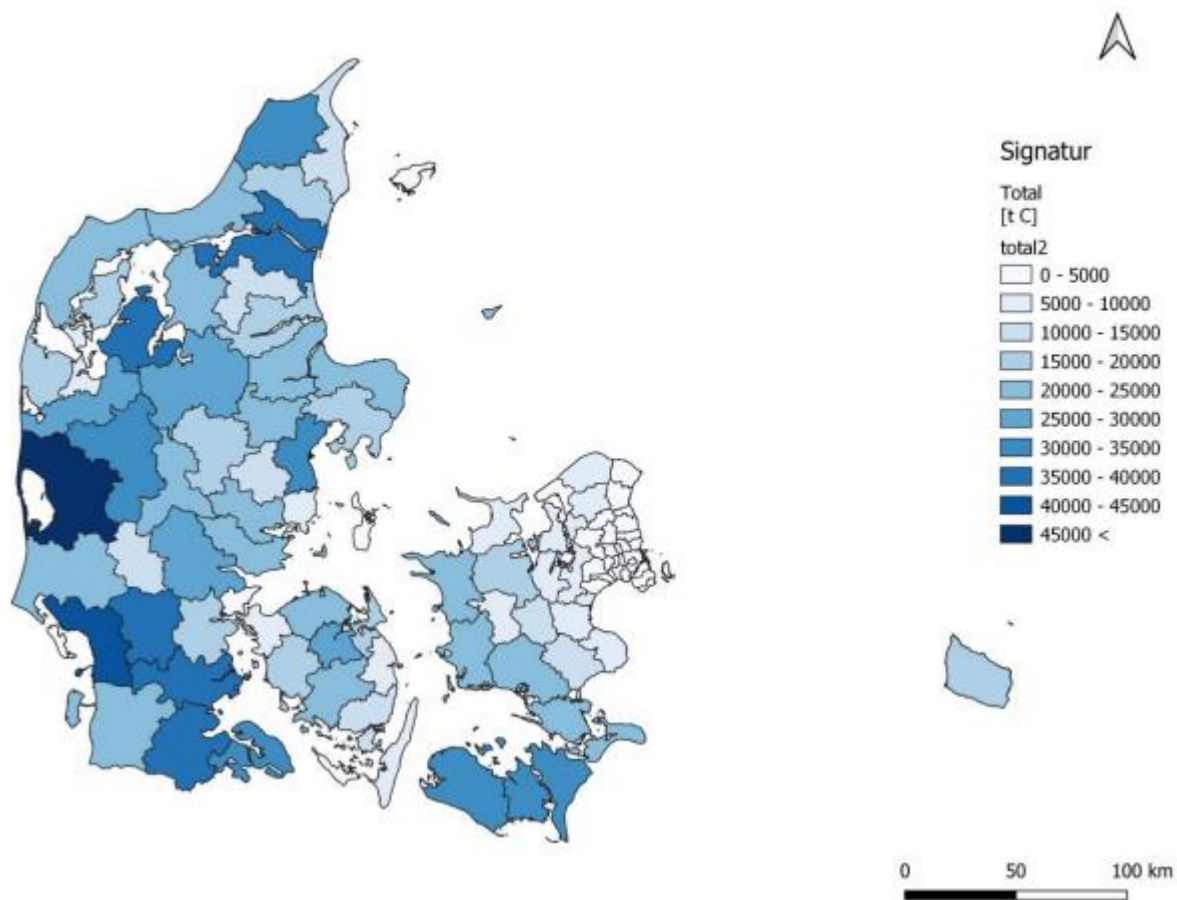


Figure 2: Biomass potential in Denmark

This and other studies leverage a background study [4] working with different scenarios for future potential. From the study it is clear that the future potential of available biomass for pyrolysis can be influenced by political decisions. Thus, in more scenarios the potential exceeds 10 Mio. ton of dry matter. “Aftale om et grønt Danmark” which includes 250.000 hectares of reforestation is likely to impact the potential of biomass. It is yet too premature to estimate the impact on this agreement but even if all new forest areas are excluded from delivering biomass there are still vast opportunities for delivering carbon capture and storage from biomass.

Biomass resources correspond well to the areas with high intensity agriculture activity. The consultancy advisor within agriculture, ConTerra, has mapped the expected consequence of the CO2-tax. The result is shown below.

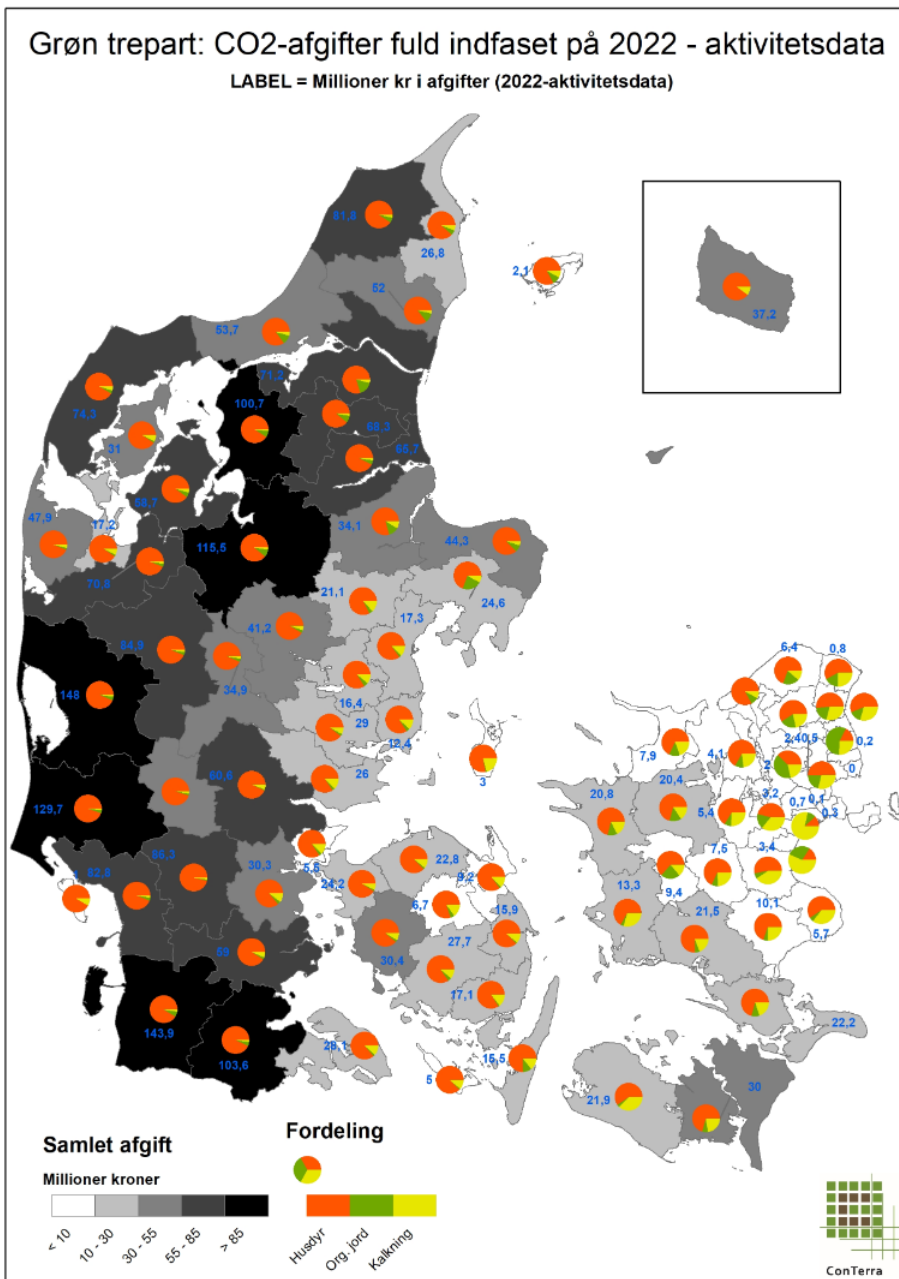


Figure 3 Expected impact of CO₂-tax

It appears there is a strong correlation between biomass availability and the expected impact of the proposed CO₂-tax. Thus, the challenge is to convert the available biomass into negative emissions by means of pyrolysis to compensate for the costs associated with the emissions.

2.1 Feedstock Quality Assessment

The most important feedstock quality parameters for SkyClean include moisture level and carbon content in the biomass. From a SkyClean perspective biomass having less than 15% moisture is considered dry and doesn't require further de-moistening prior to processing. In a Danish context this limits the potential feedstock and put demands on intermediate storage to bridge the seasonal availability of biomass. Straws from grain crops are the most obvious candidates for feedstock in Denmark.

However, efficient drying processes exist which vastly enlarge the potential. Here, biomass residue fibers, pulp from the production of green protein, moist cover crops, sludge and wood cutting increase the quantity.

SkyClean uses pelletized biomass as feedstock. Pelletization ensures a homogenous feedstock with an adequate moisture content. If the water contents get below approximately 5%, the pelletization process looks to get more challenging. This makes pelletization a focus area in itself when the pyrolysis technology leveraged gravity to as in the case of Stiesdal SkyClean.

The primary reason for pelletizing the feedstock is to ensure the production of safe and stable biochar. Also, pelletization has a big advantage in the subsequent handling of the biochar. The other main advantage of pelletization is compacting and handling of feedstock during the pyrolysis process. Once pelletized, the SkyClean process appears to be robust and allows for many kinds of feedstock.

2.2 Feedstock cost and competition

In Denmark dry straw – typically in the form of bales - is considered a commodity used as deep bedding for livestock or in many district heating plants. Pelletized straw is used as deep bedding material. Straw in the form of bales is traded at around 750 DKK/ton. This market price appears attractive to many farmers and compensates for the loss in nutritional value, lost humus potential, and cost of producing the straw bales with some margin. Based on interviews, requirements for cover crops and poor weather negatively affects the interest in producing straw bales.

The production of green protein by means of grass has been assessed several times during the last decades. So far, green protein from grass struggles to compete with imported soy in the current market situation despite the large GHG-footprint of imported soy. The grass pulp is typically used in biogas plants to generate biomethane. Any value from subsequent pyrolysis of the biogas residue fibers will contribute to the viability of this alternative source of protein. So far, grass pulp does not allow for seasonal storage but must be processed directly. However, silage methods currently used at some biogas plants might facilitate storage. Currently, there is only a limited market for grass pulp i.e. the feedstock price is negligible.

Biogas residue fibers are an interesting opportunity as feedstock for pyrolysis. As such, biogas residue fibers constitute a cost for biogas plants. Dialogues with market players within biogas indicate cost levels in the order of 40-100 DKK/ton fibers for transportation and handling.

Dialogues with community traders in Southern Europe suggest that straw bales have significant lower value many places than in Denmark as district heating systems are less common.

List of References

Ref	Standard/Author	Details
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[2]	CIP Foundation	https://cipfonden.dk/wp-content/uploads/2023/06/NIRAS-bio-masse-rapport_til-udgivelse.pdf
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[4]	Gylling, M., Jørgensen, U., Bentsen, N. S., Kristensen, I. T., Dalgaard, T., Felby, C., Larsen, S., & Johannsen, V. K. (2016). The + 10 million tonnes study: increasing the sustainable production of biomass for biorefineries. (Updated edition 2016 ed.) Department of Food and Resource Economics, University of Copenhagen.	https://static-curis.ku.dk/portal/files/167352444/Timio-planUKrevideret_1310_2016.pdf