Biofuels: Social, environmental and economic concerns

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Introductory lecture – Energy commodities and technologies

Global trends

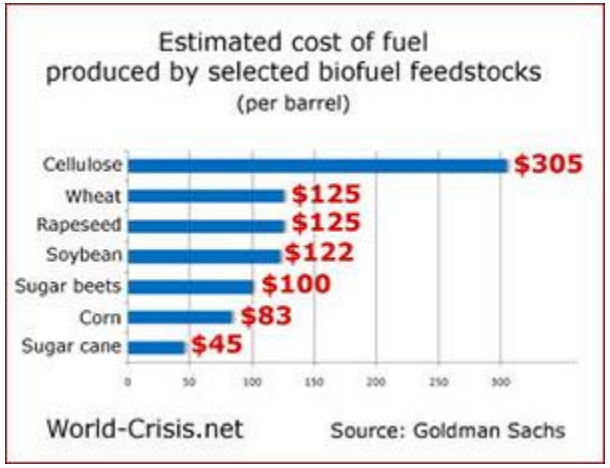
- Biofuels: overview
- Economic concerns
- Environmental concerns
- Social concerns

Biofuels: overview

- First generation biofuels (1G) – produced from food-grade biomass by natural microbiological processes.
  - Example: vegetable oils, ethanol, biogas from crops.
- 1G non-food biofuels – produced by natural processes but from non-edible biomass, i.e. from organic residues, sewage sludge or garbage.
  - Example: biogas.
- Second generation biofuels (2G) – produced by advanced thermochemical conversion methods from non-edible biomass feedstocks.
  - Example: alcohols or biosynthetic fuels from wood or from another lignocellulosic material!
- Third generation biofuels (3G) – based on more productive, special grown non-food biomass feedstocks.
  - Example: algae, genetically modified or hybrid crops, artificial photosynthesis.

Biofuels: overview

- Utilized in thermal power plants, boilers and suitable vehicles
  - Thermal efficiency 35-40-% of ICE, up to 90% in the case of cogeneration
- Base load supply
- Power plant cost comparable to fossil fuels
- Biofuel production cost depends on the fuel type



Biofuels: economic concerns

- Susceptible to aging and freezing
- Difficult to maintain the production process in small scales
- Existing infrastructure can sometimes handle biofuels but in many cases modification or equipment replacement is required

Biofuels: environmental concerns

- Deforestation
- Reduction in biological diversity
- Erosion
- Typically high input of energy required (fertilisers, harvesting processing)
- New agricultural land, less retention of water in soil, desertification (higher evapotranspiration)
- Improper irrigation of energy crops => soil salinity
- Ground water pollution due to fertilisers
- H2O for biogas production and distilleries =>
  - Production of waste water rich in N2, phosphorous and potassium.

Biofuels: social concerns

- Biofuel production requires significant amounts of water (often scarce). This leads to a clear trade-off in water allocation.

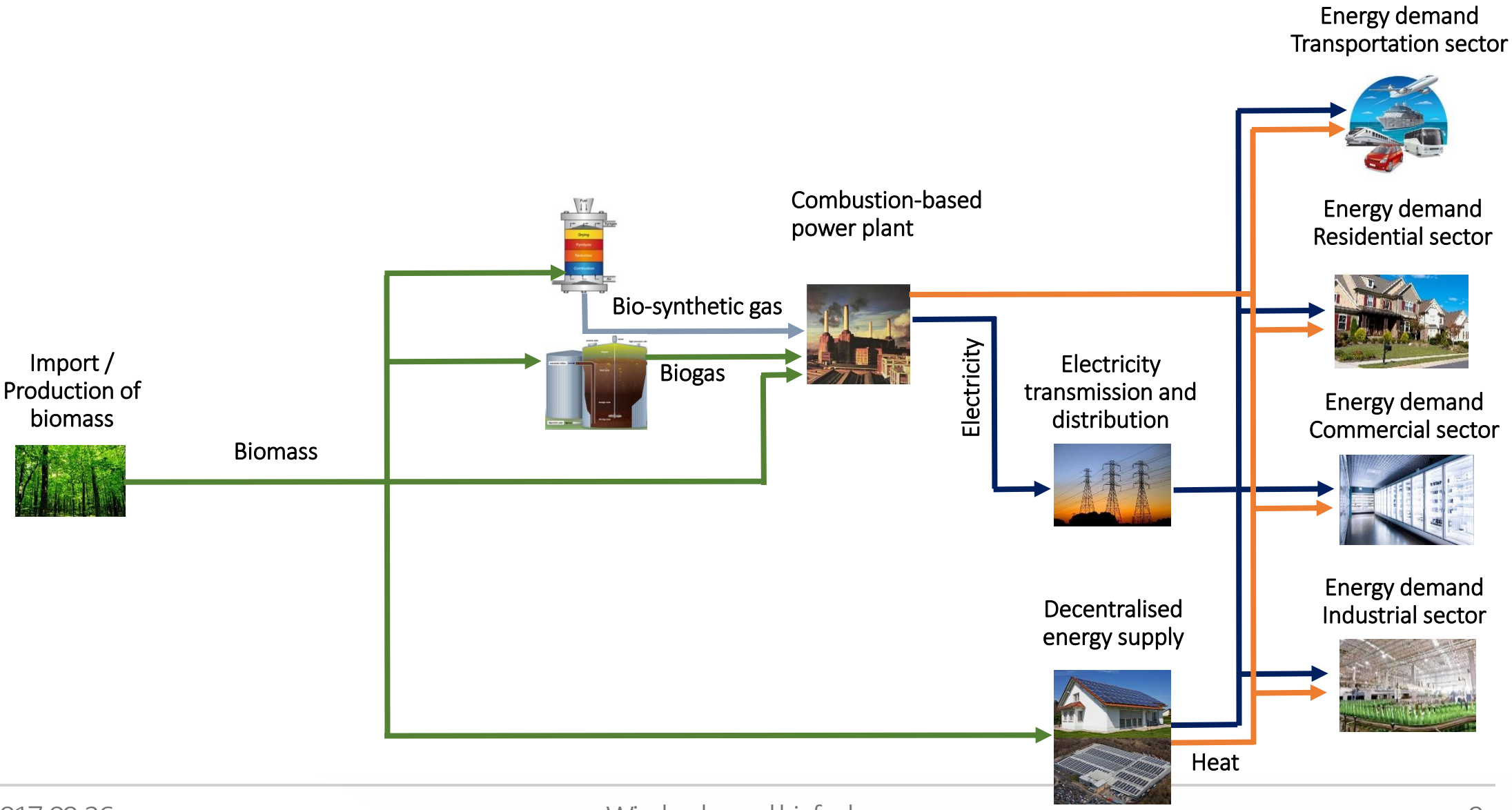
- Land use conflict. Biomass alone can NOT be a single source of both fuel and food for the growing population on planet Earth. Efficient production/conversion/utilisation methods should be sought.

- Visual impact on land.

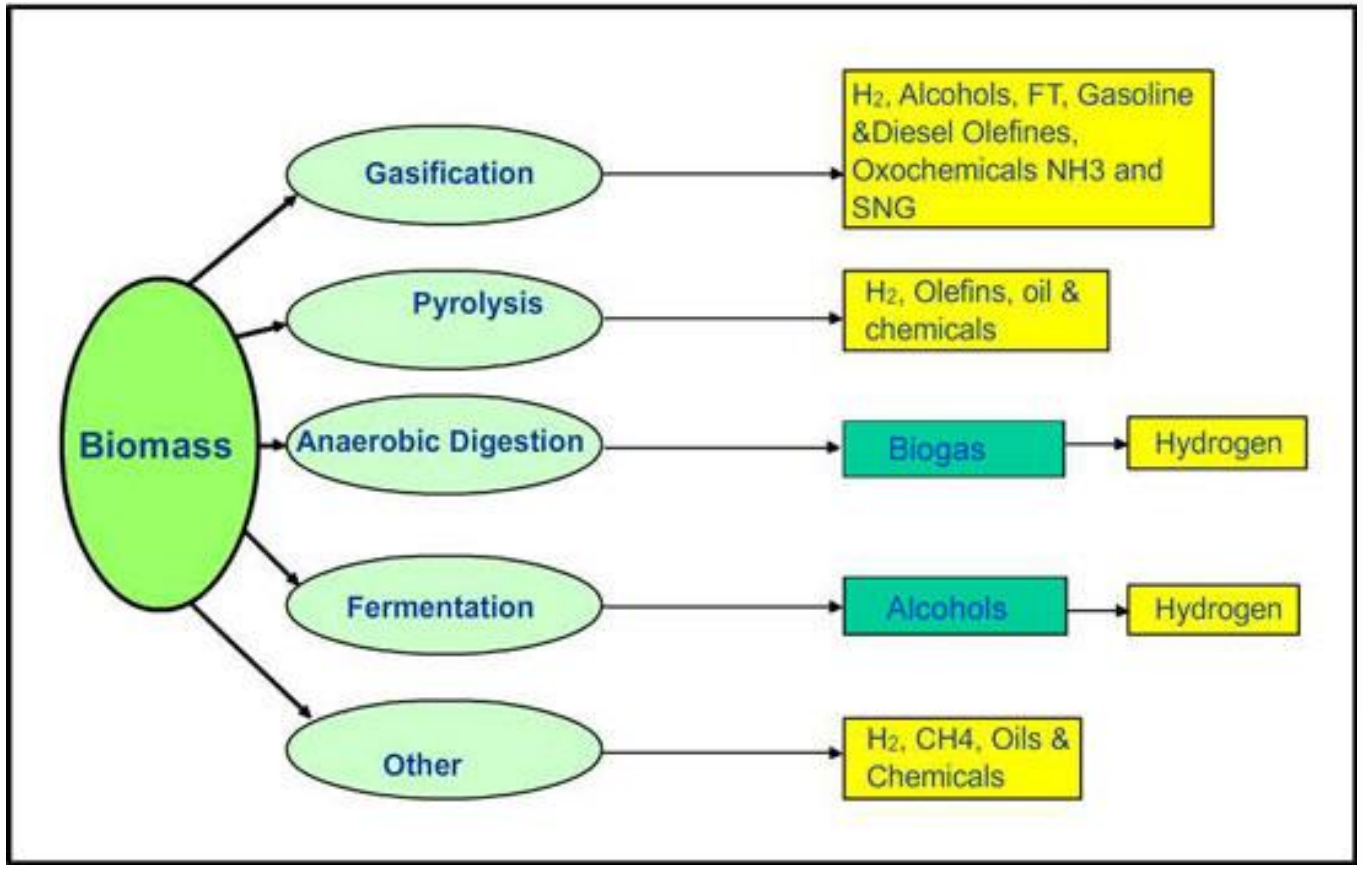
Technologies in the biofuels chain

- Biomass production
- Biogas and bio-synthetic gas production
- Biomass for heat and power

Sample Reference Energy System: biofuels



Processes for bioenergy conversion



Biomass Production

- Biomass is comes from agriculture/forest products/residues as well as waste.
- Various harvesting or collection methods are applied.
- Treatment includes chipping, drying, pelleting and torrefaction.
- Transport is done by truck, train and ship.
- It can be either used in solid form (e.g. chips or pellets) or converted in to liquid fuels (ethanol, biodiesel, etc.), or gas (syngas, biogas).

Key characteristics	
Pellet Production Plant (40,000 t/yr capacity)	
Capital cost	4866 k$
FOM cost	225 k$/a
Energy use	0.410 GJ/t pellets
Utilization factor	91%

Biogas and bio-synthetic gas production

- Biogas usually produced by anaerobic digestion. Applications also in developing countries and rural contexts.
- Bio-syngas production less mature. Gasification technologies work on same principles as those for coal. Potentially higher production rates.

Key characteristics	
Anaerobic digester	
Capital cost	5000-7500 USD / Nm3/h
FOM cost	2-7% of capital
Energy use	Up to 15% of feed
CO2 emission factor	11-20 gCO2/MJ

Biomass for Heat and Power

- The most common application of biomass in the energy sector is combined heat and power (CHP) generation.
- CHP (if not for industrial use) is coupled with district heating.
- Co-firing of biomass/biogas with coal/natural gas respectively is possible with a few adjustments.

Key characteristics	
Biomass CHP plant	
Capital cost	3000-6000 $/kW
FOM cost	100 $/kW/a
Fuel cost	30-50 $/MWh
Electric Efficiency	16-36%
Totall Efficiency	40-85%

References and reading material

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