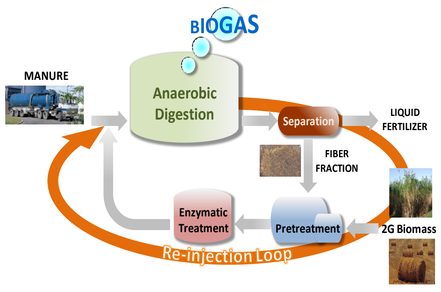

BIOMAN

DANISH TECHNOLOGICAL INSTITUTE

Economically efficient biogas production from manure fibres and straw

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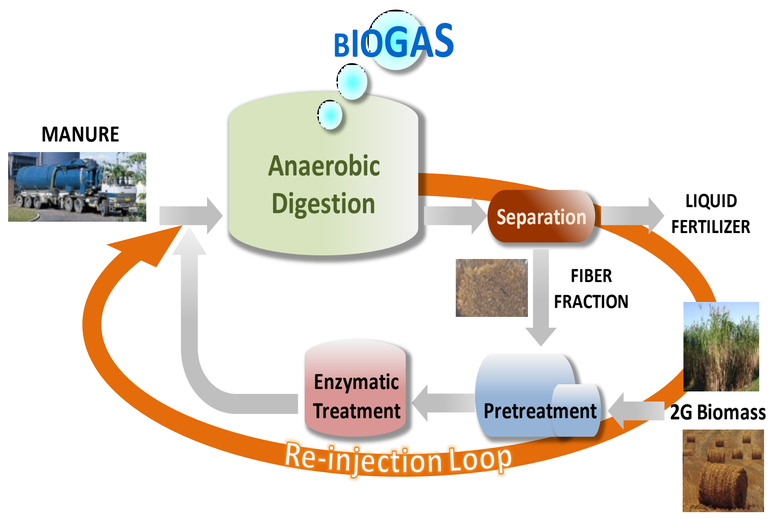
Introduction

There is a huge untapped biogas potential from manure and agricultural residues in Europe and worldwide. However, these substrates consist of a large fraction of fibres (range 5-80% of dry matter content) with a low methane potential but the economy for operation of biogas plants based on these biomass resources is marginal due to their low biogas yield per ton. The biogas yield can be improved if pretreatments are applied e.g. mechanical, thermal, chemical and biological (Angelidaki & Ahring, 2000; Uellendahl et al., 2007), but so far none have proven economically feasible. Therefore, there is an increasing demand for developing a treatment concept as the Re-Injection Loop for increasing the biogas yield per ton of waste biomass, with a prerequisite that the benefits of the treatment exceed the operational costs to ensure economical sustainability.

The Re-Injection Loop Concept

"The Re-Injection Loop"´ is for producing biogas from recalcitrant low-energy substrates with a high content of lignocellulose by combining a range of mechanical and enzymatic treatments, see **Figure 1**. Downsizing, ultra sound and enzymatic treatments are technologies to be used in the Re-Injection Loop and will be applied on pre-digested and dewatered biomasses before recirculation to the biogas reactor and of key focus is the overall economic sustainability (Uellendahl et al., 2013).



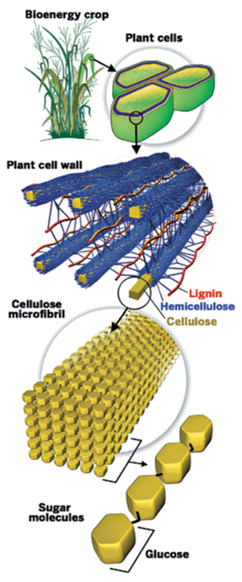


Figure 1 A) Schematic drawing of the Re-Injection Loop concept. B) Drawing of lignin, cellulose and hemicellulose in plants

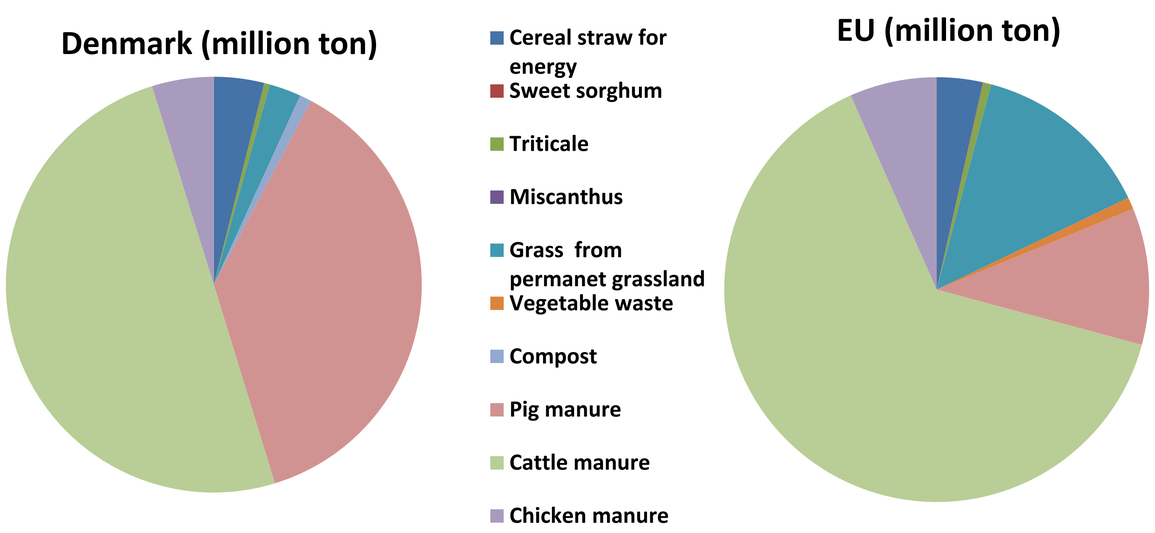


Figure 2. Amounts of biomass types applicable for the Re-Injection Loop in Denmark (38 mill. ton) and in Europe (1702 mill. ton).

Experimental approach

A survey of substrate availability within Denmark and Europe was conducted and results are depicted in **Figure 2**. Included were both digested and some undigested "green" substrates. Different separation technologies for pre-digested biomass were assessed with respect to separation efficiency and characteristics of fibre products at Morsø BioEnergi plant, shown in **Table 1**. Based on mass balances, theoretical methane potential and an expected conversion efficiency of 50%, the potential increase of methane production has been estimated in the range of 20-37% .

Acknowledgement

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Table 1. Overview of total solid concentration following separation methods

	Total solids (%w/w)				
Separation method	**Inlet**	**Solid fraction Fibre**	**Liquid fraction Reject**	**% of total VS in fibre fraction**	**Potential methane increase %**
Centrifugation Day 1	5.8	27	2.9	62	37
Screw press Day 2	5.1	31.3	3.7	39	20
Bow Screen Day 1	5.8	8.2	4.4	58	35

BioMethane Potential

A number of relevant substrates suitable for the Re-Injection loop is selected for extensive chemical characterization. Biomethane potential (BMP) measurements will be performed, serving as baseline for evaluation of the listed pretreatment technologies. The most suitable combination of physical and enzymatic treatments will be identified along with the life cycle economical calculations. Pilot scale development and evaluation of the Re-Injection Loop will be conducted prior to full scale implementation and demonstration at a recently established biogas plant in Spain.

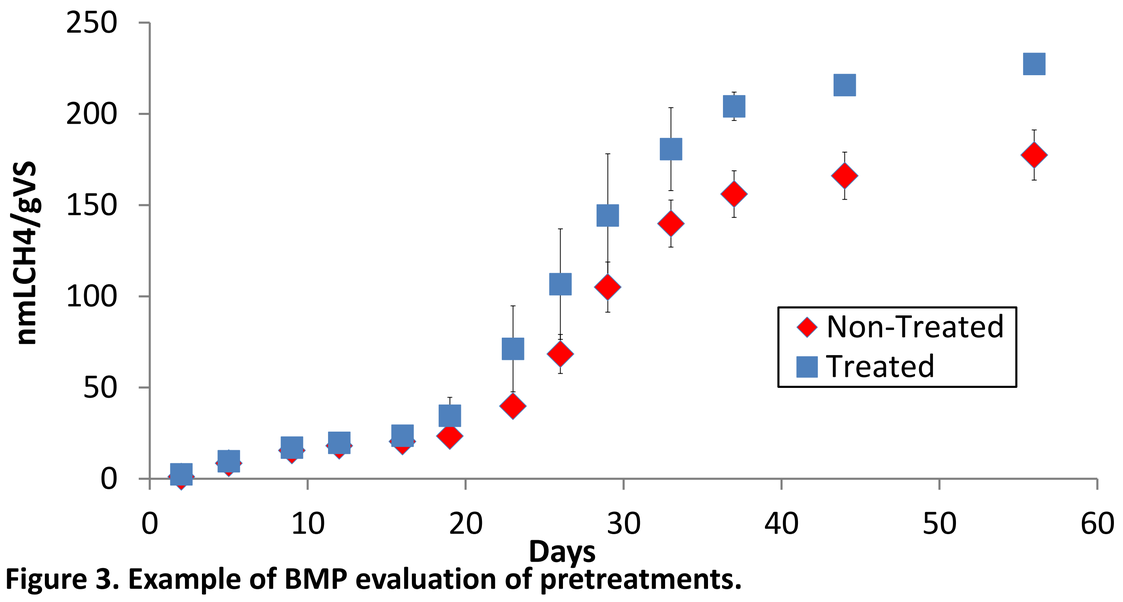

Figure 3. Example of BMP evaluation of pretreatments.

Conclusions and perspectives

- The Re-Injection loop is directed at recalcitrant degassed substrates (**Figure 1**)
- Abundant ressources available for biogas production within EU (**Figure 2**)
- Combination of pretreatments for the Re-Injection loop will be determined by BMP measurements and chemical characterization (**Figure 3**)

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