

# INTERDISCIPLINARY RESEARCH AS A KEY TO UNLOCK DANISH BIO-ECONOMY'S FULL POTENTIAL

AARHUS UNIVERSITY

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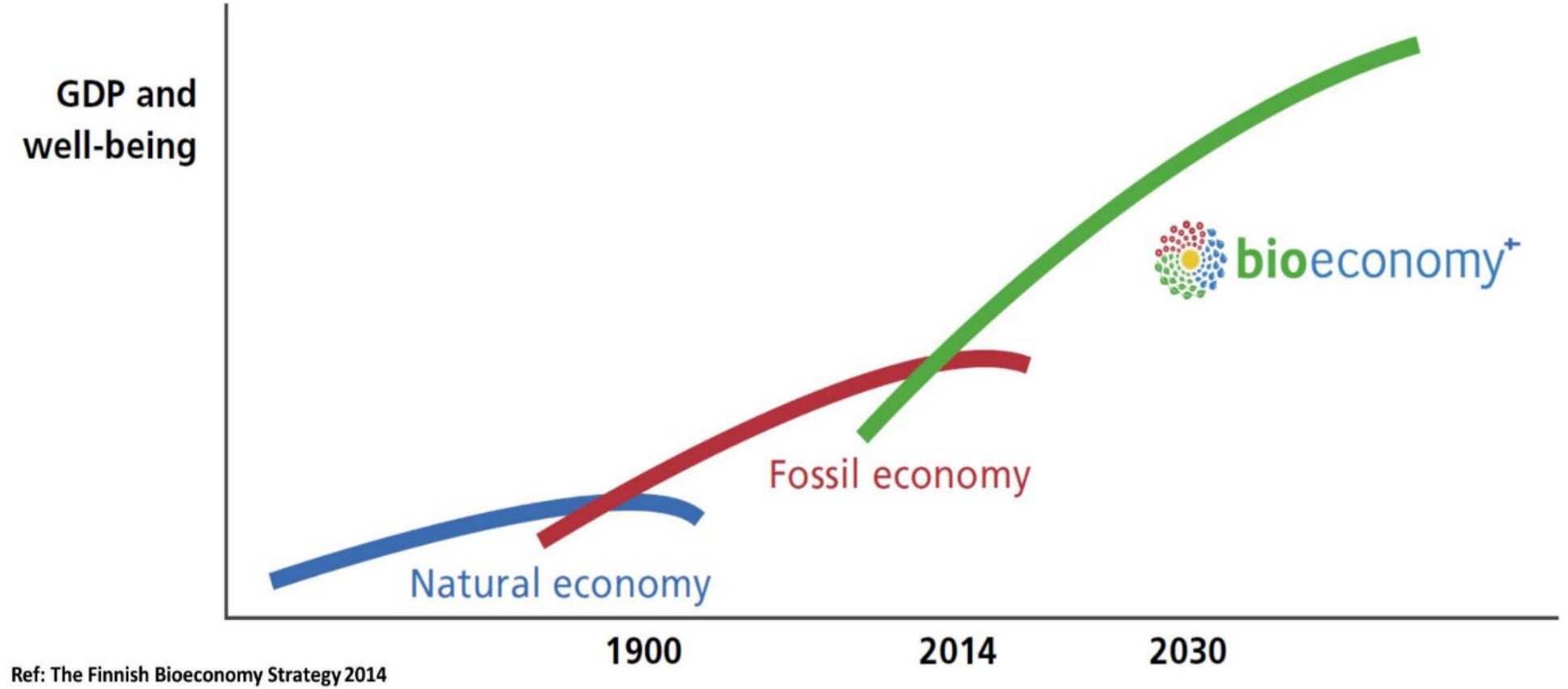
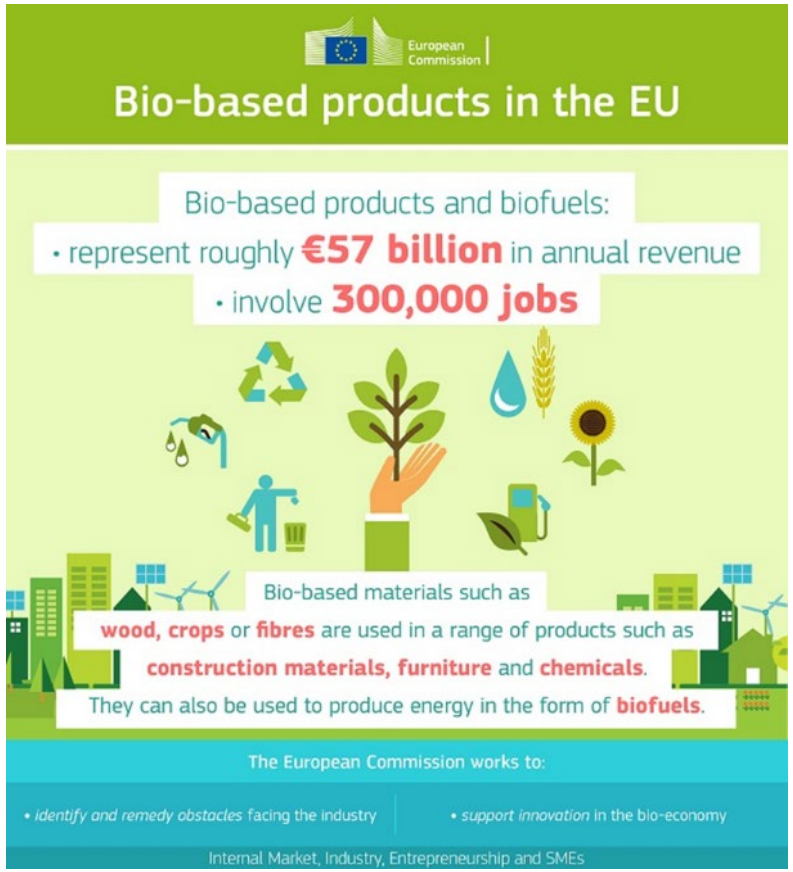
CBIO
AARHUS UNIVERSITY CENTRE FOR CIRCULAR BIOECONOMY

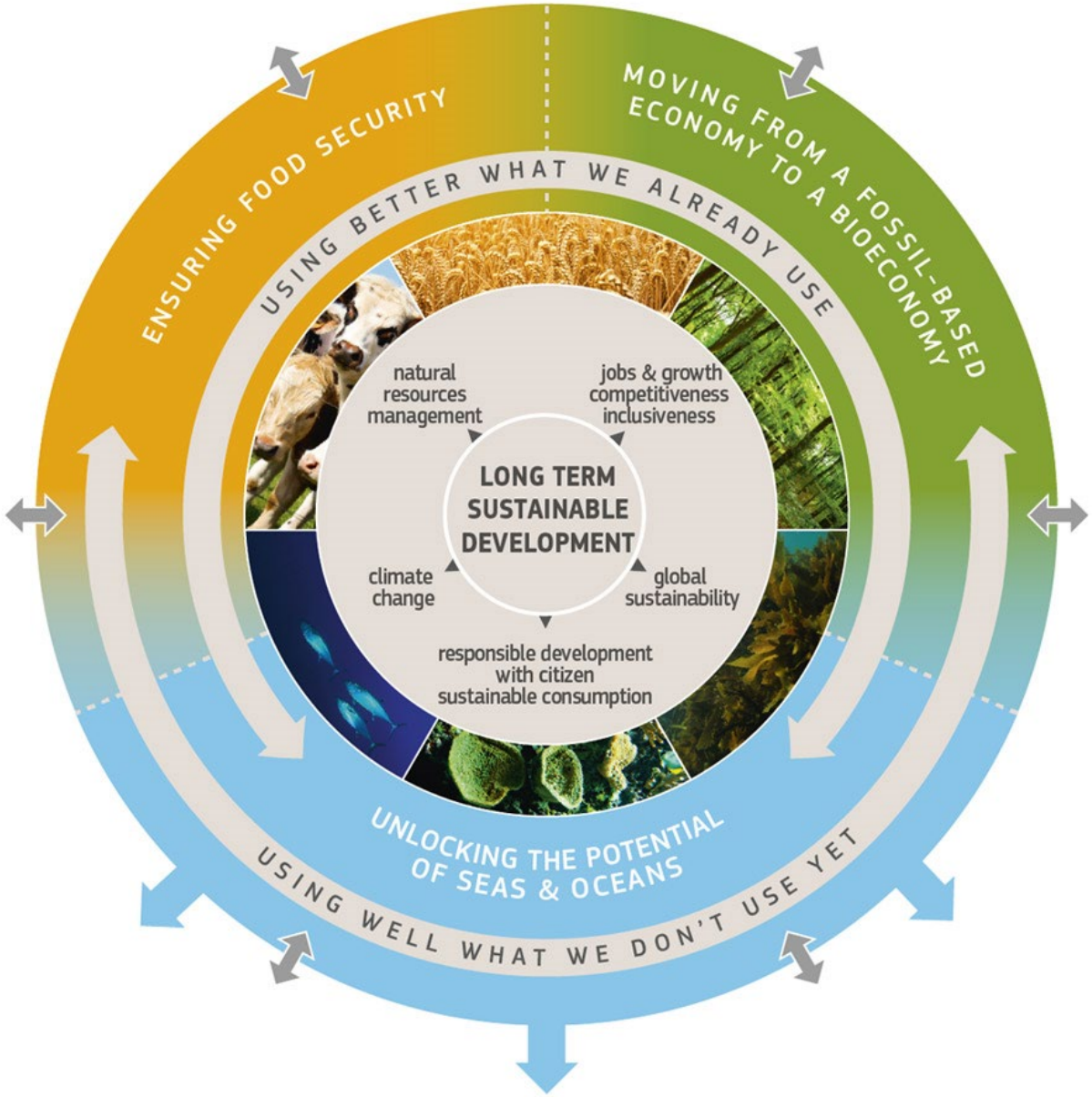
# THERE ARE GREAT EXPECTATIONS TO THE BIOECONOMY



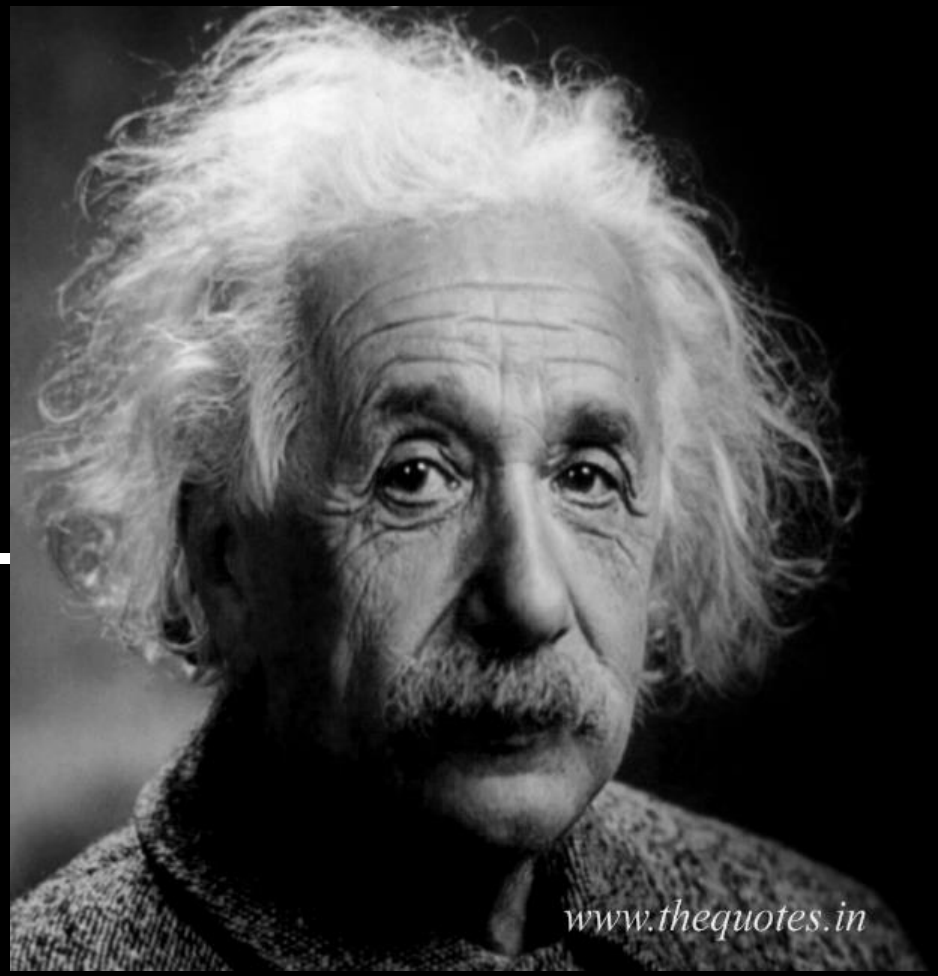

Ref: The Finnish Bioeconomy Strategy 2014

# THE EU BIOECONOMY STRATEGY[1]: RESEARCH AND INNOVATION IS KEY TO UNLOCK THE FULL POTENTIAL OF THE BIOECONOMY




1: The EU Commission 2018: COM/2018/673 final




We cannot solve our problems with the same thinking we used when we created them.

*Albert Einstein*

# AARHUS UNIVERSITY THEMATICAL CENTRES WITHIN GLOBAL CHALLENGE AREAS

Circular Bioeconomy (CBIO)

Integrated Materials Research

Water Technology

Digitization, big data, and data analytics

CiFood

iClimate

# CBIO'S CIRCULAR BIOECONOMIC RESEARCH IS ORGANIZED AROUND 7 PILLARS

**Production and management of agricultural biomass**
Senior Researcher Uffe Jørgensen
Department of Agroecology

**Environmental credibility, economic feasibility and social acceptance**
Professor Marianne Thomsen
Department of Environmental Science

**Production of marine biomass**
Senior Researcher Annette Bruhn
Department of Bioscience

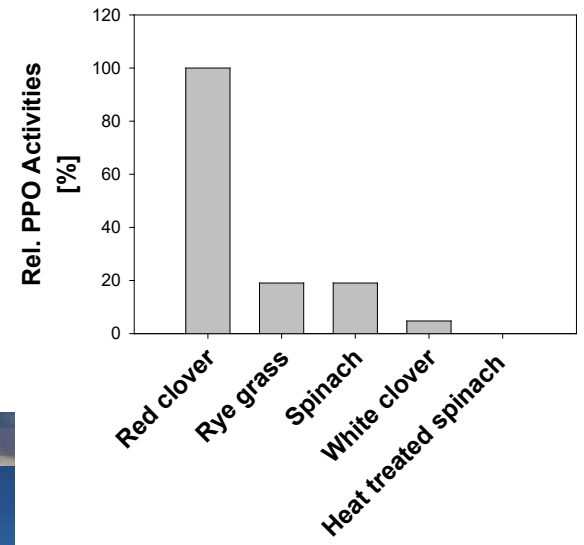
**Utilization of biomass for food, ingredients and high-value products**
Associate Professor Trine Dalsgaard
Department of Food Science

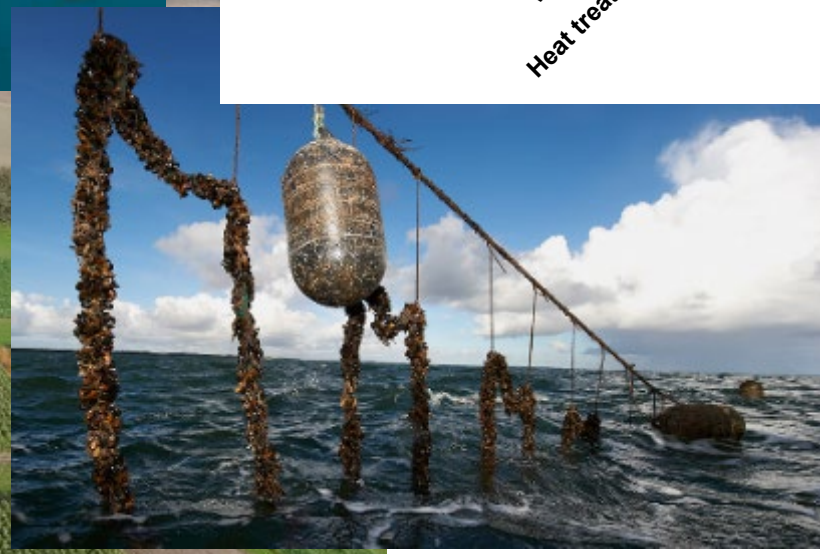
**Biorefining, conversion and recycling**
Assistant Professor Morten Ambye-Jensen
Department of Engineering

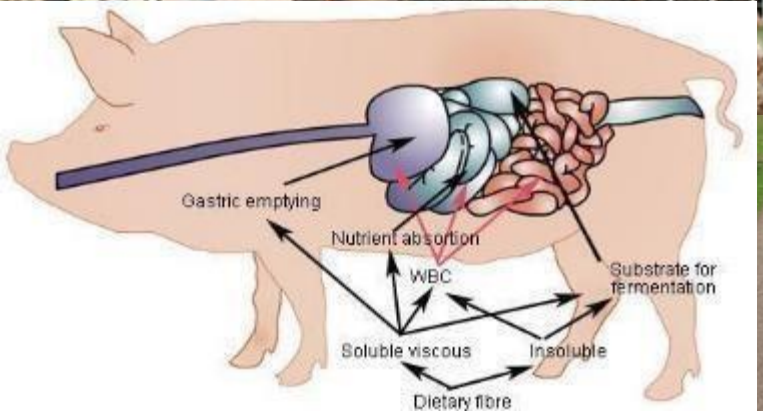
**Feeds, by-products and feed ingredients**
Professor Søren Krogh Jensen
Department of Animal Science

**Biobased materials and bio-oils**
Associate Professor Marianne Glasius
Department of Chemistry

# CBIO'S MISSION IS TO COUPLE UNIQUE RESEARCH PLATFORMS WITHIN THE UNIVERSITY





# DANISH SOCIETAL CHALLENGES WITHIN BIOECONOMY - EXAMPLES

- We can phase out fossil fuels by 2050 BUT some of the renewable energy has to come from biomass
- We need to find alternatives to oil-based chemicals and materials for e.g. packaging
- We import 1.5 -1.6 mio. Tonnes of soy protein concentrate annually, mainly from South America
- Danish agriculture is challenged to meet national and EU policies on environment and climate

# NEW DEMONSTRATION SCALE PLATFORM
## RESEARCH AND DEVELOPMENT IN BIOREFINING OF GREEN CROPS



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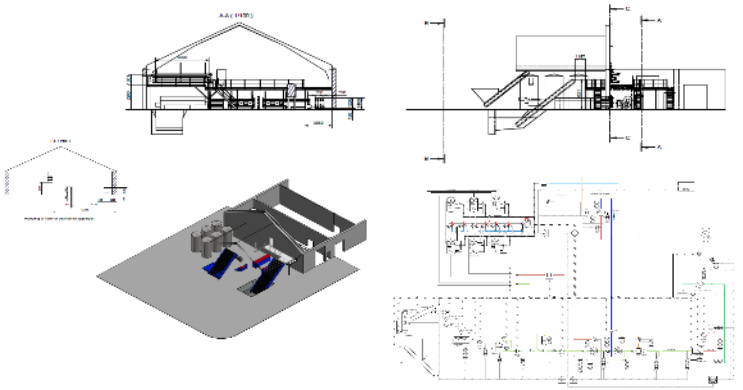

**Input capacity: 1-10 ton/hr**

**Flexible process design**

**Automatic control and extensive data collection**

**Improved unit operations & processing compaired to pilot facility**

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MAY 31, 2021 | UFFE JØRGENSEN
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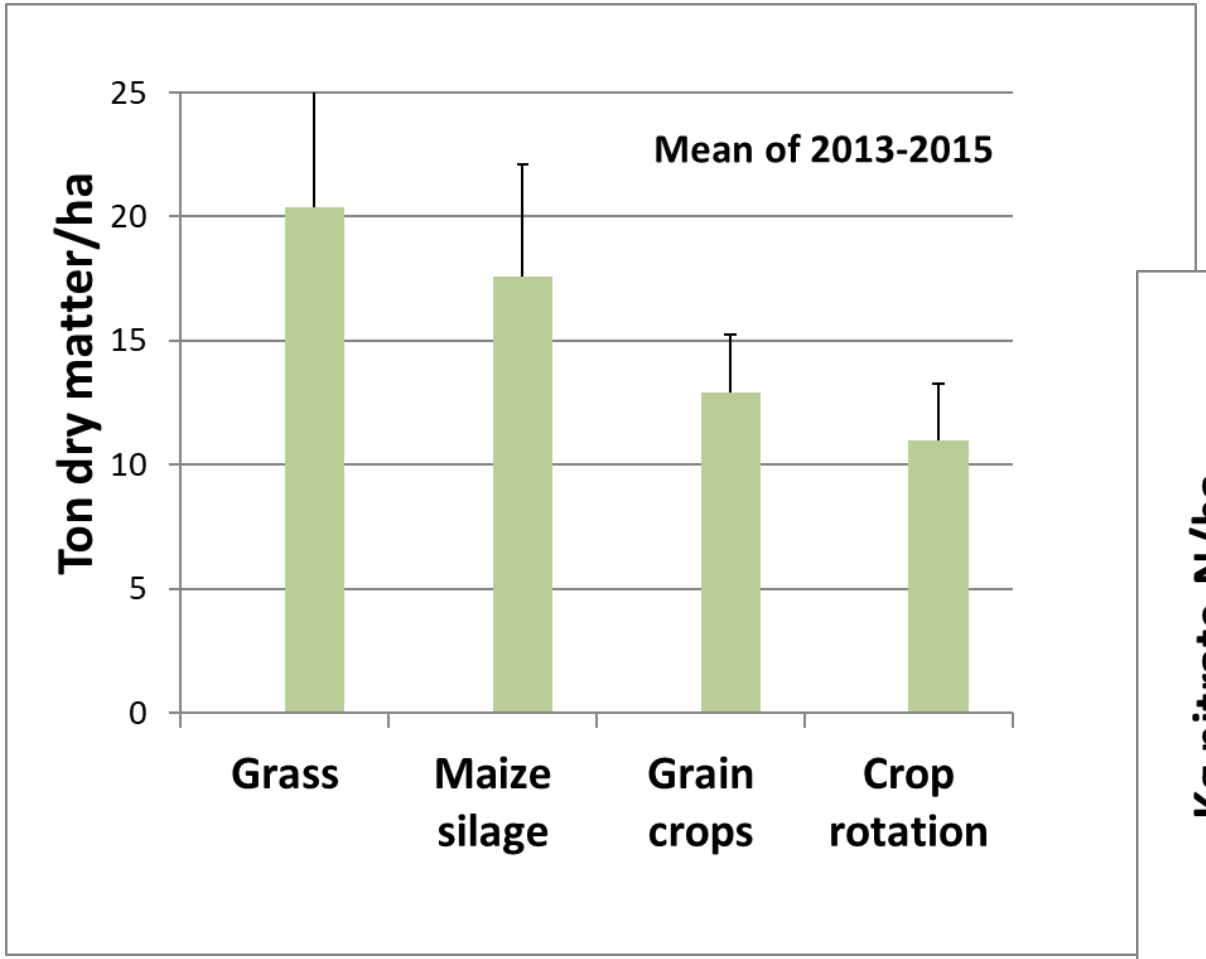
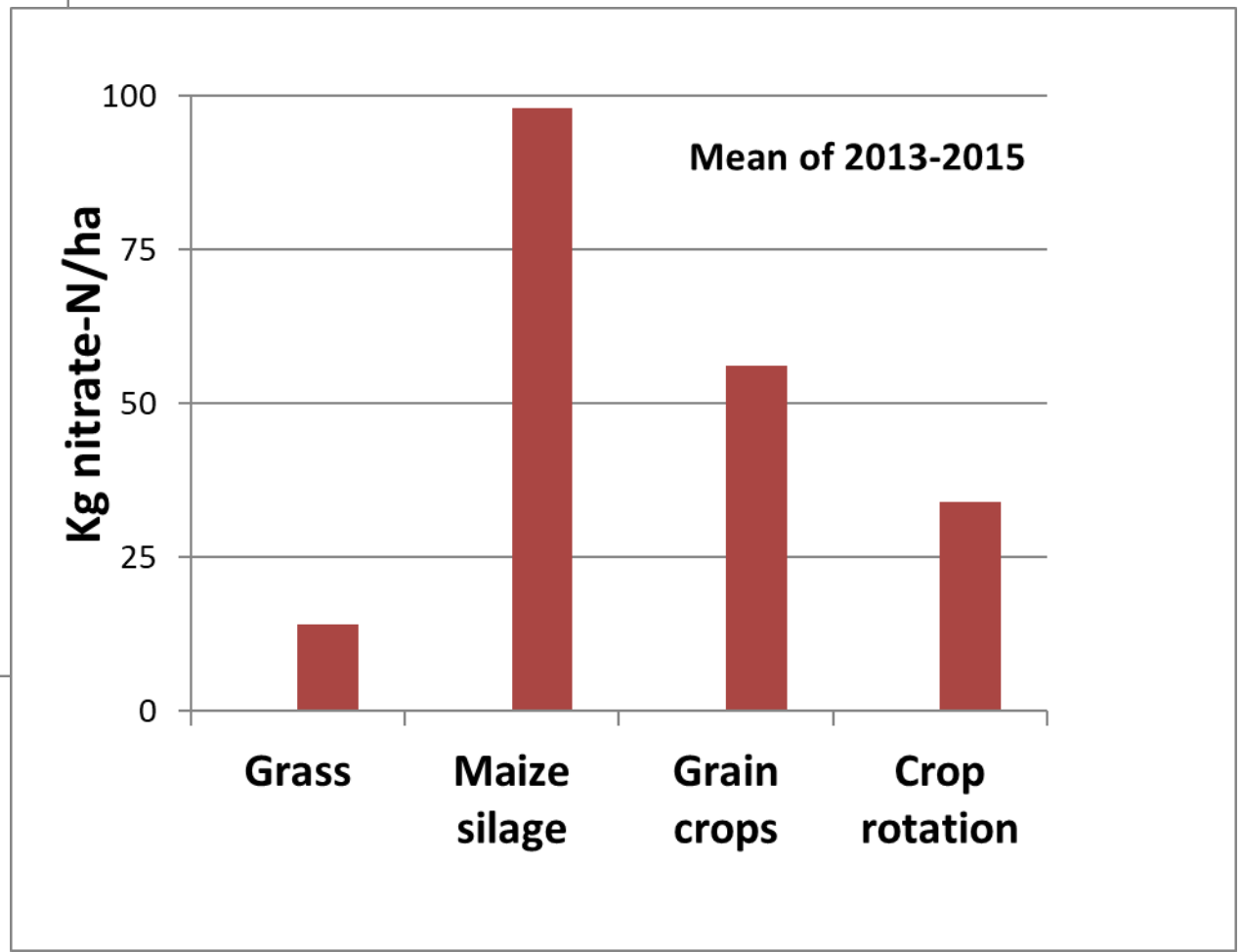
# BIOMASS PRODUCTION CAN BE DOUBLED IN DANISH AGRICULTURE

## and nitrate leaching halved

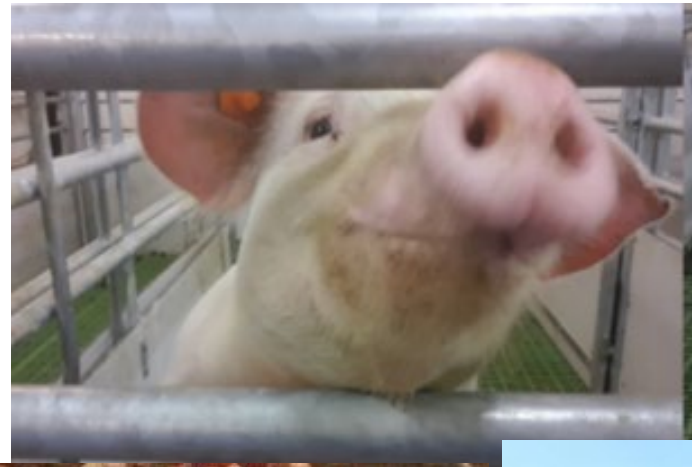


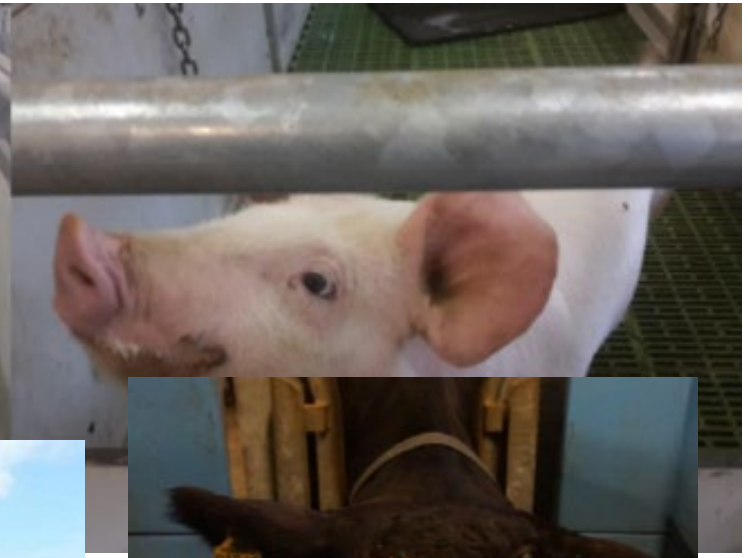




Manevski et al., 2017; 2018

# FEEDING EXPERIMENT WITH GREEN PROTEIN TO PIGS, COWS, BROILERS & EGG LAYERS – POSITIVE RESULTS

GO-GRASS





# Research on green biorefinery has paved the way for market introduction

Supported by public and industrial (Arla, Danish Crown, DLG & DLF) funding

GO-GRASS

Green Valleys

Interreg

Öresund-Kattegat-Skagerrak

gudp

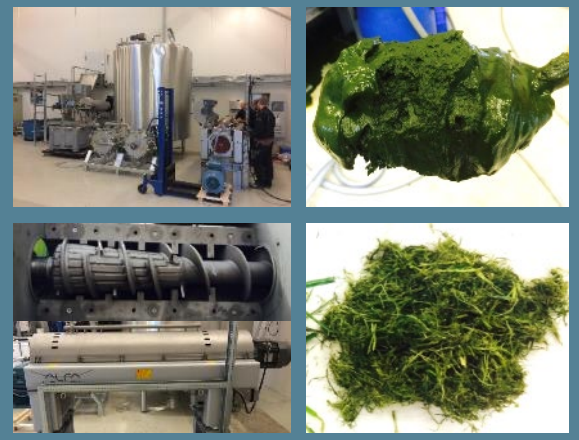
This project has received funding from the European Union's Horizon 2020 programme under grant agreement **N° 862674**

# FURTHER DEVELOPMENT OF HIGHER VALUE PRODUCTS AND OPTIMAL USE OF RESOURCES

Biogas plant

Heat/ Power

Process water



Green Biorefinery

Human food


Monogastric animal feed

Ruminant animal feed

Bio-chemicals and -materials

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# BIOMASS FROM THE SEA IS ALSO TREATED AT THE BIOREFINERY PLATFORM

- **SeaSus-Protein** – Biorefined seaweed – A sustainable protein source for functional foods
- The project aims to develop 2-3 functional food proteins from Danish macroalgae
- Sea lettuce, *Saccharina latissima, Alaria esculenta,* and *Palmaria palmate*


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# HTL - HYDROTHERMAL LIQUEFACTION PILOT FACILITY – FOR JETFUEL, BINDERS AND OTHER MATERIALS

**HTL Basic Operating Values**

**Feedstock capacity** 60-100 l/hr

**Conversion temperature** 250 - 450 °C

**Conversion pressure** 200-350 bar

| Feedstock tested |
|---|
| Wheat Straw (ws) |
| Barley Straw (bs) |
| Miscanthus (ms) |
| Switchgrass (sg) |
| Poplar (pr) |
| Willow (wl) |
| DDGS (dg) |
| Pine |
| Micro algea |
| Sewage sludge |
| Lignin |
| ..... |

Patent filed on a binder material

# TWO PATENTS FILED AND BOUGHT BY ROCKWOOL FOR PRODUCING ALTERNATIVES TO FOSSIL BASED BINDERS

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 633 005 A1**

(12) **EUROPEAN PATENT APPLICATION**

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***C08L 97/00*** *(2006.01)* ***C08L 97/02*** *(2006.01)*

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SE SI SK SM TR
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tates:

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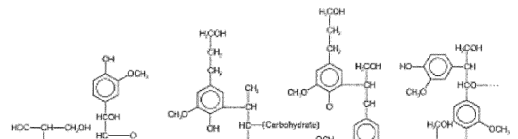
**COMPOSITION FOR LIGNOCELLULOSIC MATERIALS SUCH AS**
**OF PRODUCTION**

cted to an aqueous adhesive composition for lignocellulosic materials.

**Fig. 1**



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Designated Extension States:
**BA ME**
Designated Validation States:
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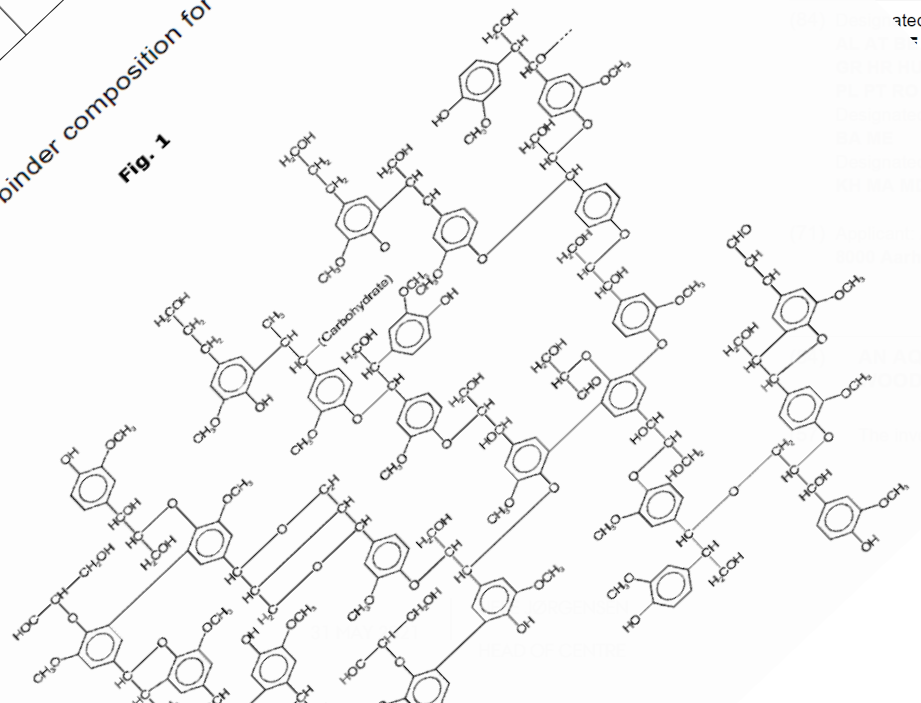
(54) **AQUEOUS BINDER COMPOSITION**

(57) The invention is directed to an aqueous binder composition for mineral fibers.

**Fig. 1**

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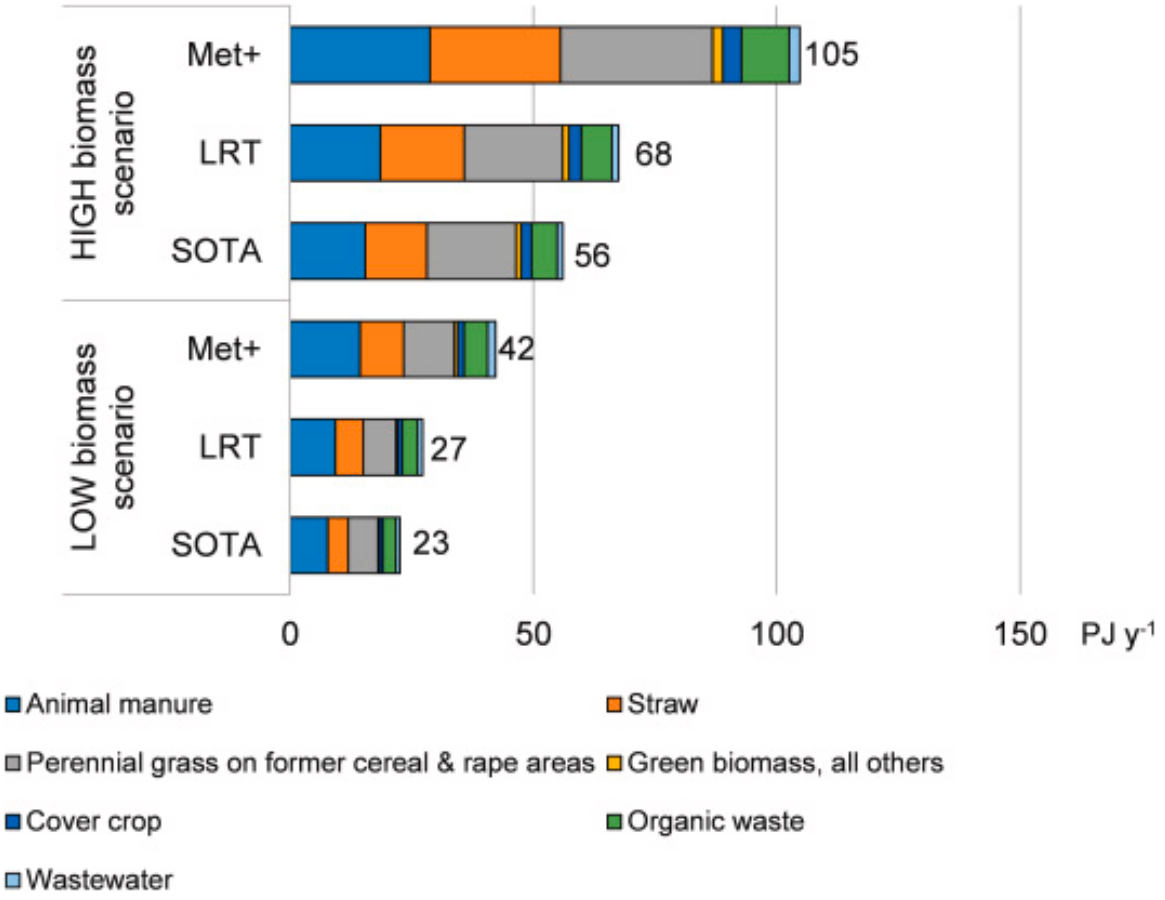
# BIOGAS: AN IMPORTANT TECHNOLOGY FOR SIDE-STREAM PROCESSING INTO BIOENERGY AND FERTILISER

Biogas fermentors from1-1.200.000 L & unique $CO_2$ upgrading

# SCENARIOS FOR SUSTAINABLE BIOMETHANE SUPPLY IN 2035

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Harnessing the full potential of biomethane towards tomorrow's bioeconomy: A national case study coupling sustainable agricultural intensification, emerging biogas technologies and energy system analysis

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ABSTRACT

Here, we demonstrate the applicability of national strategies towards massive biogas deployment, through a case study Denmark. First, a variety of sustainable agricultural intensification measures to produce additional biomass resources were investigated; as a result, it was found that the biomass currently used in Denmark's biorefineries (including biogas) could be tripled without compromising soil carbon and inducing little to no land use changes. The degree to which these resources could be mobilized for the biogas sector was analysed through examining the extremes, here labelled as LOW and HIGH biomass-to-biogas scenarios. The resulting biomethane production was calculated considering three combinations of biogas production and upgrading technologies: (i) conventional biogas production and upgrading technologies; (ii) plants with prolonged retention time and conventional upgrading technologies and (iii) as in (ii), but upgrading via biological methanation of carbon dioxide in the biogas, using renewable hydrogen. These scenarios revealed a biomethane potential of 24–111 PJ $y^{-1}$. The key finding of our study is that only the extreme deployment measures, in terms of biomass and technology, allowed to fulfill the emerging gas demands, namely buffering the deficits from fluctuating power and transport (light- and heavy-duty vehicles, urban buses, coaches), quantified at 95 PJ $y^{-1}$. Yet, just harnessing the full sustainable potential of animal manure, straw and perennial grass allows to supply half of this demand. In the LOW and HIGH biomass scenarios, doubling the retention time brought an increased methane production of 20% (energy-wise), while this increase was 87% when methanation was added.

## 1. Introduction

Facing the urgency of avoiding dangerous climatic change [1–3], a number of countries have engaged in a pathway towards a so-called decarbonized economy [4]. A low carbon economy involves an increased reliance upon non-carbon energy sources, and thus renewable electricity (hydropower, photovoltaics, wind). Yet, although it is possible to decouple the energy sector (i.e. transport, heat and electricity) from the use of carbon, this does not apply for chemicals and materials, intrinsically based on carbon. Biomass, being the unique source of renewable carbon on Earth, is thus key to start decoupling the production of future materials and chemicals from the use of fossil carbon, besides being pinpointed as a stepping stone feedstock towards a renewable energy system [5–8].

Being a versatile and storable source of carbon, biogas, i.e. the methane ($CH_4$)-based gas mixture obtained from the anaerobic digestion of biomass, is seen to have a key role to play in bridging the gap towards a low carbon economy [9,10]. This is reflected, among others, by the various financial support systems established throughout Europe and worldwide for biogas deployment [11]. It is also acknowledged as one of the most cost- and environmentally-efficient mitigation technology for greenhouse gases (GHG) in agriculture, especially when it stems from residual resources like manure and organic wastes [12–14]. In some rural regions of Africa and Asia, biogas significantly contributes to improve human health as it replaces traditional open-fire stoves [15–17], which exposes ca. 40% of the World population to illnesses attributed to soot particles and pollutants that penetrate the lungs [18]. Unlike other biomass conversion technologies, biogas almost completely

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Biogas DK 2019: 17 PJ

# SHIFTING FROM THE FOSSIL ERA TO THE BIOECONOMIC ERA IS NOT USUAL BUSINESS


To establish a new industry to substitute the fossil –

AND to disrupt agriculture –

are enormous tasks demanding for mega-investments and new partnerships