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Supergen Bioenergy

TG2 - Pretreatment and conversion

Dr. Katie Chong

12th ECCRIA Conference

5th September 2018

Structure

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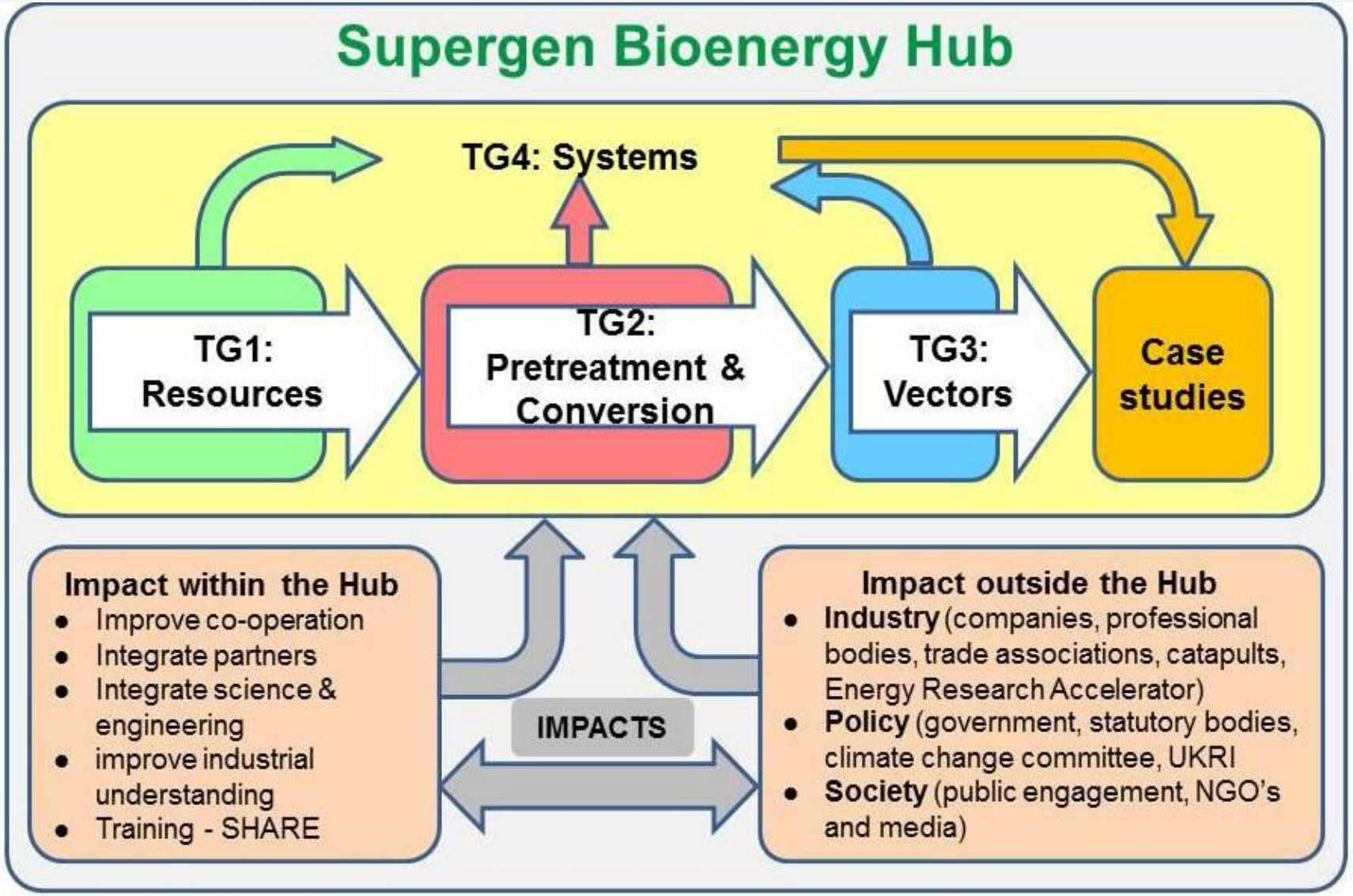

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So many routes!

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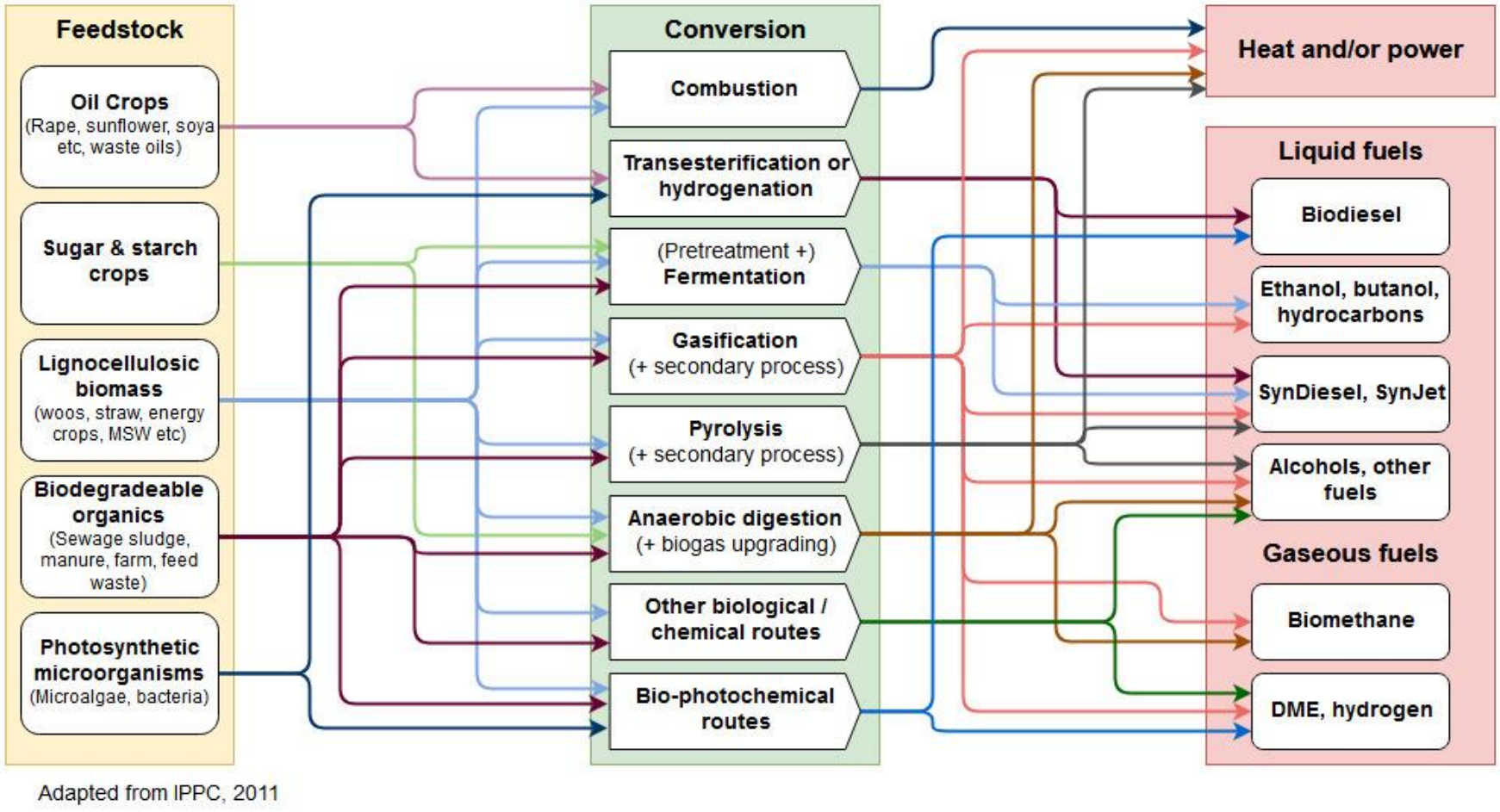

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Pretreatment and conversion

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- Experimental work in three complementary world leading labs on:
  - **Biological**
  - **Thermochemical, and**
  - **Catalytic approaches**
- Routes to liquid and gaseous vectors
- Will provide underpinning data on:
  - **Process conditions**
  - **Material and feedstock issues**
  - **Plant design**
- Integration of bioenergy with circular economy considering economic impact, material recovery and products

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Topic group leaders

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Fermentation
Jason Hallett
Imperial College

Pyrolysis
Tony Bridgwater
Aston University

Photocatalysis
Chris Hardacre
University of Manchester

Topic representative – Katie Chong

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WP2.1 – Review feedstock quality and characteristics

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- Jointly with WP1
- Review of existing research and a workshop
- During first 6-12 months of project
- Exploring how **feedstock quality/characteristics influences the choice of pretreatment and conversion technology**
- The hub's focus is lignocellulosic and waste feedstocks
- Outcome will be a series of maps describing opportunities and constraints

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WP2.2 – Fermentation

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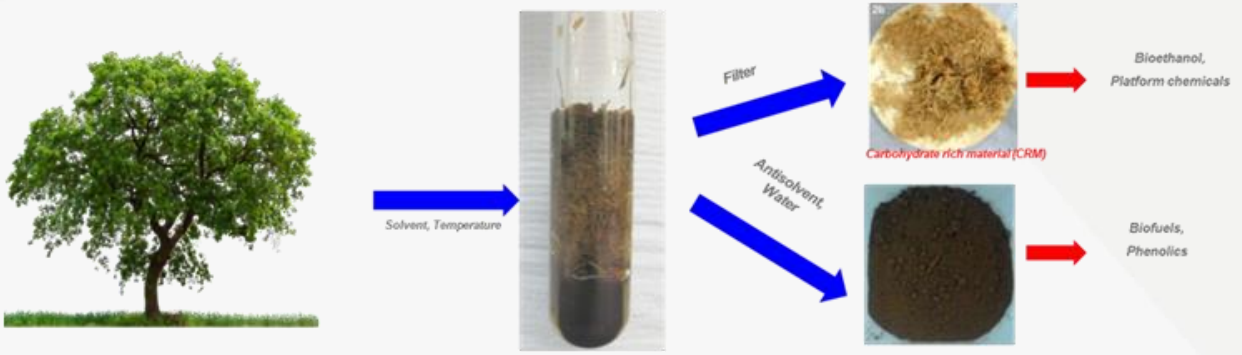
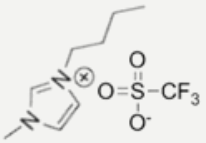
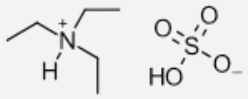
<u>Ionic liquid pretreatment</u> (**ionoSolv**)

- Heavily contaminated feedstock
- Low-cost solvents
- Integrated separations
- Outstanding economics
- Materials from all streams
  - Biofuels
  - Bioplastics
  - Renewable Materials





£2,000,000/ton



£700/ton

Biorefining with the world's cheapest ionic liquids

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ionoSolv

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‘protic’ ionic liquids

+

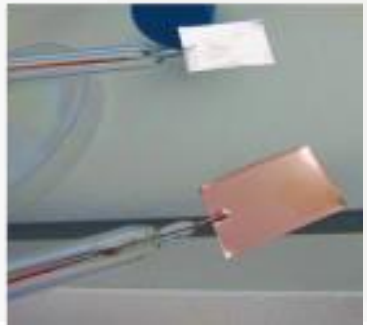
Woody biomass

Sugar rich pulp

+

Carbon rich lignin residue

+



Recovered metal contaminants

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WP2.3 – Pyrolysis

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- Biomass is heated in the absence of air or oxygen to decompose or devolatilise the biomass into:
  - **Solid char**
  - **Liquid as bio-oil**
  - **Gas**

Four topics to be investigated

- Ash effect in pyrolysis
- High lignin residue utilisation
- Bio-processing residues utilisation
- Levoglucosan production strategies and costs

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Effects of ash and contaminants

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- Catalysts as ash and char crack organic products from pyrolysis into water and carbon dioxide leading to:
  - **A lower organic content vapour and liquid with less energy**
  - **And potentially a phase separated liquid product**
- Potassium is the most active alkali metal in cracking
- Char is also catalytic from the alkali metal content
- Ash contents of typically more than 3 wt.% ash can cause phase separation in the liquid. Phase separation is non-reversible and can only be remedied by addition of high proportions of ethanol or similar solvents.

- Low ash feed – beech
- High ash feed - miscanthus

Residue utilisation

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- Key issue with chemical processing of biomass is the production of residues
- These are often of low value and difficult to process

- Investigation into **processing residues by fast pyrolysis**
- Generating:
  - Liquid fuels
  - Phenolic rich products

- The research will have impact on **strategies for integrated and optimised design of biorefineries**

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WP2.4 – Photocatalysis

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First generation bio-fuels
- Bio-ethanol → Fermentation of biomass
- Glycerol → By-product of biodiesel process

Second generation bio-fuels ⇒ Lignocellulosic biomass

Cellulose (40-50 %) Hemicellulose (25-35 %) Lignin (15-20 %)

Water gasification
Aqueous phase reforming
Dark fermentation
Enzymatic photoproduction
Photocatalytic reforming

Optimised process including the use of thermal activation in batch and continuous flow
In-situ and ex-situ spectroscopic techniques to understand the process

Selective depolymerisation

Fuels

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Photocatalysis

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- The photocatalytic reforming of:
  - **Ethanol**
  - **Glycerol**
  - **Sucrose**
  - **Cellulose**
  - **Lignin**
  - **Grass**
  - **Bio-oil (provided by Aston)**

  Under anaerobic conditions
- Generating syn-gas that can be converted into liquid bio-fuels

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Summary of tasks
Conversion and pretreatment

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- **Task 2.1 – Review feedstock quality and characteristics**
- **Task 2.2 – Fermentation**
  - **Ionosolv**
- **Task 2.3 – Pyrolysis**
  - **Impact of ash content**
  - **Pyrolysis of biorefinery residues**
- **Task 2.4 – Photocatalysis**
  - **Transformation into syngas via photocatalysis**

Plus additional work via Supergen Flexible Funding

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Thank you!

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