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BIO-ENERGY RESEARCH CLUSTER

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WHAT IS BIO-ENERGY?

- Bio-energy is obtained by converting biomass (plants or their metabolic by-products) into biofuels (biodiesel & biogas) , energy vectors (H_2) & other useful products without 'upsetting' the carbon cycle in nature.

- Feedstock can be
  - Specially grown crops (perennial).
  - Lignin & other low grade carbonaceous materials.
  - Waste biomass [food, kitchen, forestry, dead plants].

- Bio-energy research covers energy sources, production & recovery, waste elimination; taking the environment, economic and political aspects into account.

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GLOBAL CONSIDERATIONS

The main global factors that drive the need for *bio-energy* are:

- Climate Change.
- Energy Security and Supply: decline in fossil fuel , geographical location of fossil fuels, international trading, oil prices...
- Flexibility of the bio-economy: not intermittent , several markets: energy and food, electricity, heat, fuels, chemicals...
- Development (including social and economic) .
- Environmental Sustainability : global trade issues, ecosystem services, protection of water sources, atmospheric pollution control, biodiversity.

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BIO-ENERGY IN THE UK

- The UK also has a large biomass resource (~ 30 M tonnes yr^{-1}) that is largely under-utilised. There are only approximately 10,000 ha of energy crops in a 17 M ha landscape.
- Further, considerable energy is lost as ‘waste’ in wood and other ligno-cellulosic resources and in food wastes.
- Indeed, an increased contribution from the bio-energy sector is expected considering the UK policy context which is defined by some important targets:

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FACTS, FIGURES & TARGETS

- UK Renewable Energy Strategy (2009): ~30% of the UK's overall 15% renewable energy target could come from biomass heat & electricity in 2020.
- European Renewable Energy Directive (RED): UK has indicated sourcing 10% of transport energy from renewable resources by 2020.
- CO_2 emissions reduction and Stern Review: 60% reduction from 1990 emission by 2050.
- There is sufficient land to meet UK Government biomass strategy objective for electricity without significantly impacting on food production.

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RESEARCH GAPS

- Microbial conversion processes (by novel routes).
- Microbial conversion for energy vectors (carriers); e.g. biomass to give hydrogen and methane.
- Advanced Conversion technologies, e.g.
  - Thermo – chemical.
  - Advanced gasification.
  - Chemical engineering applications.
- Carbon/energy balances.

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RESEARCH GAPS

- Modelling: Whole systems modelling, lifecycle; process design, climate change impacts.
- Scaling of Bio-generation.
- Integration of different technologies.
- Environmental sustainability : land use , lifecycle, biodiversity, global context, ecosystem service.
- Economic and socio-economics.

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BIO-ENERGY @ BIRMINGHAM

We aim for a 'technology mix' that squeezes all energy vectors, useful intermediates and valuable residues out of the starting feedstock, while sticking to carbon-neutral policy and keeping our environment safe & clean!

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WHAT CAN BIRMINGHAM OFFER?

- Unique expertise in advanced hydrothermal technologies that can turn waste biomass into hydrogen and biofuel, with high efficiency & very fast rates.

- With a variety of expertise within the cluster, we have the capability to cover the different aspects required to pursue a "technology mix" approach, for maximum outcome & minimum waste.

- Our cluster has the combined capability to 'carve the path' from laboratory to commercial use; covering science, engineering and socio-economy & environment.

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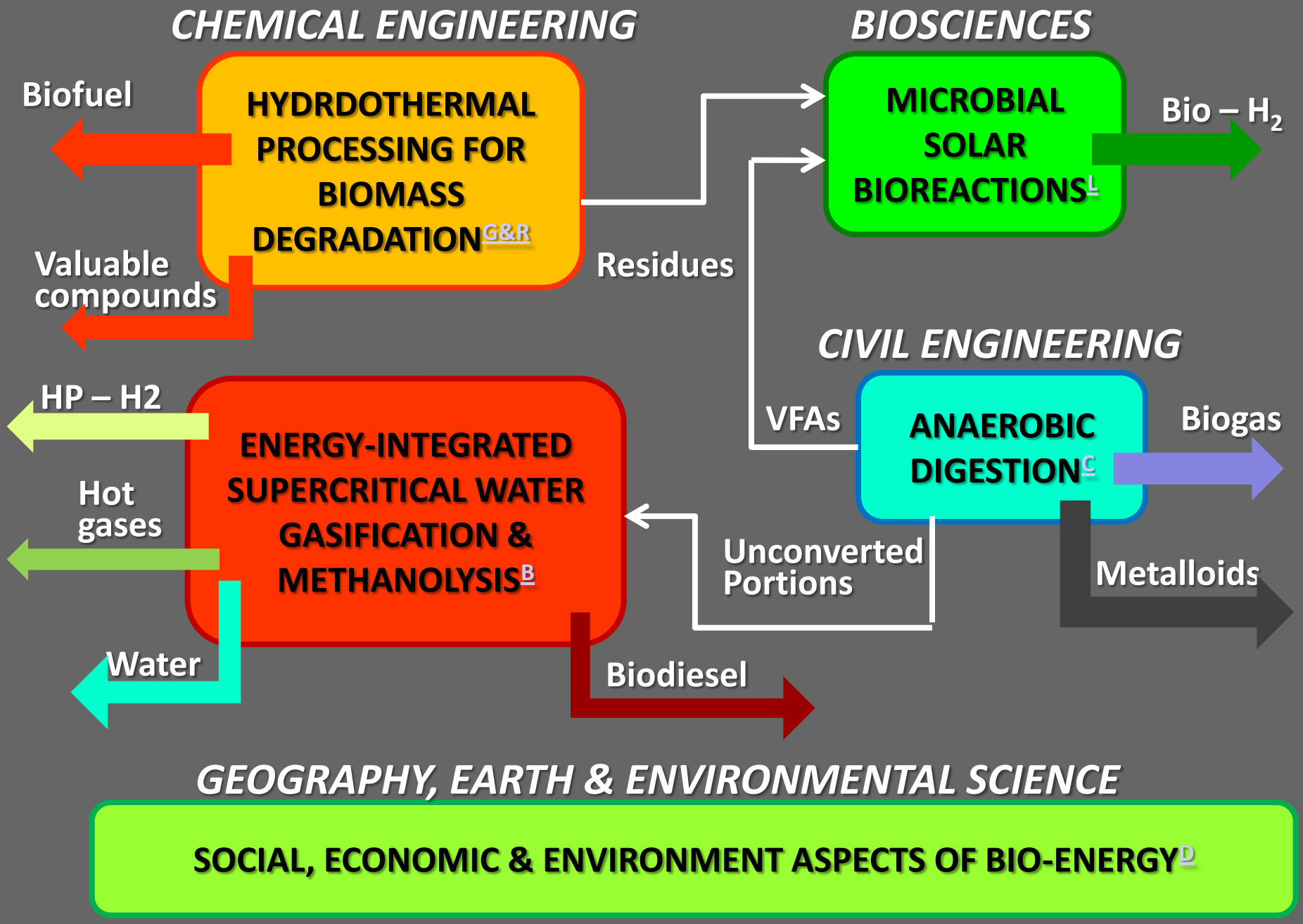
CHEMICAL ENGINEERING
BIOSCIENCES
Biofuel
HYDRDOTHERMAL PROCESSING FOR BIOMASS DEGRADATION G&R
MICROBIAL SOLAR BIOREACTIONS L
Bio – H2
Valuable compounds
Residues
CIVIL ENGINEERING
HP – H2
ENERGY-INTEGRATED SUPERCRITICAL WATER GASIFICATION & METHANOLYSIS B
VFAs
ANAEROBIC DIGESTION C
Biogas
Hot gases
Unconverted Portions
Metalloids
Water
Biodiesel
GEOGRAPHY, EARTH & ENVIRONMENTAL SCIENCE
SOCIAL, ECONOMIC & ENVIRONMENT ASPECTS OF BIO-ENERGY D

Capabilities in Anaerobic Digestion Research

- **Civil Engineering:** anaerobic digestion modelling, computational fluid dynamics modelling, microbiology & biochemistry of methane production; metal speciation in AD; resource security.

- **Biosciences:** microbial genomics; microbiology and biochemistry of combining AD with hydrogen production.

- **Geography, Earth and Environmental Sciences:** biogeochemistry of AD; social and economic aspects of bioenergy from AD.

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Capabilities in Biomaterials & Bio-Hydrogen Research

- **Biosciences:** Fermentation science specialising in bio-hydrogen production from wastes, biogenic fuel cells made with precious metals recovered from scrap and spent catalytic converters.

- **Biochemical Engineering:** Development of pilot plant for studying scale-up of bio-hydrogen production, includes fermentation reactors and solar-simulation photo-bioreactor for bio-hydrogen production from waste.

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Capabilities in Socio-Economic & Environmental Aspects of Bio-Energy

Social interactions shape technologies and technologies shape social interactions.

Our work at Birmingham covers the entire lifecycle of bio-energy:

- Public perceptions of agriculture at home and abroad,
- Local protests against proposed biomass energy plants,
- The ways in which we run our energy technologies in the home and the comfort we derive from them,
- How we dispose of biomass waste, then
- Back again to how 'green' different biomass feedstocks are.

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SCW for Waste Minimisation & Energy Production Research

SCWG is the *only* process to date, known to convert the entire lignocelluloses into high purity hydrogen *without the concurrent generation of chars and tars*, which are inevitable in other combustion and gasification processes.

We have expertise in:

- **Fundamentals & thermodynamics of SCF.**
- **Design & construction of SCW rigs.**
- **Energy integrated systems (theoretical analysis & experimental constructions.**
- **'Coupling of processes' for more efficient & economically feasible outcome.**

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Please visit our BIO-ENERGY Posters for more details, technical details and discussions!

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