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Next Generation Biobutanol

Improving the sustainability of LC biofuels: ButaNexT as a case study

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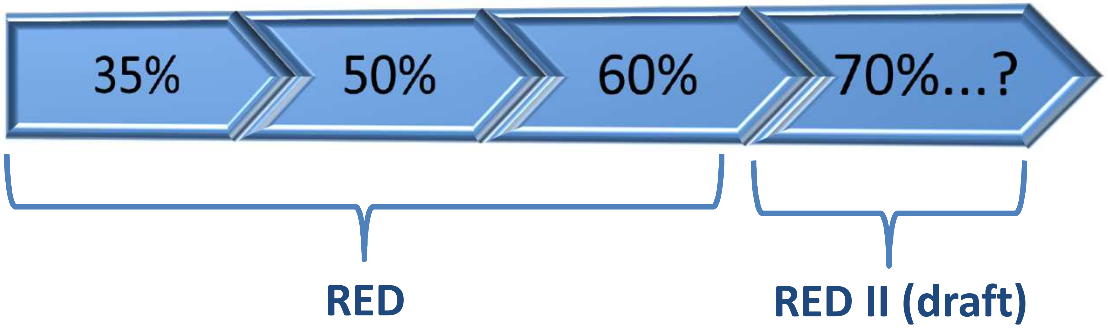
The ButaNexT project has received funding from the European Union Horizon 2020 Research and innovation Programme under grant agreement n° 640462

Sustainability is increasingly important in biofuels policy

- Long-term deep decarbonisation requires significant GHG savings

- GHG emission saving thresholds have increased over the years:



- Sustainability means more than just GHGs
- Sustainability is likely to become increasingly important and regulated in the future

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Therefore sustainability is important to biofuel developers

- Sustainability is a prerequisite in order to have access to the market.
- A shift towards market mechanisms based on GHG savings in the future would provide an economic benefit to maximising GHG savings

Projects such as ButaNexT are important in developing efficient and sustainable processes

Project aims:

- Validate a commercial process for a lower-cost and efficient butanol production process - ABE process with LC and waste feedstocks
- Investigate and demonstrate butanol blending with gasoline, diesel and conventional biofuels, and test the most promising blends in an engine.
- Demonstrate process sustainability by using low cost and sustainable feedstocks, achieving high conversion efficiencies, and reduced environmental footprint (including energy requirements, and greenhouse gas emissions)

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Lignocellulosic feedstocks and wastes are considered better for sustainability

RED Annex IXA

Agricultural residues:

- Straw
- Animal manure and sewerage sludge
- Palm oil mill effluent and empty palm fruit bunches
- Grape marcs and wine lees
- Nut shells
- Husks
- Corn cobs
- Forestry wastes and residues

Other:

- Algae
- Biomass fraction of mixed MSW ; Bio-waste that is collected separately; biomass fraction of industrial waste
- Other non-food cellulosic material
- Other ligno-cellulosic material
- Renewable fuels of non-biological origin
- Carbon capture and utilisation
- Bacteria

Industrial residues:

- Tall oil pitch
- Crude glycerine
- Bagasse

RED Annex IXB

- Used cooking oil
- Category 1 & 2 animal fats

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However sustainability risks of using such feedstocks should still be carefully considered

- Energy crops such as Miscanthus may still displace other crops
- Even feedstocks which are commonly considered ‘wastes’ may have had an alternative use
- Emissions for harvesting, collection and transport of feedstocks must still be taken into account
- Supply of wastes is generally inflexible, so there may not be an abundant supply of some wastes
- There is a risk of fraud where material is classed as a ‘waste’ without being a true waste

POET-DSM have developed their own bale type and extensive harvesting guidelines to ensure sustainable and reliable feedstock supply.

Photo credit: POET-DSM

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The ButaNexT project has resulted in improvements and innovations in the butanol production process

Biomass pre-treatment

- Improvements to mechanical and thermochemical pre-treatment

Hydrolysis

- Specialised enzyme cocktail for biomass hydrolysis

Fermentation

- Maximise production of butanol by producing next-generation, non-GMO microorganisms
- In-situ product recovery

Downstream processing

- Pervaporation is more energy efficient and reduces end-product inhibition

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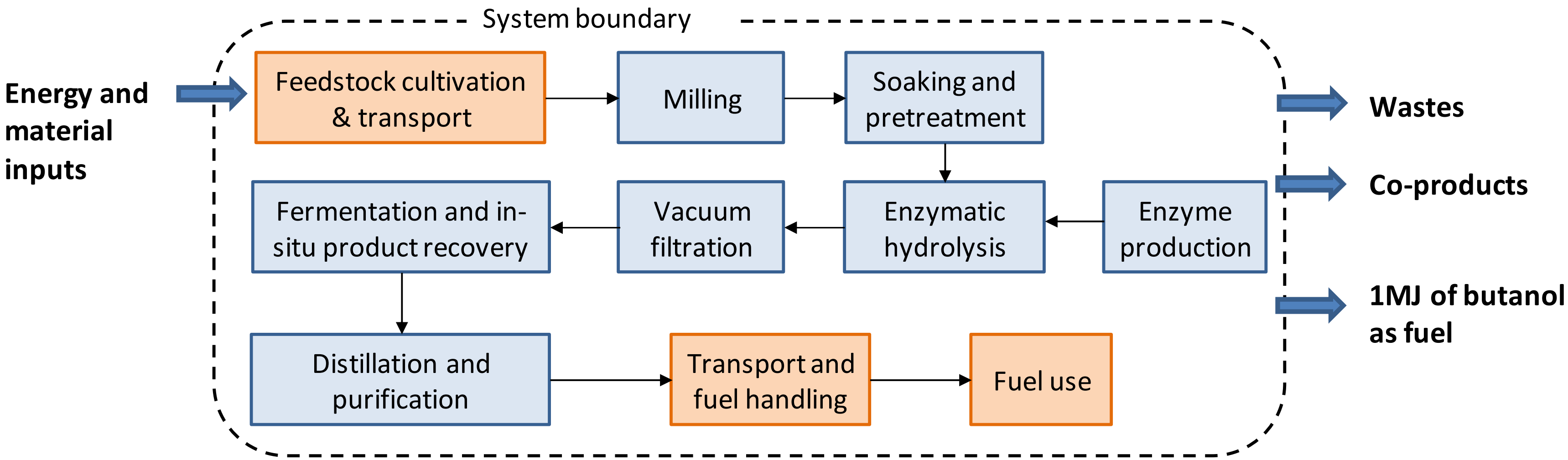
Mass and energy balance and GHG assessment of commercial-scale plant

- GHG assessment based on RED methodology
- Applicable to commercial-scale butanol production plant

System boundary of the RED-compliant GHG assessment:



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Scale-up from pilot to commercial scale must be carefully considered

- Risk of additional processes being required, or processes being significantly different from pilot-scale plant
  - Scale-up from pilot to commercial scale may result in a step-change for some processes, eg. waste treatment
- Opportunity for efficiency gains at larger scale
  - Electricity use reduced by a factor of 100 for enzyme production
- Some processes may be brought on-site
- Opportunity for process integration
  - Heat
  - Valorising non-fermented biomass

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Possibilities for process integration were explored through several scenarios

Scenarios considered:

A. Steam provision from natural gas boiler, electricity from grid

B. Steam and electricity provision from natural gas CHP, excess electricity sold to grid, providing a GHG credit to the biobutanol for displaced natural gas CCGT electricity.

C. Recalcitrant biomass (largely lignin and non-hydrolysed cellulose) burned in on-site CHP plant, excess electricity sold to grid and emissions allocated to this electricity as a co-product

D. On-site modelled waste water treatment plant (WWTP) producing biogas. Steam and electricity provided by on-site CHP burning recalcitrant biomass and biogas from WWTP. Excess electricity sold to grid and emissions allocated to this electricity as a co-product

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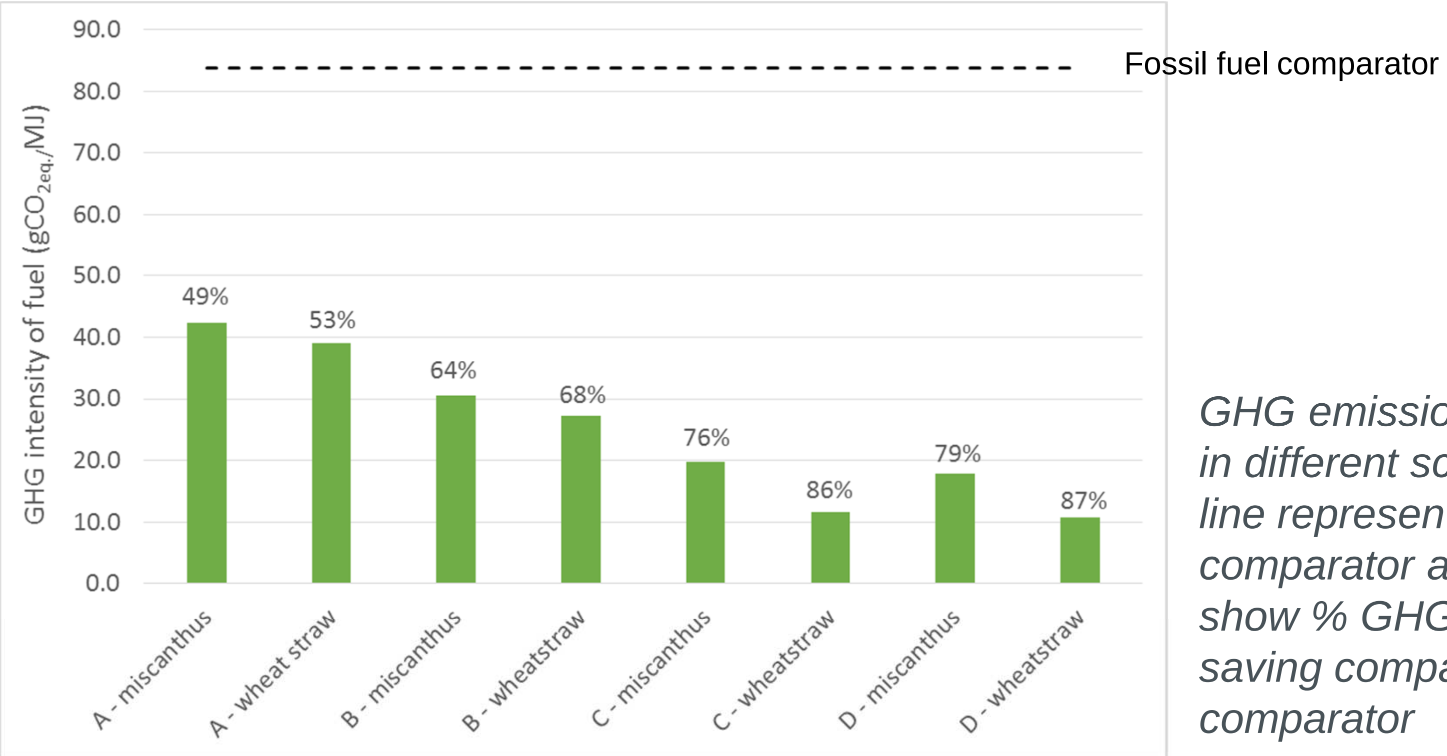
LCA modelling shows that Miscanthus and wheat straw biobutanol could have significant GHG savings



GHG emissions of biobutanol in different scenarios. Dashed line represents fossil fuel comparator and data labels show % GHG emissions saving compared to fossil fuel comparator

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Many of the key conclusions from this case study are applicable more widely

Key risk areas:

- Consider the origin and supply chain for feedstock provision
- Integration of processes within a plant
- Waste heat and renewable heat and power
- Make most efficient use of biomass
- Improvements to GHG performance can also lower production cost

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A continual focus on sustainability is beneficial when bringing a process to commercial scale

Image credit: British sugar

Wissington bioethanol plant, operating at commercial scale.

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Thank you for listening

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Image references

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