Bioliquids-CHP
Power generation from Biomass

Bio-liquids as fuels

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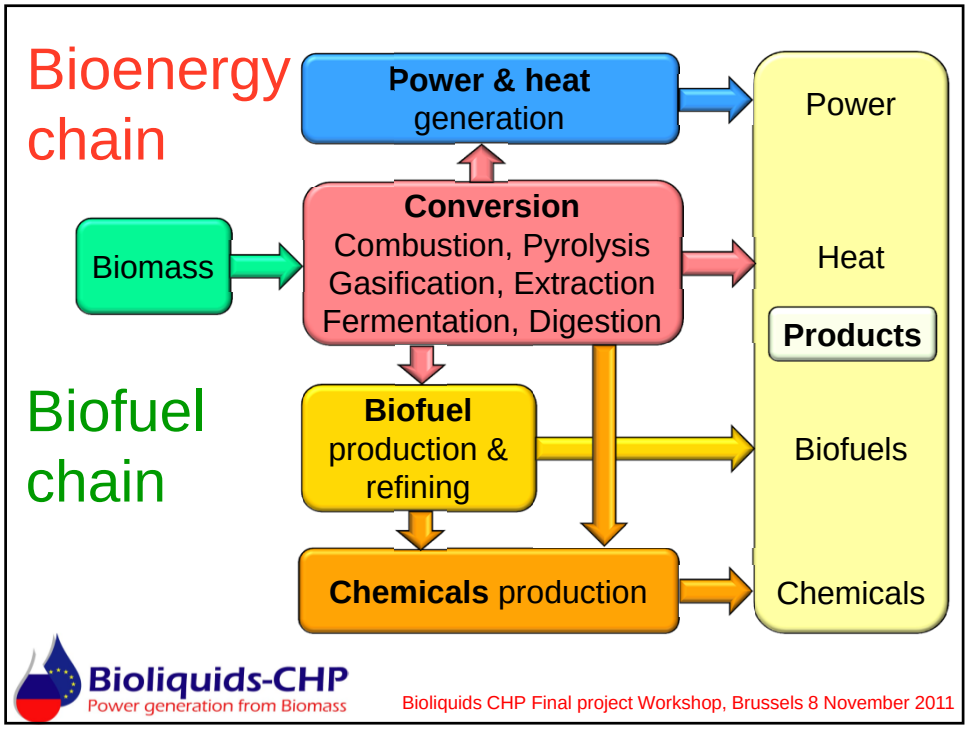

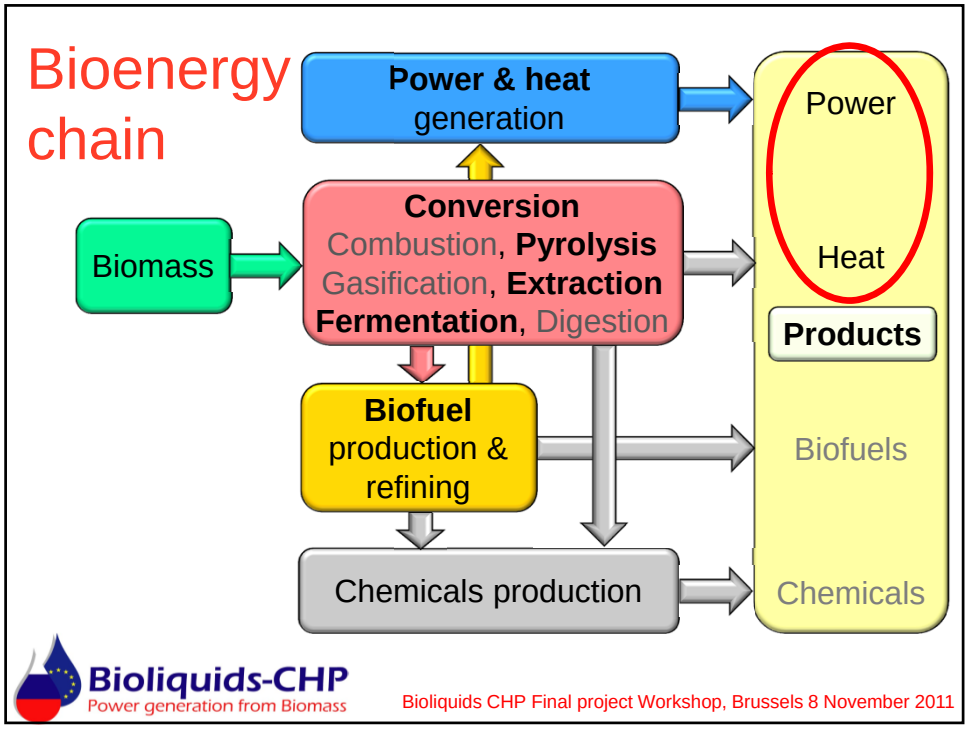
Bioenergy chain
Power & heat generation
Biomass
Conversion
Combustion, Pyrolysis
Gasification, Extraction
Fermentation, Digestion
Biofuel production & refining
Chemicals production
Power
Heat
Products
Biofuels
Chemicals
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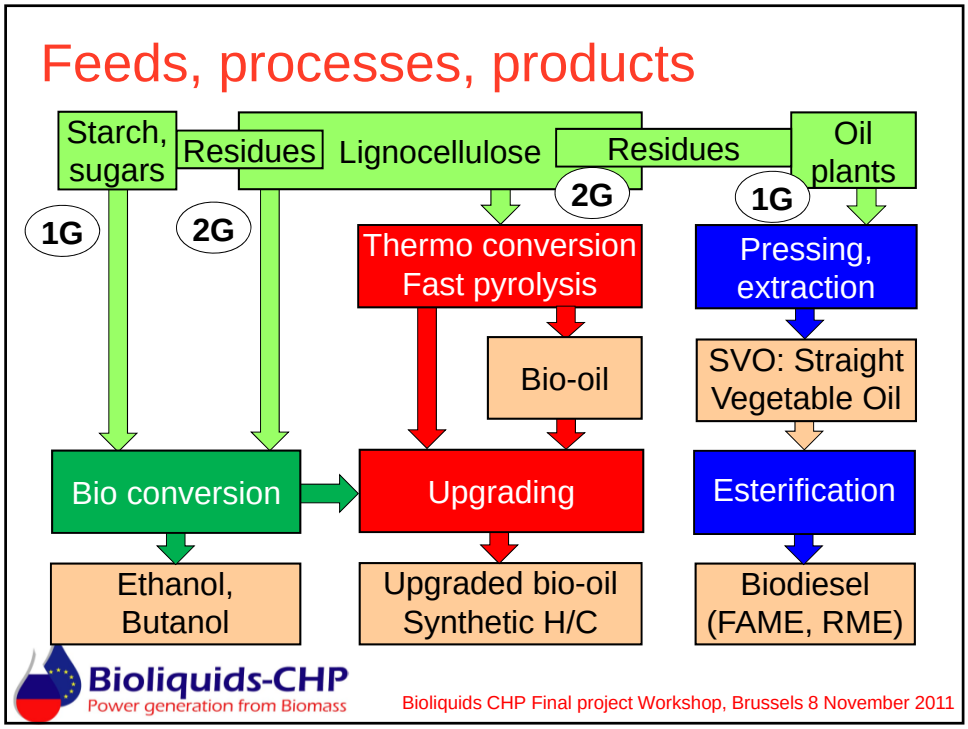
Feeds, processes, products
Starch, sugars
Residues
Lignocellulose
Residues
Oil plants
1G
2G
2G
1G
Thermo conversion Fast pyrolysis
Pressing, extraction
Bio-oil
SVO: Straight Vegetable Oil
Bio conversion
Upgrading
Esterification
Ethanol, Butanol
Upgraded bio-oil Synthetic H/C
Biodiesel (FAME, RME)
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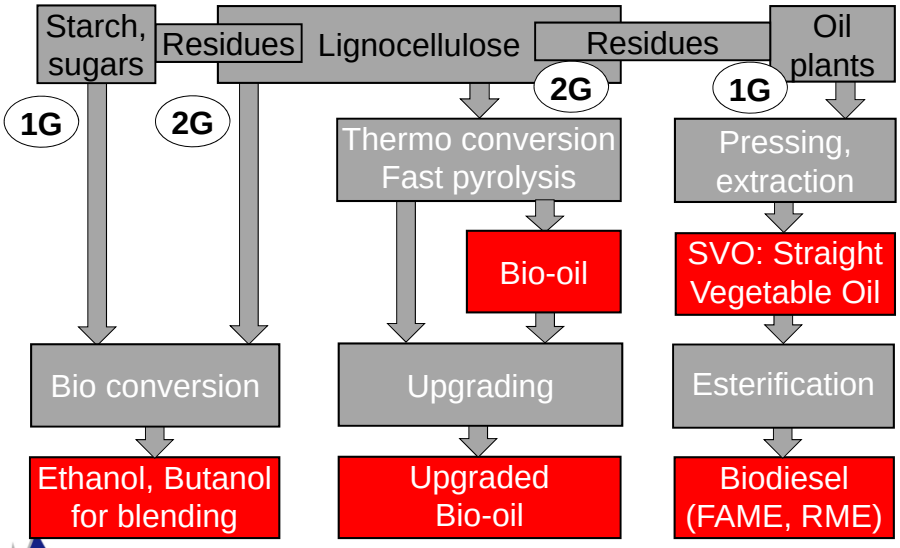
Bioliquids



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Bio-oil

- Bio-oil is made by fast pyrolysis. This involves heating small particles of biomass to 500C as quickly as possible and cooling the vapours as quickly as possible.
- This gives up to 75 wt.% bio-oil – a dark brown liquid with a heating value of around 18 MJ/kg, which is not miscible with hydrocarbons
- There are ASTM standards
- Properties are in the information pack.

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Vegetable oil

- Vegetable oil comes from oil seeds such as rape, soy, sunflower, jatropha.
- It is obtained by pressing and/or solvent extraction using e.g. hexane which is recovered and recycled.
- It is viscous and crude oil is very variable in quality with poor low temperature characteristics.
- Some vegetable oils are solid at room temperature such as palm oil.
- For fuel use, it is usually processed by transesterification to bio-diesel
- Waste vegetable oil comes from cooking processes.
- Properties are in the information pack.

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Bio-diesel

- Produced from vegetable oils and waste oils by reaction with methanol to form esters.
- Cleaner, consistent, less viscous and better low temperature characteristics compared to pure vegetable oil.
- Bio-diesel from different feedstocks and from different processes is variable
- Impurities can include glycerol, methanol, mono and di-glycerides
- There are EU and ASTM standards
- Properties are in the information pack.

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Bio-ethanol and bio-butanol

- Bio-ethanol is made by fermenting sugars into a beer type liquid which is then distilled to pure ethanol. Sugars can be 1G from cane or wheat, or 2G from lignocellulosics by hydrolysis
- Biobutanol is made in a similar way but yields are lower, there are multiple products and the process is more sensitive to contamination. Butanol is claimed to be a superior "drop-in" fuel compared to ethanol.
- Properties are in the information pack.

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Bio-liquid availability

Bio-liquid	Availability	Source	Notes
Bio-oil	Very limited	FI, NL, CA	R&D quantities available from few suppliers
Vegetable oil	Widespread	Worldwide	
Bio-diesel	Widespread	Worldwide	
Bio-ethanol	Widespread	Americas, EU	
Bio-butanol	Very limited	USA, EU	Synthetic butanol available

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Upgrading

- All the liquids can be upgraded to improve quality

In the project:

- Vegetable oil was purchased as commercial sunflower oil - filtered, blended and with commercial antioxidants etc. Vegetable oil is usually upgraded for fuel use by transesterification to give biodiesel
- Bio-diesel is available commercially. It was produced in Italy from sunflower oil, and in the UK from used cooking oil
- Bio-oil was both used as produced and also upgraded by fractionation, esterification, de-oxygenation and blending. Bio-oil is the least well developed bio-liquid used in the project.

Bio-oil quality

Acidity or low pH	Nitrogen
Aging	Odour and smell
Alkali metals	Oxygen content
Chlorine	Phase separation
Colour	Solids – char, particulates
Contamination from feed	Stability
Distillability poor	Structure
High viscosity	Sulfur
Inhomogeneity	Temperature sensitivity
Low H:C ratio	Toxicity
Materials incompatibility	Viscosity
Miscibility with hydrocarbons low	Water content

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Bio-oil quality concerns

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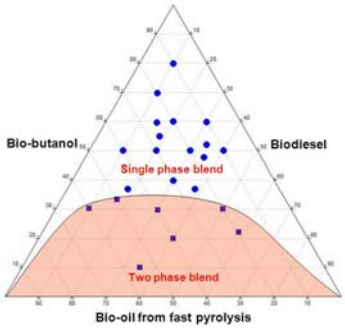
Bio-oil upgrading methods

- Biomass pretreatment
- Biomass fractionation
- Bio-oil fractionation
- Blending
- Catalytic cracking
- Co-processing
- Emulsions
- Esterification
- Gasification
- Heat treatment
- Hydrodeoxygenation
- Hydrotreating
- Reforming
- Supercritical processing
- Thermal cracking

Bio-oil upgrading methods employed

- Esterification – water and acidity reduction, improved compatibility with other fuels; low efficiency
- Hydrodeoxygenation – improved heating value, better compatibility with hydrocarbons, improved stability. Low conversion efficiency
- Blending – high efficiency, more control of liquid properties.



Thank you

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