Bioenergy research at
The University of Manchester

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Bioenergy @ Manchester

- 60 researchers carrying out bioenergy-related research
- Interdisciplinary work across 10 schools and 6 research groups
- Capabilities along the entire bioenergy chain
Capabilities in production, storage and processing

- Agricultural emissions – fluxes, particulates, biogenetics, gases, ammonia, methane
- Land use change
- Feedstock – biomass crops – microalgae
- LCA on biomass production
- Sensor based methods of optimising crop yields/reducing fertiliser use
- Aesthetics – psychological practices
- Shipping – logistics
- Gaseous and liquid hydrocarbon production, especially propane
Capabilities in conversion

- Metabolic engineering (cell level – enzyme pathways) for bioethanol and biobutanol, biodiesel, biopropane production
- Emissions: particulates, black carbon, organic – monitoring, formation, modelling, climate impacts
- Particulates & their impacts
- Biodiesel – whole cell production
- Plants to feedstock
- Cellulose and lignin degradation
- Bioenergy with carbon dioxide removal
- Combustion of fluids
- Biocatalysis and synthetic biology
- Membranes – biofuel application – separation processes e.g. Polymers
Cross-cutting capabilities

- Supply chains: production/end use; logistics; optimisation
- Food – fuel conflict
- Chemical modelling – atmospheric reactions
- Protein research – Starch, enzyme studies
- Chamber studies, reactor studies
- Techno economics, energy markets, policy analysis
- Impact of biogas on grid/heat networks, integration with other renewables
- Energy scenarios
- Energy system integration
- Economics of ecosystem services and land use
- Greenhouse gas balances, GHG accounting, life cycle assessment
- Social impacts, processes and perceptions
- Sustainability
- Innovation management - innovation systems – co-evolution, socio-institutional
Biomass availability and mobilisation

- Biomass resource availability analysis
- Bioenergy potential analysis
- Biomass supply vs. demands analysis
- Biomass global trade analysis (potentials & dynamics)
- Wider benefits and impacts of indigenous and international bioenergy value chains
Environmental impact assessment

- Assessment of BE pathways
- Life cycle assessment
- Wider environmental impacts

Fig. 3 – Relative greenhouse gas reductions compared to the reference case.
Emission uncertainties

- Real emission profiles of BE pathways
- Uncertainties along supply chains and BE systems
- Natural variation, technological, socio-economic and policy aspects
Temporal aspects

- Forest BE systems timing of carbon sequestration and release

IEA Bioenergy 2013
Techno-economic assessment and market modelling
Process modelling

- Process optimisation to achieve operational excellence for flexible, efficient and environmentally sustainable systems (Bio-CCS)
Feedstock and emission analysis

- Sustainable transport fuels
  - Performance and emissions using biofuels in diesel engines
- Biomass Combustion
  - Feedstock effects on air quality using domestic biomass stoves
- Energy from waste biomass
  - Evaluation of wastes as potential feedstocks
Socio-economic assessment

• Wider social, economic, market and societal impacts of BE systems
• Barriers and opportunity analysis
Stakeholder perception

- Improve understanding of the synergies between land use, livelihoods, technology, and bioenergy
- Investigate perception of the different stakeholders
Policy analysis

- Policy makers face challenges concerning uncertainties about the sustainability of bioenergy pathways, technology and resource costs, or future energy market framework conditions.

- Impact of policy on BE development and BE systems

Purkus, A., et al., 2015
Evaluation of IAM: From scenarios to reality

4 critical issues:

1. BECCS deployment in IAMs is driven by the need to stay within cumulative carbon budgets consistent with a 2°C target.

2. Scale of BECCS implied in most scenarios.

3. Uncertainty as to the magnitude of carbon dioxide removal achieved by BECCS.

Bioenergy in developing countries

- Rice straw to energy S.E. Asia
- Sugarcane residues in South Africa
Mapping and scoping exercises

- Mapping of SGH activities
- Scoping of UK aviation biofuel research

<table>
<thead>
<tr>
<th>Route</th>
<th>Feedstock</th>
<th>Emission gCO₂e/MJ fuel</th>
<th>Savings CO₂e vs jet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional jet fuel</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BTL</td>
<td>Energy crops</td>
<td>7.3</td>
<td>92%</td>
</tr>
<tr>
<td></td>
<td>Forestry residues</td>
<td>4.8</td>
<td>95%</td>
</tr>
<tr>
<td>HEFA</td>
<td>Conventional oil crops</td>
<td>40-70</td>
<td>20-54%</td>
</tr>
<tr>
<td></td>
<td>Jatropha</td>
<td>30</td>
<td>66%</td>
</tr>
<tr>
<td></td>
<td>Camelina</td>
<td>13.5</td>
<td>85%</td>
</tr>
<tr>
<td></td>
<td>Tallow</td>
<td>10</td>
<td>89%</td>
</tr>
<tr>
<td></td>
<td>Algae</td>
<td>-21 (best case) 1.5(realistic case)</td>
<td>124% (best case) 98%(realistic case)</td>
</tr>
<tr>
<td>Syn. hydrocarbon</td>
<td></td>
<td></td>
<td>70-90</td>
</tr>
</tbody>
</table>
Biomass gasification with CCS using crop residues as solid feedstock

To identify, assess and understand the techno-economic barriers and potential environmental impacts, of a flexible and efficient biomass gasification process with a carbon capture and storage (CCS) system, using agriculture residues as feedstock.

- Impact of scale of operation
- Biomass resource availability
- Environment al impacts (GHG emissions)
- Product gas composition–process efficiency
- Techno-economic barriers
- Energy policy recommendations

- Literature review
- Biomass resource modelling
- Aspen process modelling
- Life Cycle Assessment
- Techno-economic assessment
Can social innovation foster sustainable bioenergy solutions? An analysis of agricultural bioenergy systems in developing countries

The path to sustainable energy

- Engage farmers in technology development
  - Value-driven and voluntary
- Social business as a platform for engagement
  - Financial or moral/ethical incentives
  - Community participation
- Support from policy and governance systems

Rethinking bioenergy development

- How can we make it value- and user-driven?
- Can we go beyond knowing what is happening to understanding why and how farmers will engage?
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