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Industrial Energy-Related Technologies and Systems

An Implementing Agreement established under the auspices of the International Energy Agency

## BIOREFINERIES : A New Concept for biomass based industries

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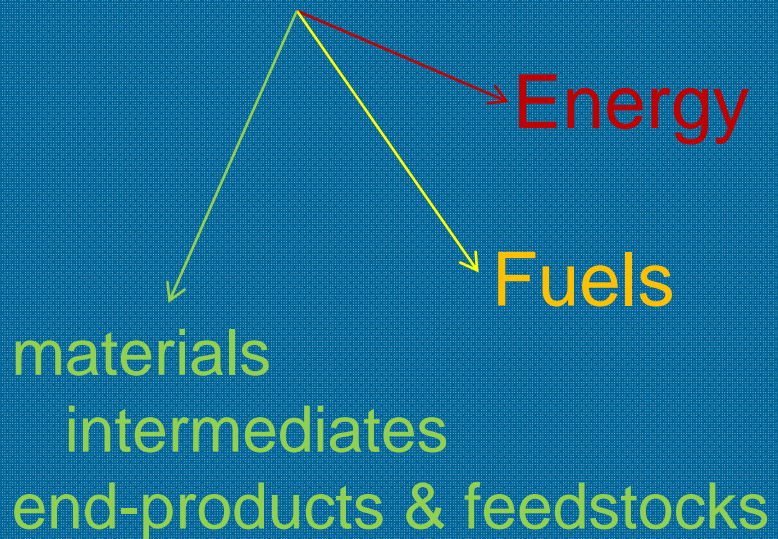
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# ANNEX XI – Industry-based Biorefineries



- The concept...

- The biorefinery industrial concept - an integrated process converting biomass available related to the industrial complex into valuable products



## ANNEX XI – Industry-based Biorefineries

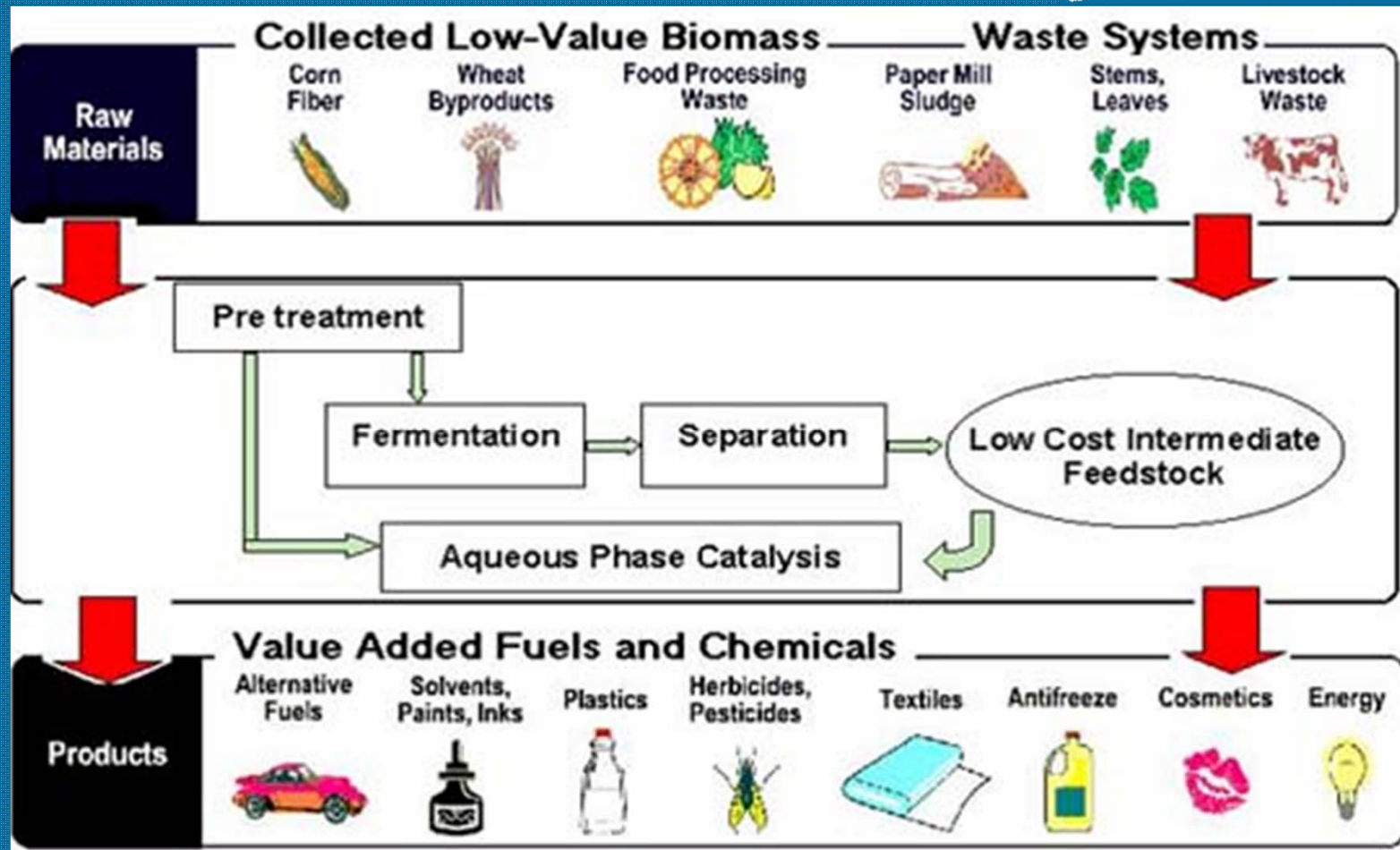


- The general objective is to provide a sound basis for the integration of biorefinery concept in different industrial sectors where biomass is used as resource or biomass based waste is available, which could be used for fuel/energy production, also considering opportunities of bio-products generation with added value.

- Wide range of valuable products
  - Competitiveness
  - Market
- Ability to process different biomass feedstocks
  - Resources
  - Flexibility
  - Economics
- Efficient integration with minimum impacts
  - Energy
  - Waste
  - Emissions
  - Sustainability

Source: Cabrita, Isabel.; Gulyurtlu, Ibrahim; Sousa, Gabriel; Matos, Henrique "Balancing production of energy fuels and materials in an ideal concept of industry-based biorefinery", *International Workshop on Biorefineries*, NREL, Denver, USA, Nov. 6, 2009.

# ANNEX XI – Industry-based Biorefineries



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## ANNEX XI – Industry-based Biorefineries



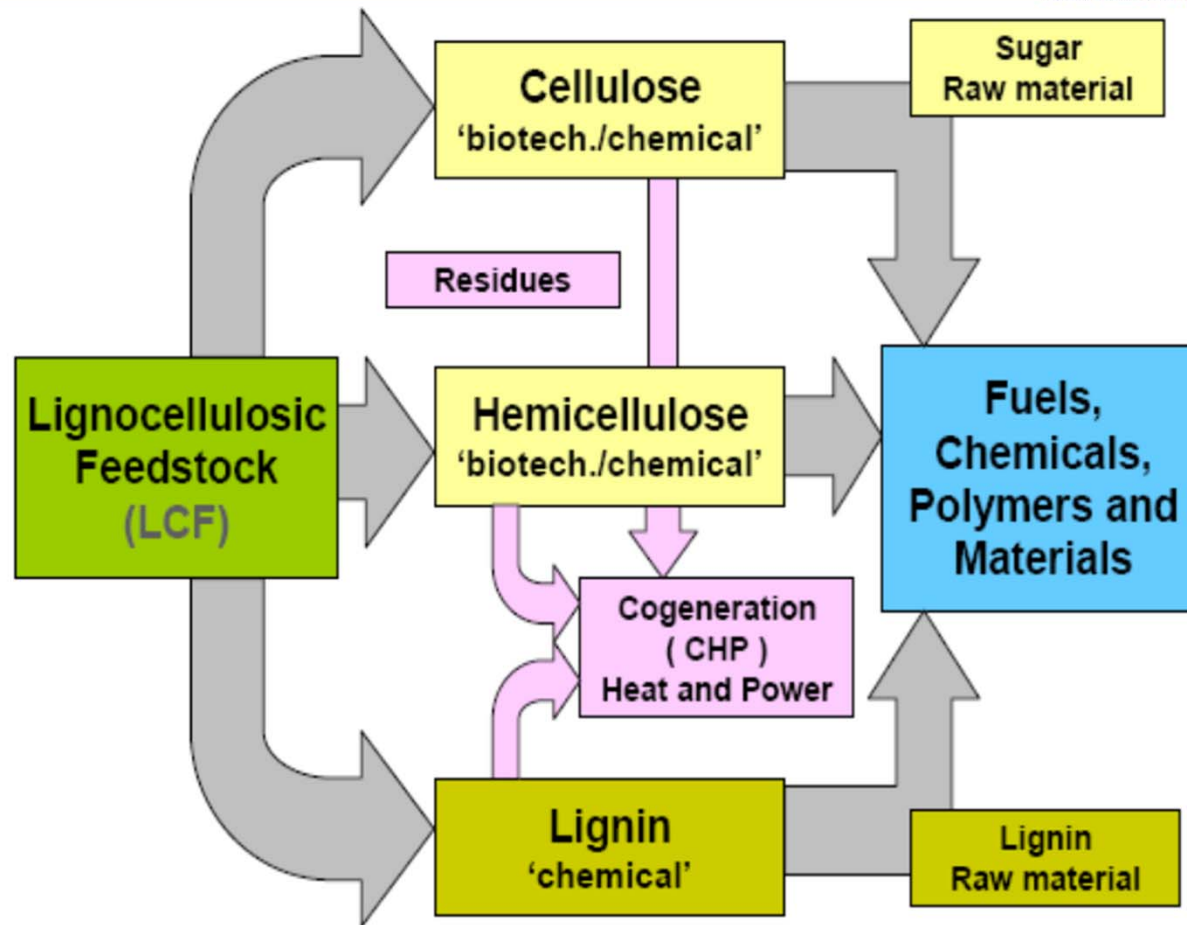
• Classification of biorefineries depend on complexity and commercial viability

- Biorefinery systems depend on the nature of feedstock and type of conversion process
  - Lignocellulosic Feedstock Biorefinery (LCF)
  - Whole Crop Biorefinery (WCB)
  - Green Biorefinery (GBR)
  - Two Platform Biorefinery (TPB)

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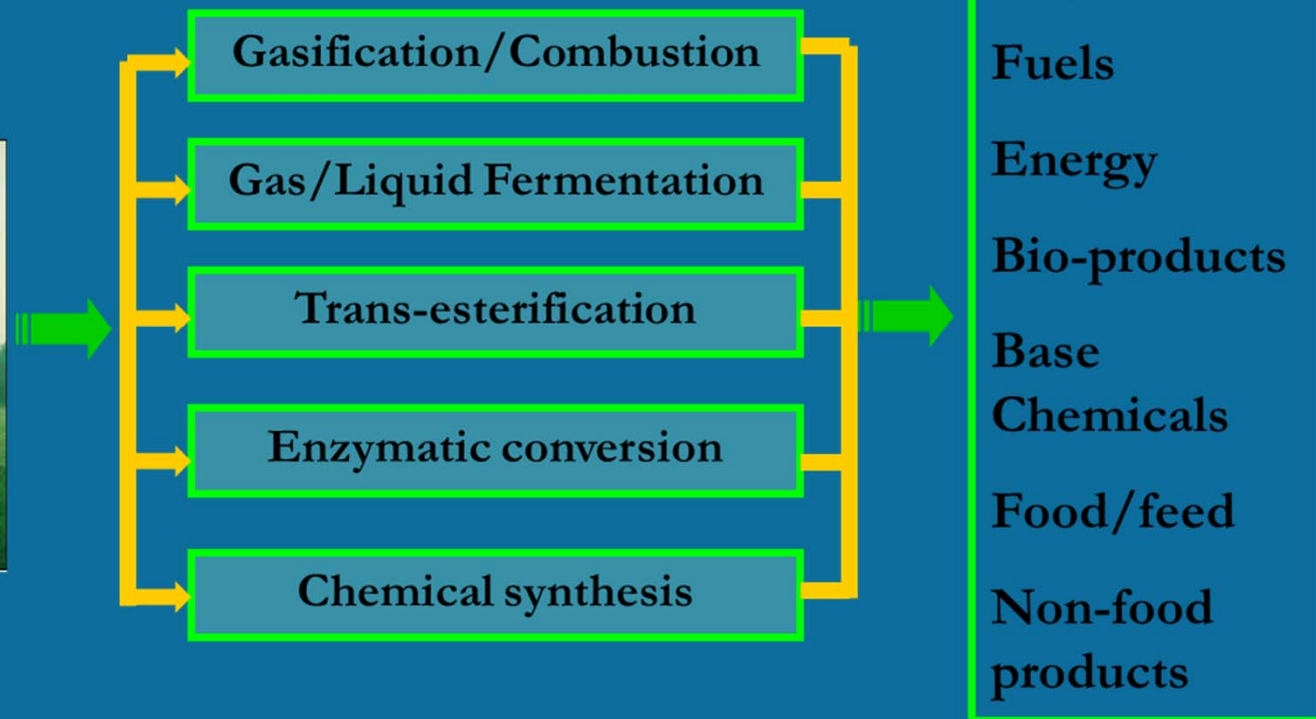
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# ANNEX XI – Industry-based Biorefineries



## Fibre Biorefinery

## Pathways and Opportunities



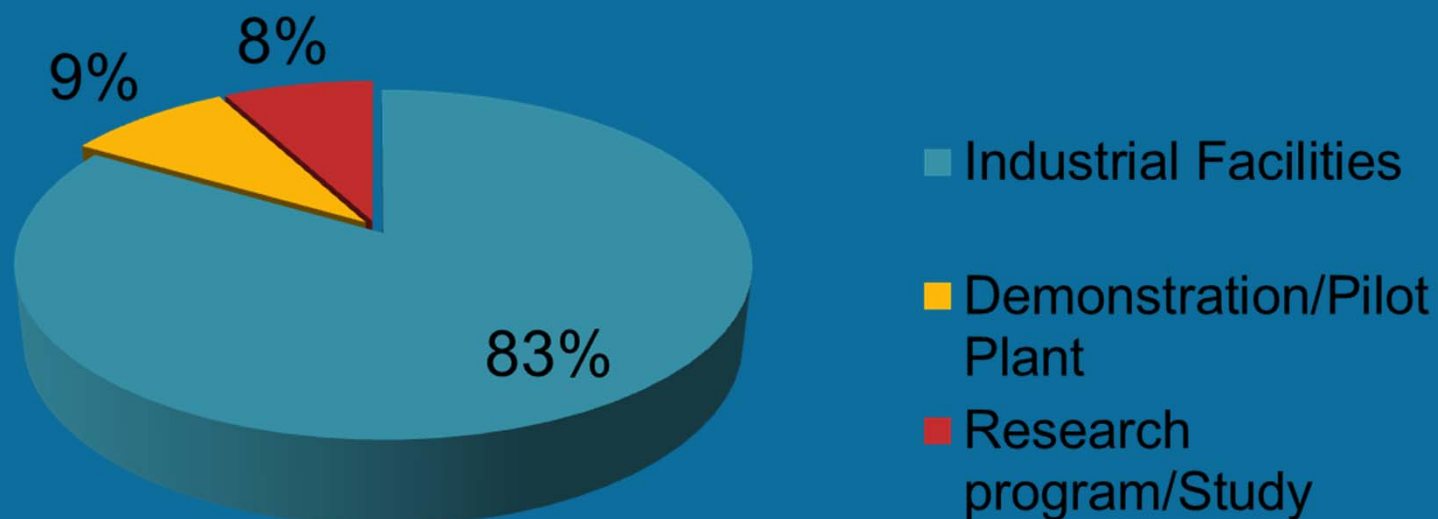
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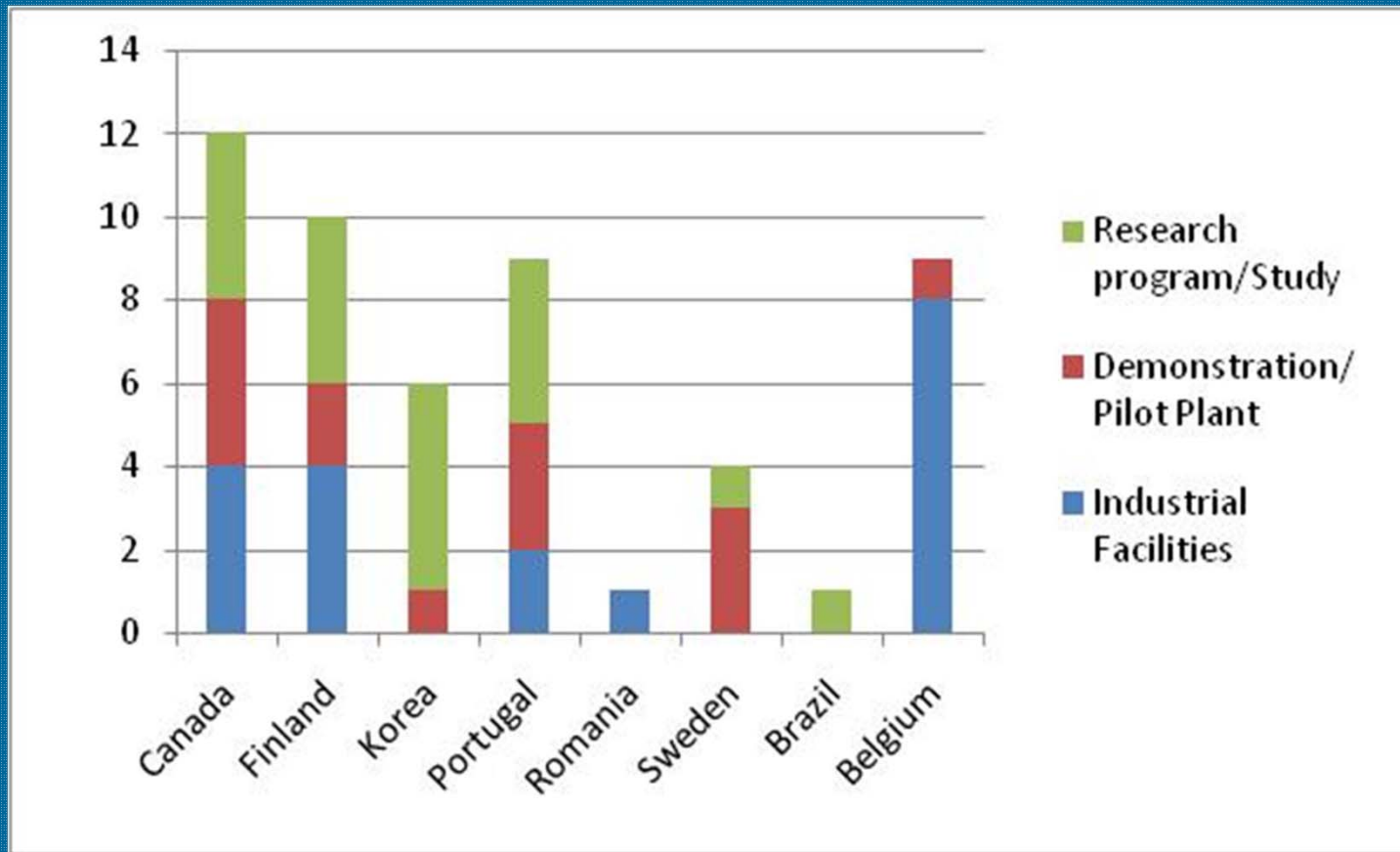
### 2008 INVENTORY Initiative within participating countries



# ANNEX XI – Industry-based Biorefineries



## 2008 INVENTORY Initiative



## ANNEX XI – Industry-based Biorefineries



# 2008 INVENTORY Initiative

- Inventory results
  - Mainly industrial units reported
  - Industrial units
    - Focus on biofuel production
  - Common reported R&D areas
    - Catalysis, Enzymes, Pyrolysis, Gasification, Algae carbon fixation for biodiesel production

# ANNEX XI – Industry-based Biorefineries



## TASK AND PROJECT MANAGERS

## 1<sup>ST</sup> MEETING



LNEG, Lisbon, Portugal  
March 30, 2011

## Briefing implemented activities

### Issues addressed



- ❑ visibility of the work to promote expanding participation to other research groups and countries
- ❑ project management taking into consideration that the collaboration is not financially supported by IEA and funding grants need to be obtained through other sources
- ❑ the advantage of networking with other groups
  - task 42 of the Bioenergy IEA IA
  - European network Star Colibri
  - European Biofuel Technology Platform



# Briefing implemented activities



## Projects approved in November 2010 ExCo meeting



- ❑ **Project XI/1 (Sub-Task 1) BUGWORKERS** - New tailor-made PHB-based nanocomposites for high performance applications produced from environmentally friendly production routes
  - *Project Manager- Bruno Sommer Ferreira*
- ❑ **Project XI/2 (Subtask 2) ALGAECASCAD** - The biorefinery of Algae, a CASCADE approach
  - *Project Manager - Ludo Diels*
- ❑ **Project XI/3 (Subtask 3) Heterogeneous catalysts for first generation biodiesel production**
  - *Project Manager – to be confirmed*
- ❑ **Project XI/4 (Subtask 4) Integrated Biofuel Production Processes Based on Systematic Optimization Methodologies**
  - *Project Manager - Nuno Oliveira*



# Project XI/1 - BUGWORKERS



**European collaborative project (funding from the European Union Seventh Framework Programme (FP7/2007-2013) aiming to develop new tailor-made materials from lignocellulosic residues using environmentally friendly production routes.**

The project started in July 2010.

A list of plastic equipment parts and required specifications for the composite materials has been compiled. Trials targeting the improvement of the yields of the hydrolysis of the lignocellulosic materials have started. Fermentation protocols with decreasing production costs have already been reproducibly implemented. Solvent-free downstream processing development is underway.

## Decisions – R&D areas



### Bugworkers" project – IETS integration



- ❑ Joint Dissemination activities of non-confidential results
- ❑ Implementation of joint studies
  - review of the state-of-the-art of the development of models for LCA and energy efficiency assessment
  - use of raw materials to other applications, broadening the scope of applications of the EU project
  - use of cheaper sources with an approach to lead to high added value products
    - use of primary sludge from the pulp and paper sector, broadening the scope of application to other cellulose sources
    - use of waste gas, rich in Hydrogen and CO<sub>2</sub>

# Project XI/2 - ALGAECASCADE



## CASCADE treatment of Algae and related biomass

### Food/feed – Materials/chemicals - energy

- carotene & apolar compound extraction
- algae biomass transformation into chemicals,
- energy production through microbial fuel cells
- bio electrochemical fuel cells
- valorization of algae products through hydrolysis

Problems to be solved were discussed, such as upscaling and high current output in the case of microbial fuel cells.

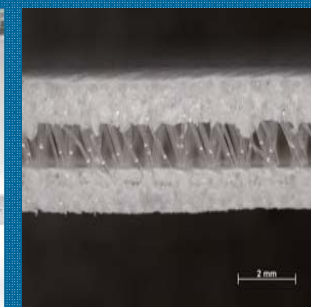
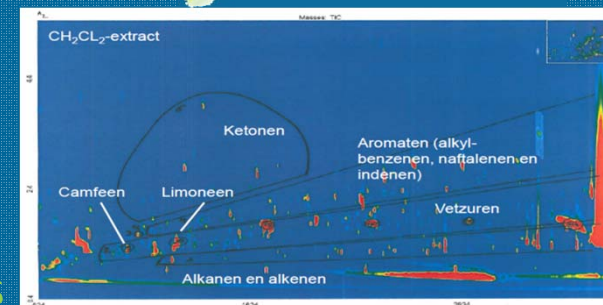


# R&D areas

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- Algae production
- Wet biomass harvesting via membranes
- Biomass cell disruption & extraction
- Analysis of small and large molecules
- Fractionation of small and polymeric molecules
- Enzymatic (immobilized on membranes) and chemical transformation
- In Situ product recovery (fermentation + membrane separation)
- Membrane functionalization for sharp separation of small molecules





## Projects XI/3 and 4



### XI/3 - Studies on Heterogeneous Catalysis

- ❑ Heterogeneous catalysis for the esterification of fatty acids
  - ❑ application on pulp & paper effluents containing tall oil, with a large amounts of fatty acids
  - ❑ application to biodiesel production from animal fat through esterification of fatty acids

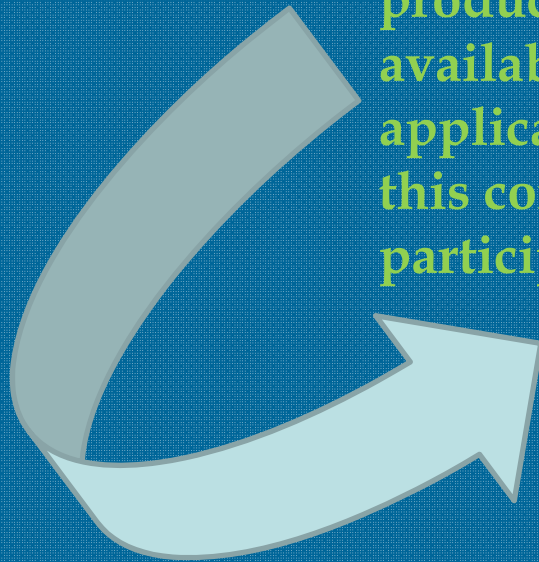
### XI/4 - Systematic Optimization Methodologies

- ❑ Ionic liquids
- ❑ use of process integration tools for both biodiesel and bio-ethanol production

# Conclusions



As a conclusion of discussions, it was acknowledged that the real challenge is on the integration of different processes leading to fuels and high-added value bio-products with cheap resources, guarantying the feedstock availability for energy efficient decentralized applications. The basis of the work will be oriented by this conclusion and the team looks forward to enlarging participation to other IETS member countries.



*Thank you...*

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