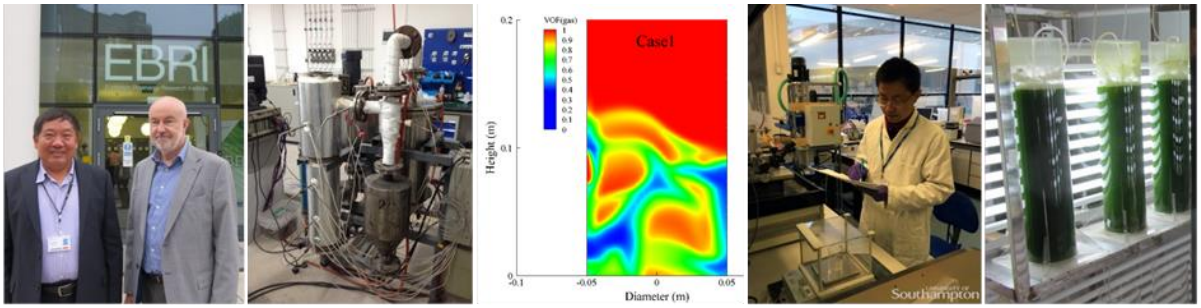
The EU Marie Curie ECOFUEL project

was a five-year exchange programme funded by FP7-PEOPLE-2009-IRSES Grant 246772 which ran from 2010-2015. The main objectives of the project were:
To carry out a programme of exchanges bringing together multi-disciplinary research teams with a common interest in the field of bioenergy production and novel biofuel technologies.
To create a platform for research training, cross-fertilisation and knowledge transfer.
To establish long-term networks for collaborative research, exchange and scientific dissemination.
To contribute to the advancement of scientific knowledge and to stimulate the commercialisation of second generation biofuels from biomass through pyrolysis and biochemical conversions.

The **ECOFUEL** project partners included the University of Southampton UK (Soton - project coordinator Prof Charles Banks), Aston University UK (team leader Prof Anthony Bridgwater), Aalto University Finland (team leader Prof Juha Lehtonen), Guangzhou Institute of Energy Conversion Chinese Academy of Science (GIEC – team leader Prof Pengmei Lv), and Shanghai Jiao Tong University China (SJTU – team leaders Prof Ronghou Liu and Prof Zhenjia Zhang).

The work programme was based on six work packages focusing on:
- WP1 Development of computational models for biomass thermal conversion processes
- WP2 Kinetics of biomass thermal and biochemical conversions
- WP3 Characterisation and utilisation of biofuels
- WP4 Development of scale-up processes
- WP5 Biofuel upgrading technologies
- WP6 Knowledge transfer

Exchanges
The **ECOFUEL** project supported 265 months of exchanges between the EU and Chinese partner organisations, and a further 14 shorter visits funded by the participating universities. A total of 61 staff took part in these, including 36 experienced and 25 early-stage researchers, of whom 39 were male and 22 female. Out of a total of 90 separate visits made, 40 were outbound from China and 50 from the EU, reflecting the location of the coordinating team. The longest stays were just over 12 months, the maximum allowed under the programme: the shortest visits, of 4-5 days by senior staff, were not always eligible for funding but nevertheless made a great contribution to the work programme and to the formation of lasting links. Many participants were formally hosted by one partner institution, but managed to visit another in the same country (e.g. Soton/Aston or GIEC/SJTU) during their stay, thus further extending the benefits of these exchanges and helping to build a lasting network. Planned activities extend beyond the project with further exchanges, workshops and collaborations.



Left to right: Prof Ronghou Liu and Prof Anthony Bridgwater in Aston. Bubbling fluidised bed pyrolyser and modelling results. Dr Zhixiang Zhang in Soton labs. GIEC algal column reactors.

Main scientific achievements

The **ECOFUEL** project achieved significant advances in the following areas:

- Development and experimental validation of a novel advanced discrete element method which provides detailed insight into multiscale and multi-physics phenomena in biomass fluidised beds
- Development of a new and powerful mesoscopic simulation approach based on lattice Boltzmann methods capable of predicting flow behaviour with realistic physical parameters for the first time
- Characterisation of the properties of pyrolysis feedstocks and products (liquids, biochar and gas)
- Novel catalyst systems for hydrodeoxygenation (HDO) of bio-oils and model compounds, including Rh/ZrO_2 and Co-based metal catalysts and others.
- Coated TiO_2-supported micro-reactor catalysts for oxidation of butanol to value added chemicals
- New technology for fuel upgrading and novel low temperature catalytic reforming of biogas.
- Creation of ZnO nanoflakes as value-added products using pyrolysis as a carbon source and nano-pore creator, with photoelectrochemical H_2 production from effluents.
- Advanced membrane materials for resource recovery, emission avoidance and photocatalysis
- Selective catalytic reduction system for efficient NOx reduction in engine exhausts
- Linking of specific biofuel properties to effects on engine operation.
- Operational parameters for utilisation of agro-wastes in biochemical conversions to methane
- Protocols to determine the anaerobic toxicity of aqueous products of intermediate pyrolysis
- Acclimatisation of readily-available large-scale sources of inoculum to marine salt concentrations, allowing the use of unwashed marine algal biomass in anaerobic digestion
- Protocols for quantifying the energy potential of microalgal biomass via anaerobic digestion
- Establishment of upper tolerance levels of mesophilic anaerobic digestion to ammonia toxicity
- Enhanced understanding of microbial community transitions during acclimatisation periods

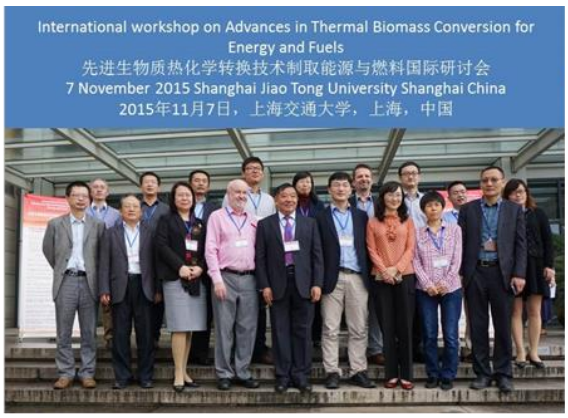
The project produced substantial outputs, including 28 published journal papers and 12 completed PhD theses, with a further 22 peer-reviewed papers and 16 theses in preparation.

Impact

The creation of cost-effective and environmentally sustainable technologies for production of second generation biofuels is of global importance, due to their potential to replace fossil fuels and reduce CO2 emissions. These technologies can also provide sustainable ways of managing agricultural, industrial and municipal wastes. Thermal and biochemical conversions have the further advantage that they can produce liquid fuels with high energy densities, making them suitable for future transport needs. They also allow the use of previously unexploited biomass sources, such as marine and freshwater algae, without competition for agricultural land and resources.

Events

The project included a number of highly successful workshops, in-house seminars and group meetings. The most high profile events were the joint international workshop in Nov 2014, and the final thermal and joint biochemical international workshops in Nov 2015, hosted by SJTU. Further details of these and of project publications are available on the project website.



ECOFUEL final thermal and joint biochemical workshops at SJTU in November 2015