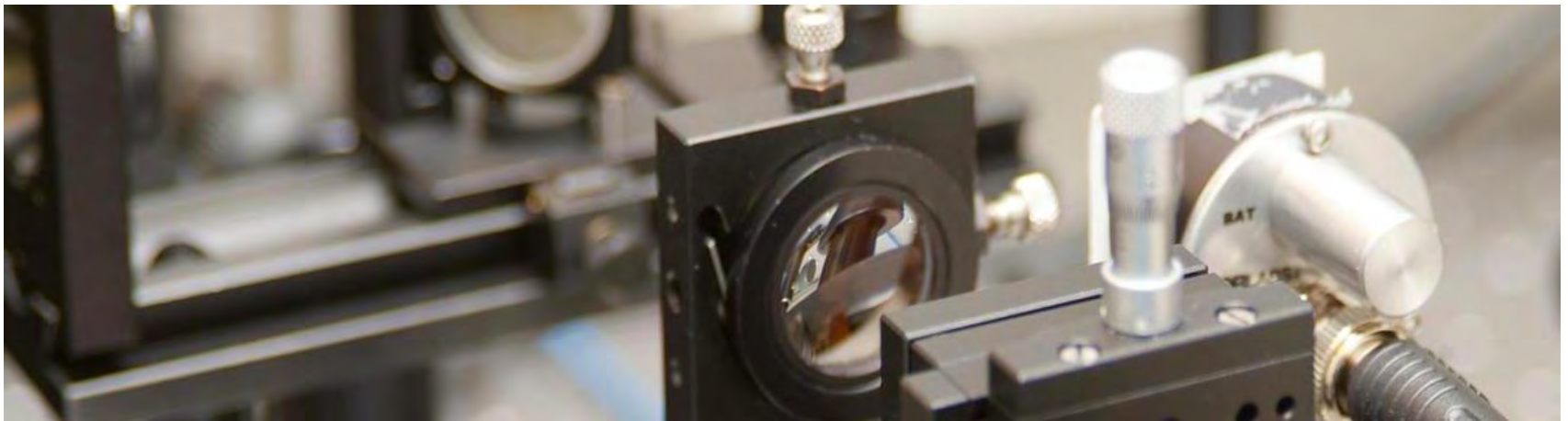


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## **Biorefineries for Transportation Biofuels**

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# Outline

2

- Key drivers for development
- Biorefineries for transportation biofuels using
  - Microalgae
  - Wood and straw
  - Sweet sorghum
  - Sugar, starch and oil
- Conclusions

# Biomass for Transportation Biofuels and Biorefineries



# Overview Transportation Biofuels

4

- 1) (pure) Vegetable oil**
- 2) Biodiesel**
  - a) conventional biodiesel via esterification
  - b) hydro-treated biodiesel via hydration
- 3) Bioethanol**
  - a) conventional bioethanol from sugar and starch
  - b) lignocellulosic bioethanol
- 4) Biobutanol**
- 5) Biogas**
- 6) Synthetic Biofuels**
  - a) Fischer-Tropsch biofuels (e.g. FT-Diesel)
  - b) Synthetic natural gas (SNG)
  - c) Dimethylether (DME)
  - d) Methanol
  - e) Synthetic hydrogen
- 7) Biological hydrogen**
- 8) (upgraded) Pyrolyses oil**
- 9) Biofuels from direct liquifaction**
  - a) HTU-Biofuels from hydro-thermal upgrading
  - b) CLC-Biofuels from catalytic low temperature conversion

# Two European Directives are Key Drivers for Transportation Biofuels in Europe

5

## RED

### Renewable Energy Directive 2009/28/EC<sup>15</sup>

- By 2020, mandatory targets of 20 % share of RES in final energy consumption, 20 % increase in energy efficiency and 10 % of RES in transport in each Member State.
- Harmonised approach with Fuel Quality Directive
- No biofuels from carbon rich or bio-diverse land. EC has to report on compliance with environmental and social sustainability criteria of major biofuel exporting countries.
- Minimum GHG reduction for biofuels of 35% and 50% from 2017 onwards, and 60 % for new installations from 2017 onwards. For plants already operating in January 2008 GHG requirement will start in April 2013.
- Bonus of 29g CO<sub>2</sub>/MJ for biofuels from degraded/contaminated land.
- Biofuels from waste, residues, non food cellulosic material, and lignocellulosic material will count twice for RES transport target.
- Member State Implementation into national legislation by December 2010.

## FQD

### Fuel Quality Directive 2009/30/EC

- Further tightening of environmental quality standards for a number of fuel parameters.
- Enabling more widespread use of ethanol in petrol (E10) with transitory regulations (protection grade E5) for older cars and derogations for petrol vapour pressure, subject to EC approval.
- Increase of allowed biodiesel content in diesel to 7% (B7) by vol., with an option for more than 7% with consumer info.
- Introducing a mechanism for reporting and reduction of the life cycle GHG emissions from fuel.
- Reduction in life cycle GHG emissions from energy supplied. Binding target of 6% between 2011-2020 as first step, while leaving open the possibility to increase future level to 10 %.
- In a 2012 review, the Commission will need to assess a further increase of the level of 2% from other technological advances, such as the supply of electricity for use in transport. A further 2% is envisaged by the use of CDM credits for flaring reductions not linked to EU oil consumption.

# Biofuels are Already Part of the Austrian Transportation Sector 2010

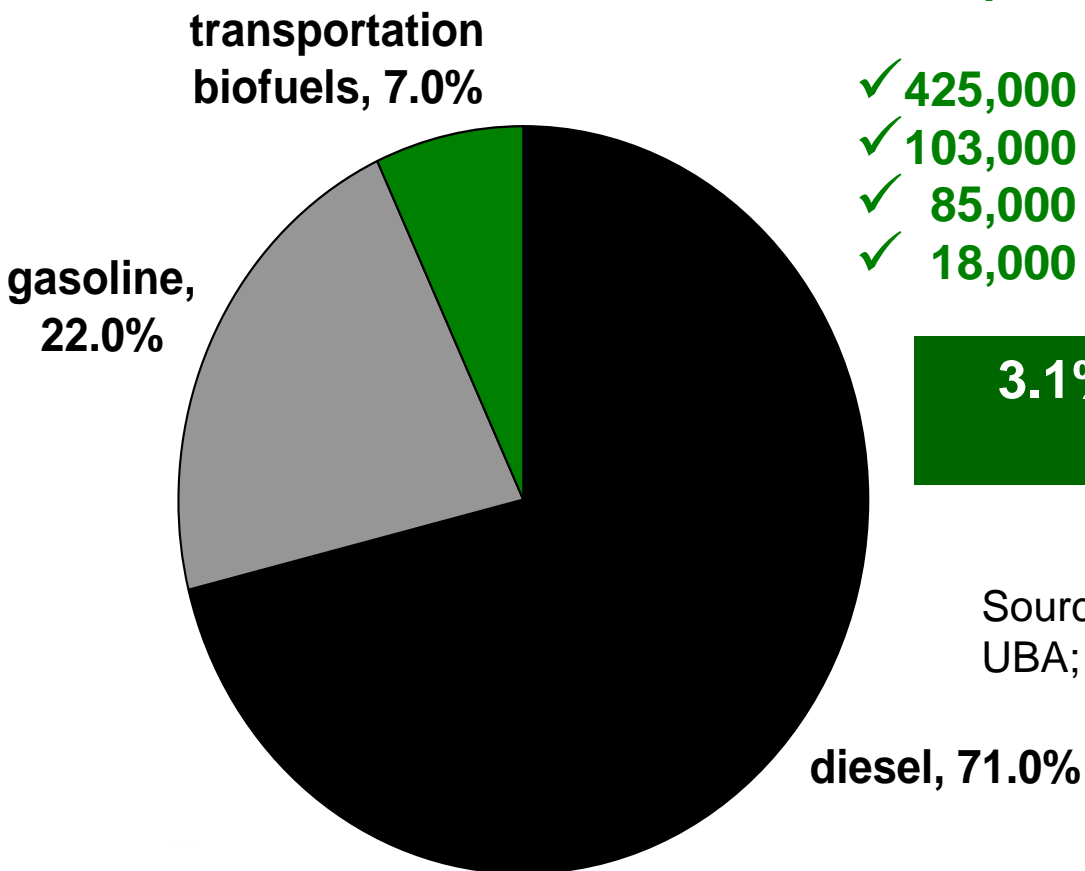
6

## Transportation biofuels:

- ✓ 425,000 t/a biodiesel blending to diesel
- ✓ 103,000 t/a bioethanol blending to gasoline
- ✓ 85,000 t/a pure biodiesel
- ✓ 18,000 t/a pure vegetable oil

**3.1%-reduction GHG intensity of road transportation fuels**

Source: Biokraftstoffe im Verkehrssektor 2011, UBA; own calculations



# Biofuels are Already Part of the Austrian Transportation Sector

transportation  
biofuels, 7.0%

Tran

line

**Two key question for 2020:**

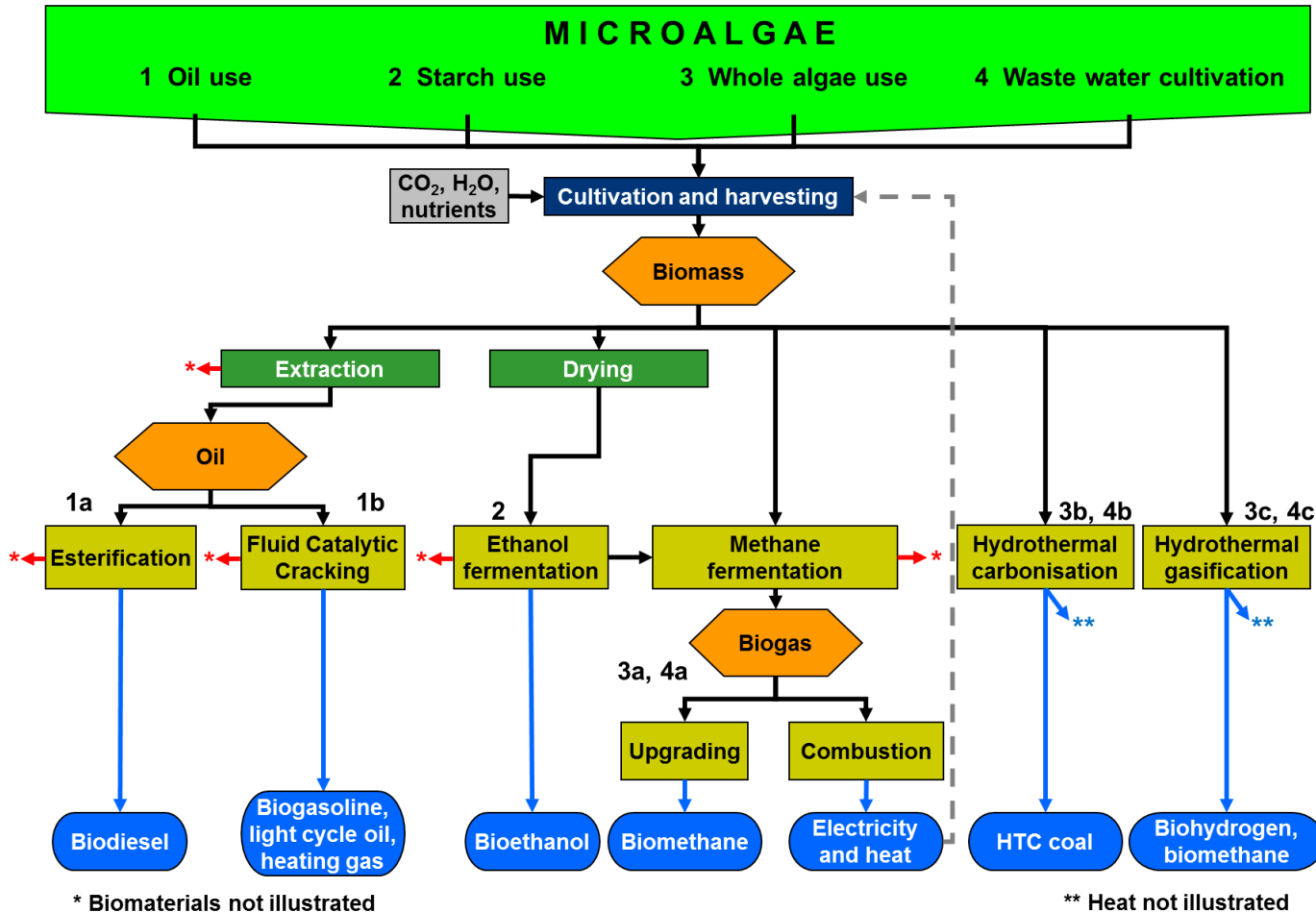
- 1) 10%-renewable transportation fuels**
- 2) 6%-reduction GHG intensity of road transportation fuels**

diesel, 71.0%

Source: Biokraftstoffe im Verkehrssektor 2011, UBA; own calculations

# Algae – A Future Renewable Austrian Energy Source? I

8





# Algae – A Future Renewable Austrian Energy Source? II

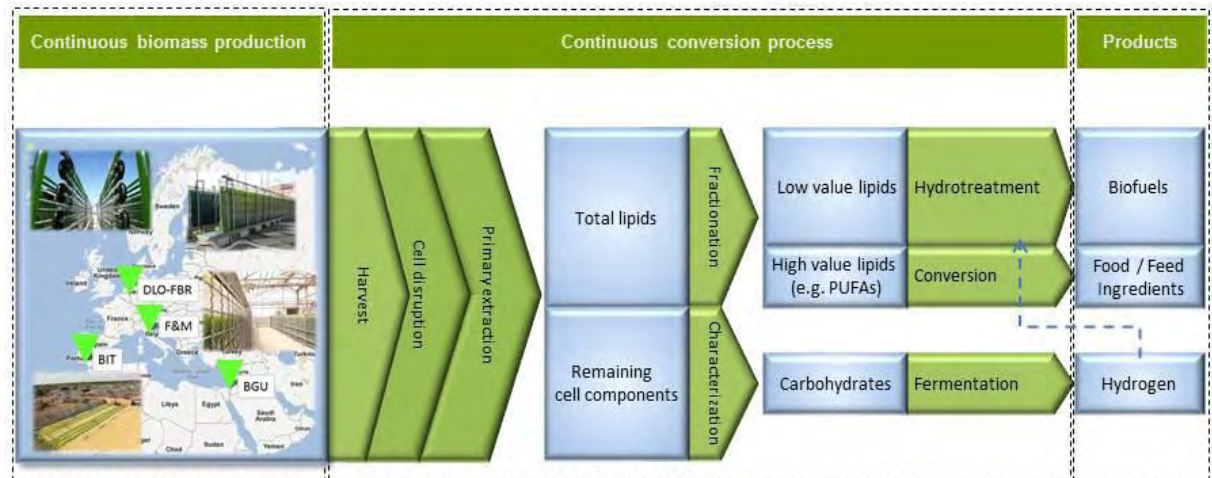
- Optimal and efficient use of algae:  
biorefinery for bioenergy and biomaterials
- Photobioreactors most promising technology due to Austrian climate conditions
- Obstacles in Austria:
  - Climate: sunshine duration, temperature
  - Area demand: no non-arable land in Austria, especially in the surroundings of CO<sub>2</sub> sources
- Contribution of algae energy in the Austrian energy system:
  - probably low in a medium term
  - in a long term possible
- R&D demand:
  - cultivation and harvesting
  - algae production with waste water treatment
  - upscaling

# FUEL4ME

## Future European League for Microalgal Energy

- Project funded by program FP7-ENERGY-2012-1
- Overall aim:
  - Establishing a sustainable chain for continuous biofuel production using microalgae as a production platform
  - Thereby making 2<sup>nd</sup> generation biofuels competitive alternatives to fossil fuels
- Role of JOANNEUM - Sustainability assessment
  - Economic
  - Environmental
  - Social

<http://www.fuel4me.eu/>



# Assessment of 13 Lignocellulosic Bioethanol Concepts in Austria I

11

- Concept development
- Sustainability assessment:
  - Economic
  - Environmental



No	Feedstock	Fermentation of sugars	Co-products	
1	Straw	C6	Electricity	
2		C6+C5	Electricity	
3		C6	Electricity	Heat
4		C6	Ligninpellets	
5		C6+C5	Ligninpellets	
6		C6	Ligninpellets	Heat
7		C6	C5 Molasses	Ligninpellets
8		C6	C5 Molasses	Ligninpellets
9		C6	C5 Molasses	Heat
10		C6	C6	Biomethane
11	Softwood	C6	Electricity	
12		C6	Ligninpellets	
13		C6	Biomethane	Electricity

# Assessment of 13 Lignocellulosic Bioethanol Concepts in Austria II

- Straw and wood are interesting raw materials for lignocellulosic bioethanol in Austria
- Type and amount of co-products influences technical, economic and environmental performance
- Commercial technology not available, technology under development
- GHG-reduction: 41% - 76%
- Costs of lignocellulosic bioethanol:  
0.6 - 1 €/l<sub>gasoline-eq.</sub>
- Further R&D necessary, e.g. in Austrian demo plant

# Green Bioethanol for Green Styria in a Pulp and Paper Biorefinery

## Feasibility analysis of bioethanol production in the Styrian pulp and paper industry

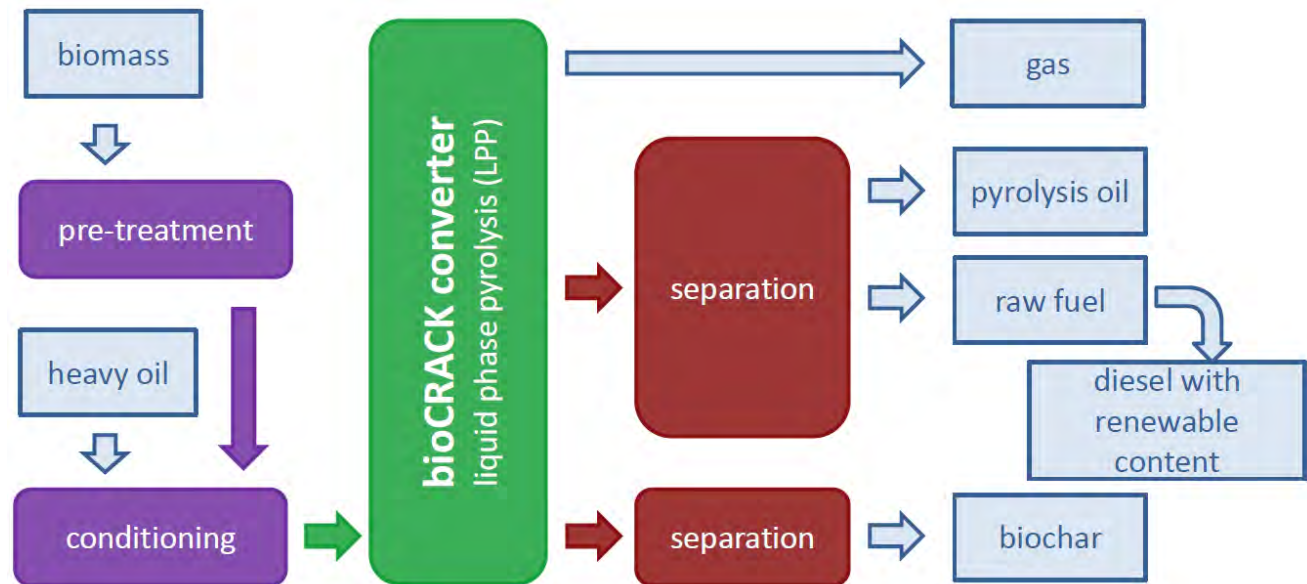
- Integrated production of bioethanol in pulp&paper industry has many technical, economic&infrastructural advantages
- Bioethanol from sulfite spent liquor commercial possible of about 0.6€/l<sub>gasoline-eq.</sub>
- Amounts are limited 10,000 – 20,000 t/a
- Greenhouse gas reduction 60-80%
- Until 2020:  
Realization of 2 - 3 integrated advanced bioethanol biorefineries seems possible in the Austrian pulp and paper industry.



# BioCRACK – Assessment of by-products use

14

- Description of the possible uses of by-products
- Technical, economic and environmental assessment of the perspectives until 2020 of energetic and material uses
- Under contract of BDI

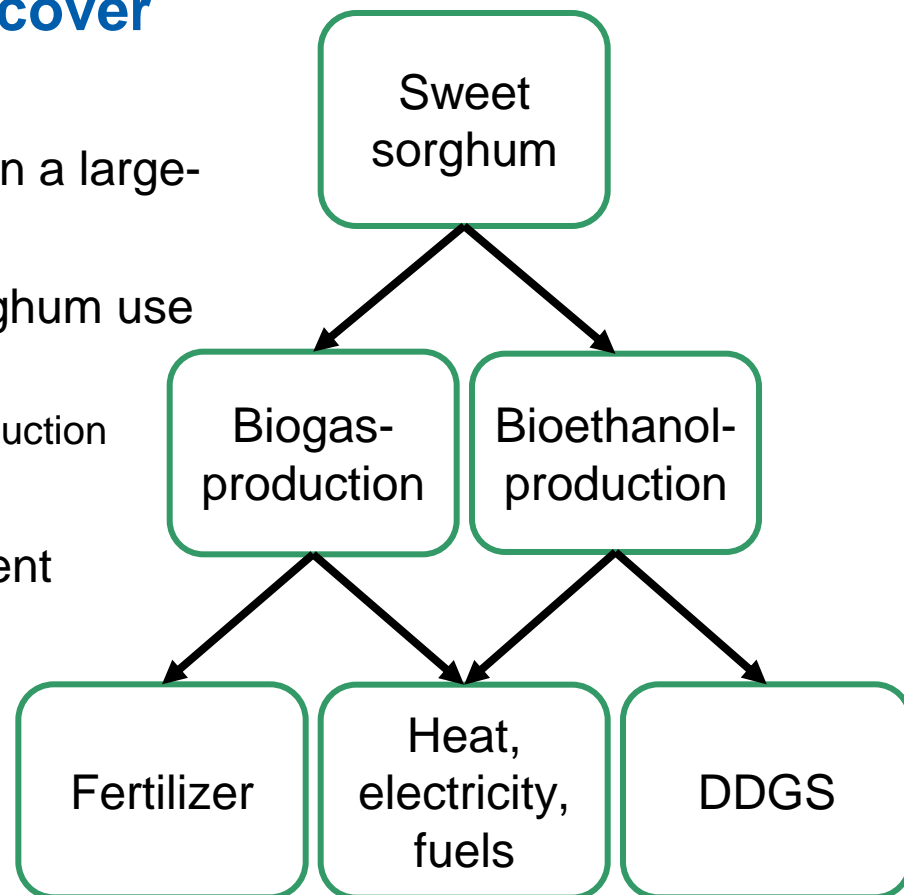


Source: Peter Pucher, BDI, 2013



## Bisunfuel: Sweet sorghum as cover crop for biofuels production

- Cultivation, harvesting and storage in a large-scale experiment
- Technical optimization of sweet sorghum use for energy and materials production
  - Bioethanol- & biogas/biomethane-production
  - Feed & fertilizer
- Environmental assessment of different concepts with life-cycle analysis
- Future security of sweet sorghum in terms of climate change



# Biorefineries with sugar, starch and oil



- Existing bioethanol and biodiesel biorefinery plants
- In Austria, Hungary, Germany and Belgium, e.g.
  - Pischelsdorf: AGRANA Bioethanol GmbH
  - Arnoldstein: Biodiesel Kärnten GmbH
  - Vienna: Münzer Bioenergie GmbH
  - Szabadegyhaza: HUNGRANA kft
  - Wanze: Crop Energies
  - Zeitz: Crop Energies.....





# Conclusions

***Co-producing biofuels and biomaterials in biorefinery offers new opportunities***

***Many advantages of integration of biofuel production in existing industry***

***Transportation biofuels from wood and straw under development, e.g. pilot/demo-level***

***High R&D demand for transportation biofuels from microalgae in different process steps***

***Many possibilities to produce transportation biofuels from various raw materials***

***Renewable transportation fuels and greenhouse gas reduction are key drivers for biorefinery development***

# Thank you for your attention!

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