IEA Bioenergy

Task 42

Biorefineries: Co-production of Fuels, Chemicals, Power and Materials from Biomass

Ed de Jong

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Facilitating commercialisation and market deployment of environmentally sound, sustainable and cost-competitive bioenergy technologies……

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IEA Bioenergy……..

- Set up in 1978 by the International Energy Agency
- Provides an international forum for sharing information and developing best practice on
  - Technology development
  - Non-technical barriers and issues
  - Regulatory and legislative issues
- Produces authoritative scientific and technical information on key strategic issues affecting deployment
- One of two Implementing Agreements with major relevance for Biofuels (the other IEA-AMF (Advanced Motor Fuels))
- Annual budget 1.7 M US-$ (2007)

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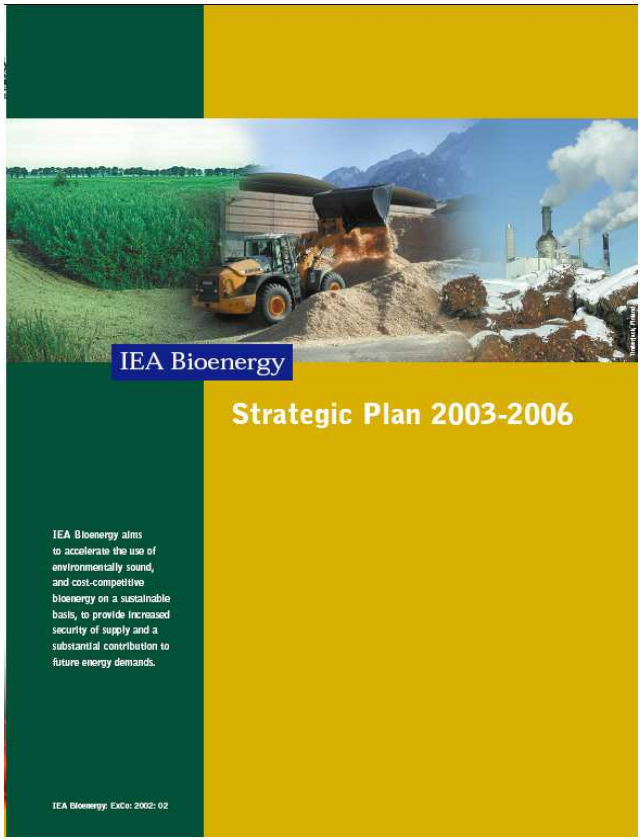
Vision and Mission

Vision:

To accelerate the use of environmentally sound and cost-competitive bioenergy on a sustainable basis, to provide increased security of supply and a substantial contribution to future energy demands.

Mission:

To facilitate commercialisation and market deployment of environmentally sound, sustainable and cost-competitive bioenergy technologies.



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Strategy

To provide platforms for international collaboration and information exchange in bioenergy research, development and demonstration. This includes:

- the development of networks,
- dissemination of information,
- involvement of industry and
- encouragement of membership by countries with a strong bioenergy infrastructure

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22 Contracting Parties

- Australia
- Austria
- Belgium
- Brazil
- Canada
- Croatia
- Denmark
- European Commission
- Finland
- France
- Germany
- Ireland
- Italy
- Japan
- Netherlands
- New Zealand
- Norway
- South Africa
- Sweden
- Switzerland
- United Kingdom
- United States

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Tasks

- **Feedstock**
  Forest and agricultural products, MSW and recovered fuels

- **Conversion**
  Combustion, gasification, pyrolysis, anaerobic digestion, fermentation, biorefineries

- **Integrating Research Issues**
  GHG balances, socioeconomic drivers, international trade, systems analysis

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Task 42: Biorefineries

Focus on:

Biorefinery as a facility that optimises the integrated production of materials, fuels, energy and chemicals and so maximises the value derived from the biomass feedstock.

Aims to:

Assess the worldwide position and potential of biorefineries.

Gather new insights of the possibilities for the simultaneous manufacture of transportation fuels, added value chemicals, heat, power and materials.

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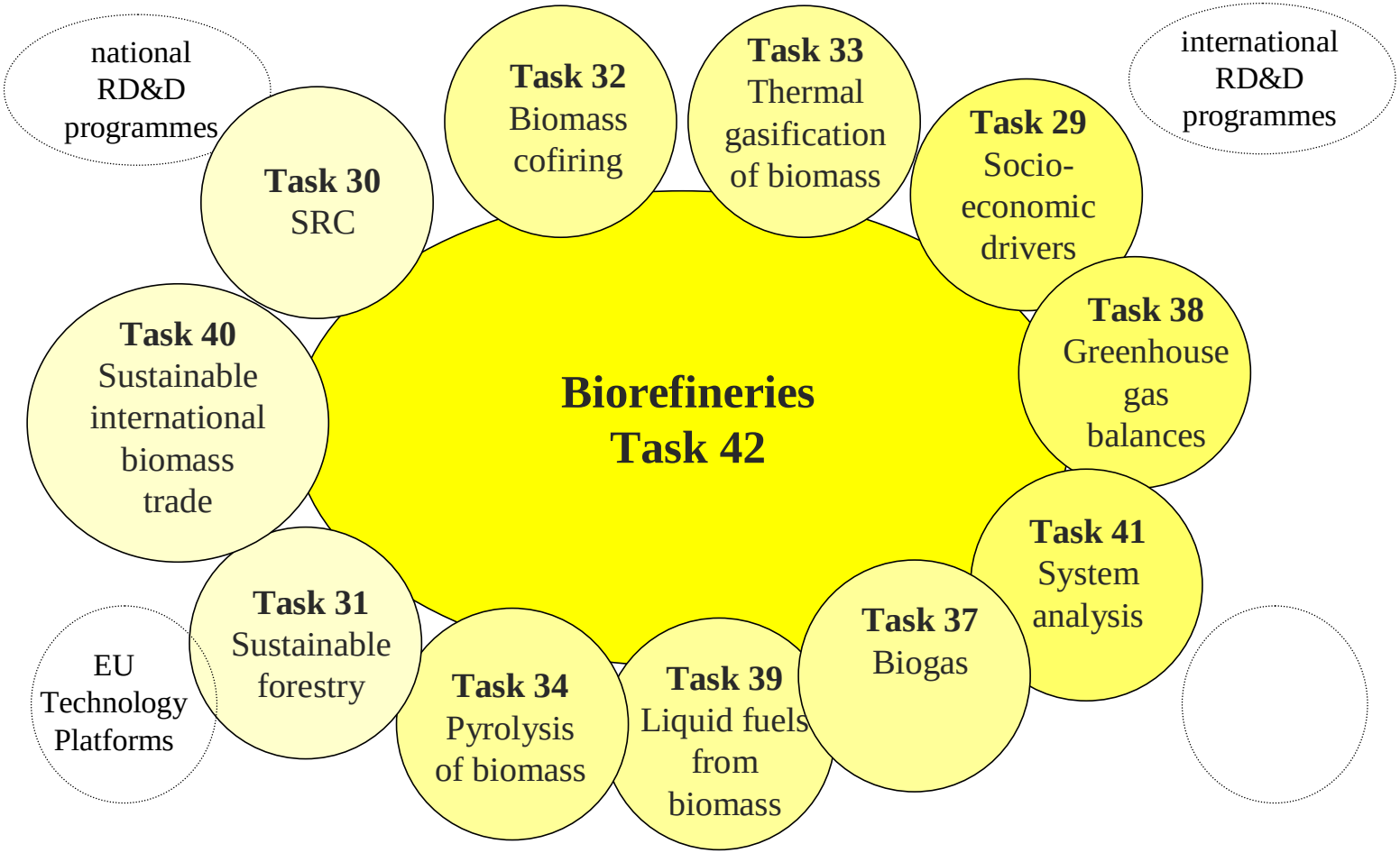
Task 42 on Biorefineries

Position Task within IEA Bioenergy



Partners Task 42

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Founding members:

Austria, Canada, Denmark, EU, France, Germany, Ireland, **the Netherlands**

New Members:

2009: Australia, Italy
2010: USA, New Zealand

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Task 42: Key Activities and Achievements

- Development of a common definition for biorefineries.
- Development of a common classification system for biorefineries.
- Country reports on current processing potential and mapping of existing plants.
- Identification of biorefinery related RD&D programmes in participant countries.
- Annual biorefinery seminar for stakeholders.
- Linking of ongoing international activities through joint events and new initiatives

Task 42 Definition on Biorefineries:

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Biorefinery: the sustainable processing of biomass into a spectrum of marketable products and energy

- *Biorefinery*: concepts, facilities, plants, processes, clusters of industries
- *Sustainable*: maximizing economics, - social aspects, minimizing environmental impacts, fossil fuel replacement, closed cycles
- *Processing*: upstream processing, transformation, fractionation, thermo-chemical and biochemical conversion, extraction, separation, downstream processing
- *Biomass*: wood & agricultural crops, organic residues, forest residues, aquatic biomass
- *Spectrum*: multiple energic and non-energic outlets
- *Marketable*: Present and forecasted (volume and prices)
- *Products*: both intermediates and final products (i.e. food, feed, materials, chemicals, fuels, power, heat)

Biorefinery

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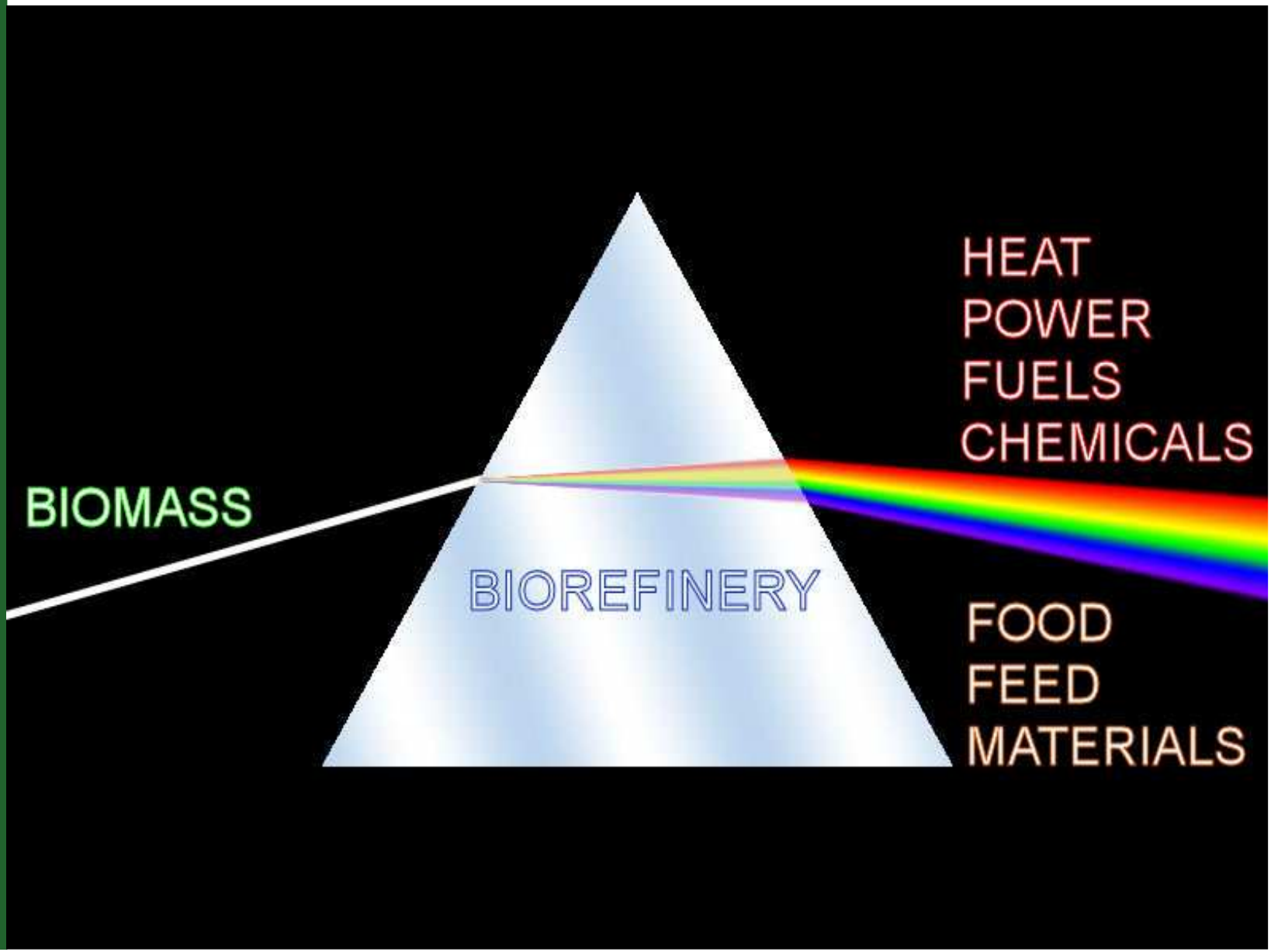

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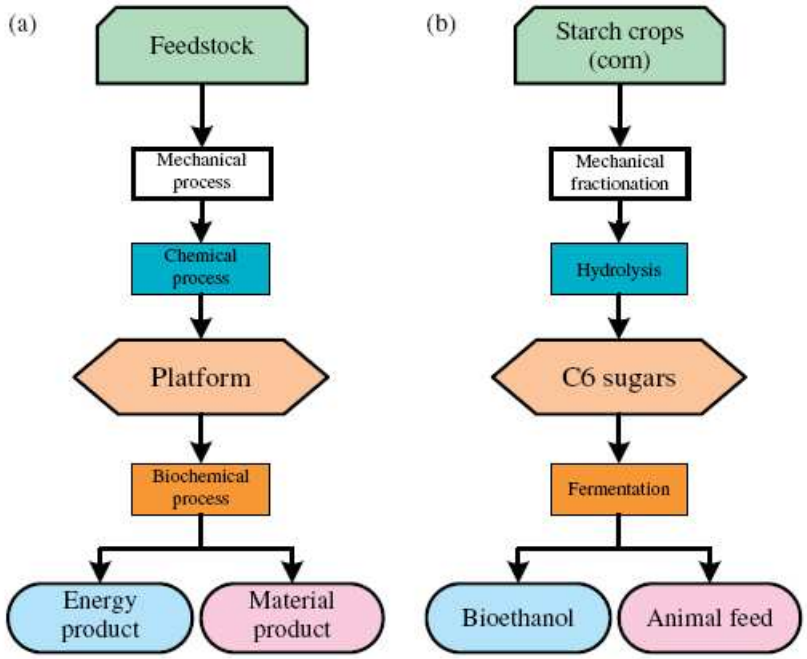
Development of a common classification system for biorefineries



Rationale biorefinery system classification method

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The classification approach consists on four main features:

Feedstocks:

- energy crops from agriculture (e.g. starch crops, short rotation forestry)
- biomass residues from agriculture, forestry, trade and industry conversion processes

Conversion Processes:

- biochemical (e.g. fermentation, enzymatic conversion)
- thermo-chemical (e.g. gasification, pyrolysis)
- chemical (e.g. acid hydrolysis, synthesis, esterification)
- mechanical processes (e.g. fractionation, pressing, size reduction)

Platforms:

- (e.g. C5/C6 sugars, syngas, biogas)

Energy/products:

- energy (e.g. bioethanol, biodiesel, synthetic biofuels)
- products (e.g. chemicals, materials, food and feed)

Application of the classification to biorefinery systems

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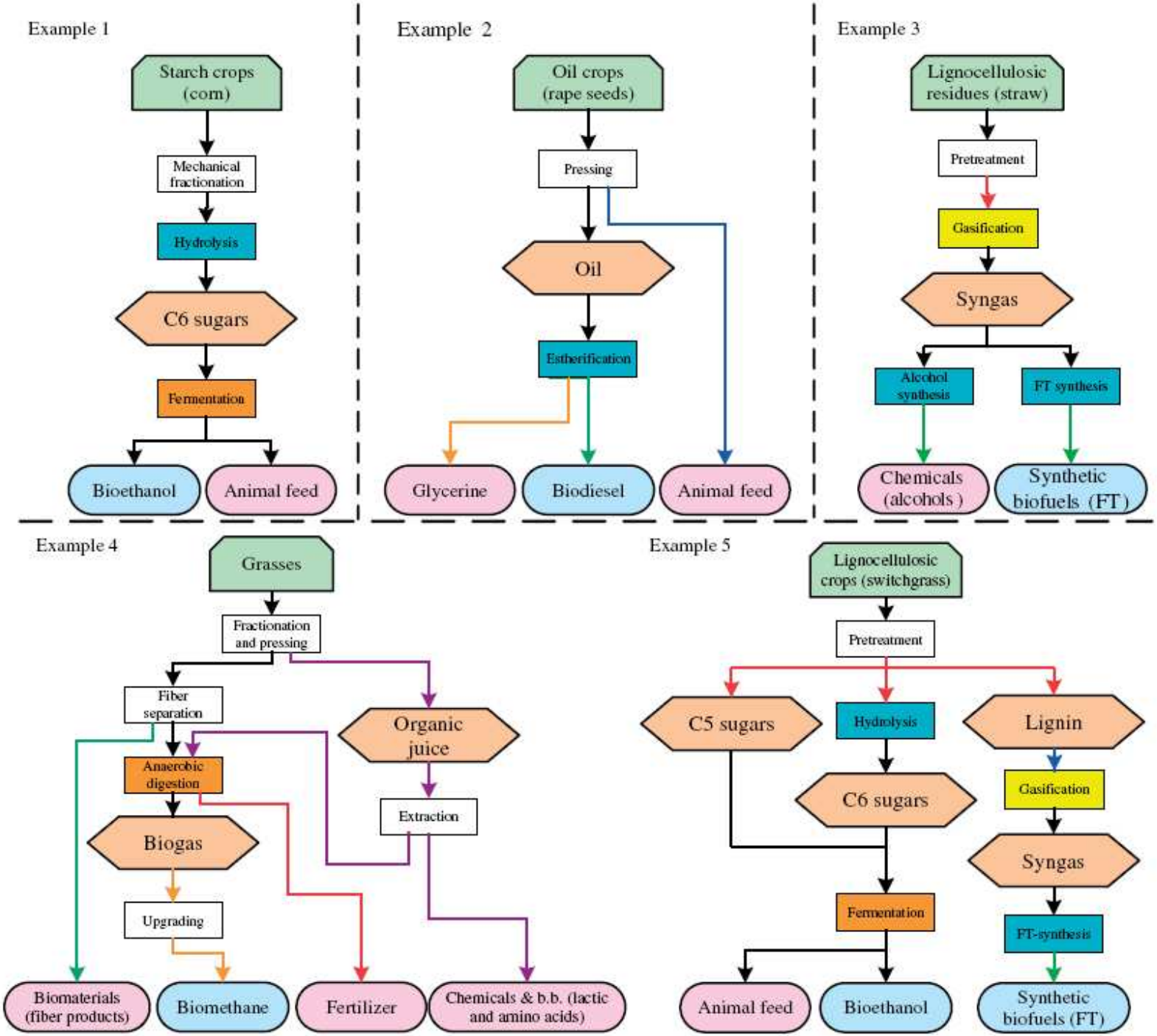
Table 3. Application of the classification to selected biorefinery systems.

#	Name	Platforms	Products		Feedstock	Processes	Source of auxiliary energy	
			Energy	Material			Heat	Power
1	One-platform (C6 sugar) biorefinery for bioethanol and animal feed from starch crops	C6 sugars	Bioethanol	Animal feed	Starch crops (corn)	Hydrolysis, fermentation	Natural gas	Grid
2	One-platform (oil) biorefinery for biodiesel, animal feed and glycerine from oil crops	Oil	Biodiesel	Animal feed (rape cake), glycerine	Oil crops (rapeseed)	Pressing, transesterification	Natural gas	Grid
3	One-platform (syngas) biorefinery for synthetic biofuels and chemicals from lignocellulosic residues	Syngas	Synthetic biofuels (FT-fuels)	Chemicals (alcohols)	Lignocellulosic residues (straw)	Pre-treatment, gasification, FT synthesis, alochol synthesis	Natural gas	Grid
4	Two-platform (biogas and organic juice) biorefinery for biomethane, chemical b.b., biomaterials and fertilizer from grasses	Biogas, organic juice	Biomethane	Chemical b.b. (lactic acid, amino acid), biomaterials (fibers)	Grasses	Pressing, fiber separation, anaerobic digestion, upgrading (…)	Natural gas	Grid
5	Four-platform (C6/C5 sugars and lignin/syngas) biorefinery for synthetic biofuels, bioethanol and animal feed from lignocellulosic crops	C6/C5 sugars, lignin, syngas	Synthetic biofuels (FT-fuels), bioethanol	Animal feed	Lignocellulosic crops (switchgrass)	Pre-treatment, hydrolysis, fermentation, gasification, FT synthesis	Natural gas	Grid


Example 1
Starch crops (corn)
Mechanical fractionation
Hydrolysis
C6 sugars
Fermentation
Bioethanol
Animal feed
Example 2
Oil crops (rape seeds)
Pressing
Oil
Estherification
Glycerine
Biodiesel
Animal feed
Example 3
Lignocellulosic residues (straw)
Pretreatment
Gasification
Syngas
Alcohol synthesis
FT synthesis
Chemicals (alcohols)
Synthetic biofuels (FT)
Example 4
Grasses
Fractionation and pressing
Fiber separation
Organic juice
Anaerobic digestion
Extraction
Biogas
Upgrading
Biomaterials (fiber products)
Biomethane
Fertilizer
Chemicals & b.b. (lactic and amino acids)
Example 5
Lignocellulosic crops (switchgrass)
Pretreatment
C5 sugars
Hydrolysis
Lignin
C6 sugars
Gasification
Syngas
Fermentation
FT-synthesis
Animal feed
Bioethanol
Synthetic biofuels (FT)

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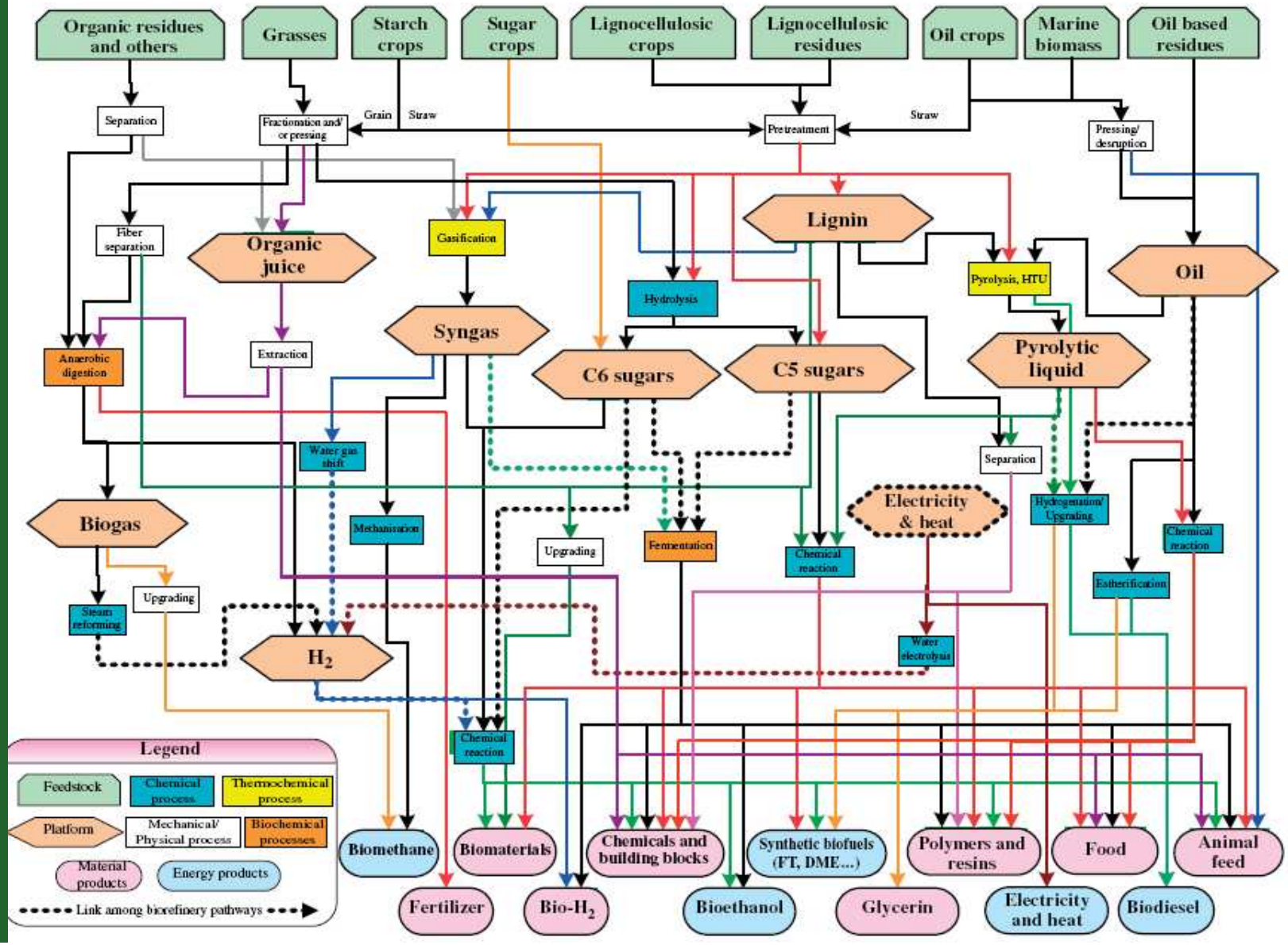
Network on which the biorefinery system classification method is based



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Further reading:
Paper in BioFPR (*in press*)

Modeling and Analysis

Biofpr
Biofuels Bioproducts & Biorefining

Toward a common classification approach for biorefinery systems

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***Biofuels, Bioprod. Bioref.* (2009)**

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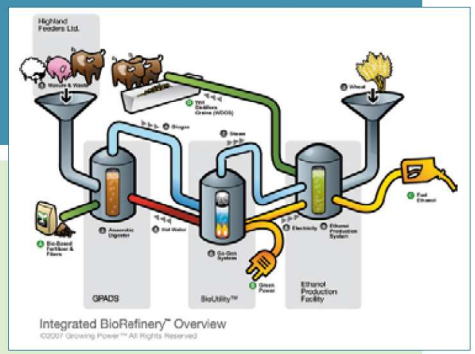
Biorefinery

Brochure

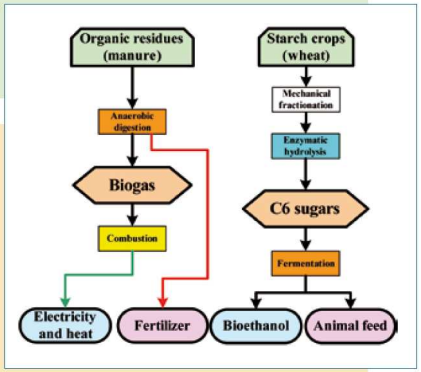
Highmark Renewables (Canada)

Classification: C6 sugars and biogas biorefinery for bioethanol, animal feed, fertilizer, electricity and heat from starch crops and organic residues
State-of-the-art: Commercial
Owner: Highmark Renewables
Feedstocks: Wheat, manure, slaughtering waste
Products: Bioethanol, amimal feed, fertilizer, electricity and heat
Stakeholders:



Integrated BioRefinery™ Overview

Highmark Renewables is developing the first Integrated BioRefinery™ in Canada. Their unique process converts grain (e.g. high-starch wheat) into fuel ethanol. The residual, distillers grains, is fed to cattle at a nearby feedlot. Cattle manure is used to generate biogas, which is converted to electricity and steam in a BioUtility process. The highly integrated process is targeted for the most cost and energy efficient production of fuel ethanol. The Integrated BioRefinery™ once it is in full production, will generate 40 million litres of ethanol, 10 thousand tonnes of BioFertilizer, and over 75 thousand tonnes of greenhouse gas emissions credits each year. Agricultural and food industry residues, often thought of as wastes, are converted into valuable energy and other renewable products. Highmark Renewables is proud of their technology development capability, technology portfolio, experience in developing enewable energy facilities, facility operation skills and world-class management team.



Highmark Renewables, a designer and operator of renewable energy facilities, developed the Growing Power Anaerobic Digestion System (GPADS) which can derive energy from high-solids and fibrous organic wastes (manure, industrial residues and municipal solid waste). After more than two years of operations, the system now can generate special value from tough to handle wastes. GPADS, our first large scale installation is the largest feedlot manure - energy plant in the world. It processes about 15% of the manure from a 36,000 head feedlot which is managed by our partners Highland Feeders and the Spring Creek Ranch (producers of verified premium Alberta beef). GPADS, currently producing 20 tonnes of biofertilizer along with up to 24,000 kWh of electricity each day is expected to grow four times in size while its technology may in the future be applied elsewhere. Highmark Renewables vision is to generate the maximum return on available resources with minimal risks.

Contact: Highmark Renewables, Vegreville, Alberta, Canada.
Projects@highmark.ca

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1) Website: www.IEA-Bioenergy.Task42-Biorefineries.com
2) Classification of Biorefineries
3) Country reports on Biorefineries
4) Leaflet
5) Brochure with examples of biorefineries

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Thank you for your attention

Further information:

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