

Institution: Aston University		
Unit of Assessment: UoA12 General Engineering		
Title of case study: The EBRI Business Investment in Research project – business development in bioenergy and sustainable supply chains		
Period when the underpinning research was undertaken: 2000-2020		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Professor Tony Bridgwater	Reader	1987 –1996
	Professor	1996 – to date
Professor Andreas Hornung	Professor	2007 – 2014
Dr John Brammer	Lecturer	2002 – 2013
	Senior lecturer	2013 – 2016
	Lecturer	2005 – 2008
Dr Phillip Davies	Senior lecturer	2008 – 2018
	Lecturer	2005 – to date
Dr Gareth Griffiths	Senior research fellow	2008 – 2016
Dr Daniel Nowakowski	Lecturer	2016 – to date
	Research fellow	2014 – 2019
Dr Yang Yang	Lecturer	2019 – to date
Period when the claimed impact occurred: May 2016 – June 2019		
Is this case study continued from a case study submitted in 2014? N		
1. Summary of the impact <p>Aston research into bioenergy technologies and value chains – and the project it informed – supported the economic development of 103 West Midlands SMEs, of which 11 were new enterprises. The support enabled the SMEs to:</p> <ul style="list-style-type: none"> • Increase RD&I investment by an estimated £410,000, create ~31 new jobs and benefit from £3.6 million Gross Value Added (GVA). • Identify business and value opportunities. • Develop and trial technologies or processes to help them diversify. • Identify potential new products or services. • Improve their innovation ability. <p>The research also stimulated the low-carbon economy, contributing to UK national and regional policy objectives relating to the environment, energy security and economic development.</p>		

2. Underpinning research

The Energy and Bioproducts Research Institute (EBRI) at Aston University carries out world-leading research into new and innovative ways of converting biomass into sources of sustainable energy, using thermochemical, biological and catalytic processes. The impacts on SMEs and the low-carbon economy were driven by a broad range of EBRI research, including:

- **Technology development [R1]:** The researchers designed and patented an intermediate pyrolysis reactor (Pyroformer™), which balances efficiency and performance to produce power. Biomass feedstocks, including mixed wastes, were processed to produce pyrolysis oil that, when blended with biodiesel, drives liquid-fuelled, combined heat and power engines. The char produced is used for land improvement, resulting in a carbon negative process.
- **Anaerobic digestion [R2]:** The research demonstrated that wastes can be utilised more effectively by linking Anaerobic Digestion (AD) and other energy generation processes.
- **Algae [R3]:** The researchers developed novel methods for the efficient pyrolytic conversion of algae residues and products, reusing biomass for energy generation at the site of production. The researchers combined heat and power applications with microalgae bioreactors which have been used to capture flue gas CO₂.
- **Biorefineries [R4]:** The researchers developed integrated biomass conversion processes for the production of biofuels, bioenergy, biochemicals and biomaterials by combining thermal and biochemical processes. The research focused on utilising agricultural and agro-industrial residues as feedstocks and developing efficient, sustainable and viable processes and catalytic pathways for industrially important chemical transformations.
- **Energy systems [R5]:** The researchers investigated the integration of biofuels and bioenergy into the energy system with further integration of other energy vectors, such as electric transport. The research shows how combinations of technology and service offerings improve the sustainability and resilience of the energy system by reducing the need for stand-by generation from fossil fuels.
- **Process modelling [R6]:** The researchers applied mathematical models and CFD codes to study fluidised bed reactors' performance, predict the product quality during biomass gasification and pyrolysis, and build 3D predictive models of biomass gasification in fluidised bed reactors.
- **Feedstock evaluation [R3,R4,R5]:** A key part of the research is the evaluation of biomass sources for the product required and the consequences of using agricultural land for energy crop production. A wide range of high volume agricultural, domestic and industrial wastes and residues were evaluated – including from paper mills, breweries and sewers – in collaboration with companies in related sectors. Other research projects have investigated utilising residues – including municipal solid waste, de-inked sludge, paper industry waste, pig manure, compost, dairy fibre, meat and bonemeal, and spent brewer's grain – for AD, gasification, pyrolysis and biorefinery applications.
- **Techno-economic assessment [R5]:** The research demonstrated the locations and scale at which bioenergy generation has the greatest potential by minimising costs and maximising performance – balancing, for example, transport costs of the feedstocks with those of the consumer products.

Detailed analyses are particularly relevant for stakeholders in bioenergy supply chains, and the extensive research expertise enabled the Aston project to support the development of a regional bioenergy supply chain and the promotion of innovative, new bioenergy technologies. The project delivered support to companies in the Local Enterprise Partnerships (LEP) of Greater Birmingham and Solihull, The Marches, Black Country, Coventry and Warwickshire, and Stoke and Staffordshire.

3. References to the research

- R1.** A. Hornung and A. Apfelbacher, "Thermal treatment of biomass," 2009. Patent number GB2460156. IPC C10B53/02.
- R2.** Y. Yang, S. Heaven, N. Venetsaneas, C. J. Banks, and A. V. Bridgwater, "Slow pyrolysis of organic fraction of municipal solid waste (OFMSW): Characterisation of products and screening of the aqueous liquid product for anaerobic digestion," *Applied Energy*, vol. 213, pp. 158-168, 2018.
- R3.** K. Kebelmann, A. Hornung, U. Karsten, and G. Griffiths, "Intermediate pyrolysis and product identification by TGA and Py-GC/MS of green microalgae and their extracted protein and lipid components," *Biomass and Bioenergy*, vol. 49, pp. 38-48, 2013/02/01/ 2013.
- R4.** E. A. Christoforou, P. A. Fokaides, S. W. Banks, D. Nowakowski, A. V. Bridgwater, S. Stefanidis, et al., "Comparative Study on Catalytic and Non-Catalytic Pyrolysis of Olive Mill Solid Wastes," *Waste and Biomass Valorization*, vol. 9, pp. 301-313, 2018/02/01 2018.
- R5.** Y. Yang, J. Wang, K. Chong, and A. V. Bridgwater, "A techno-economic analysis of energy recovery from organic fraction of municipal solid waste (MSW) by an integrated intermediate pyrolysis and combined heat and power (CHP) plant," *Energy Conversion and Management*, vol. 174, pp. 406-416, 10/15 2018.
- R6.** X. Yu, P. H. Blanco, Y. Makkawi, and A. V. Bridgwater, "CFD and experimental studies on a circulating fluidised bed reactor for biomass gasification," *Chemical Engineering and Processing - Process Intensification*, vol. 130, pp. 284-295, 2018/08/01/ 2018.

4. Details of the impact

The EBRI Business Investment in Research project supported over 100 West Midlands SMEs through the exchange of knowledge and commercial research. This enabled the SMEs to identify business and value opportunities, trial technologies or processes to help them diversify, and explore potential new products or services. The project also helped stimulate the UK low-carbon economy, contributing to national and regional policy objectives.

A total of 103 SMEs received non-financial support, including 11 new enterprises. Of these, 39 collaborated with EBRI on R&D, 12 received support to develop new-to-market products or services, and 23 to develop new-to-firm products or services [S1].

Focus Consultants was appointed by Aston to undertake an independent assessment of the project's performance and collate rigorous evidence of its effectiveness. The study was based on qualitative data collected through a survey and face-to-face interviews with some of the beneficiaries.

Impact on commerce and the economy

The project supported SMEs in a wide range of industry sectors, including manufacturing, agriculture, bioenergy, automotive/transport, construction, consultancy, engineering, land/property management, waste management, environmental services, utilities, food and drink, life sciences, smart specialisation and marketing. As a result of Aston's support [S1]:

- 37.5% of the surveyed beneficiaries diversified into new areas of business.
- 31.25% developed new services.
- 18.75% developed new products or brought new products to market.

The SMEs also reported increased efficiency and competitiveness, the deployment of new technologies, and a reduction in waste/landfill. Other key findings of the high-level economic study of the Aston project's impacts are estimated to be [S1]:

- 25% of the surveyed SMEs increased research, development and innovation (RD&I) spend, leading to a total increase of approximately £410,000.

- 44% stated that they will have increased their investment in RD&I within two years, leading to a projected £1.47 million increase over that period.
- 31 new jobs directly or indirectly created, with a projected 169 jobs created after two years.
- £3.6 million Gross Value Added, with a projected £19.9 million GVA after two years.

The support provided by the project had different levels of impact for each beneficiary. For example, working with Aston allowed renewable energy technology developer FuturEnergy Limited to fill its knowledge gap in the thermochemical conversion of materials. Using Aston's recommendations, its pyrolysis unit moved from a pre-production to a testing and full production stage, requiring 25 to 30 new staff [S1,S2]. This also led to a long-term support contract with one of FuturEnergy's clients, Waste to Energy Technologies Limited, resulting in the development of high efficiency equipment with the demonstrated ability to produce high value products from end-of-life tyre repurposing [S1,S2]. The company has also leased one of the reactors developed by Aston to demonstrate the technology's benefits to clients. A new company, Combind Industries Limited, was created to commercialise the technology. Aston is represented on the board of directors and provides technical support for its development [S1]. The new company has now been contracted to do the design and development of several plants, under a contract for a value above £200k [S2].

The project also enhanced the SMEs' understanding of waste management and renewable energy generation. For example, following the support and knowledge transfer of the Aston project, Modus Waste and Recycling, a waste management company, has expanded its business horizons after becoming more ethically aware [S1].

Impact on public policy, law and services

As a result of the business and regional engagement generated by the project, Aston staff was involved in activities linked to the development of public policy. Aston has participated in the Birmingham Energy Capital board, part of the West Midlands Combined Authority (WMCA). This has influenced:

- The inclusion of Energy Innovation Zones in regional and national policy [S3,S5]. The Zones were adopted as a national pilot by BEIS with trial deployments in Cornwall and the West Midlands. They provide modified planning and regulatory environments for innovative energy propositions and innovation funding to accelerate the development of energy-related greenhouse gas reduction, pollution reduction and low environmental impact technologies.
- Development of the Regional Energy Strategy [S4,S5]. The Strategy consolidated work carried out for the WMCA and sets out how the region plans to invest in local energy projects that will improve the local economy.

Aston is also part of the Technical and Communications and Engagement advisory groups of the Road to Zero (R20) Taskforce. Led by Birmingham City Council, the R20 project aims to develop an action plan which sets out how the city intends to respond to the climate emergency and deliver its net zero carbon by 2030 ambition. The Taskforce is a cross-party and cross-sector group of council members, officers, partners, environmental campaigners and academia [S6].

Aston researchers linked to the Supergen Bioenergy Hub participated in the preparation of the Renewable Energy Association's industry-led Bioenergy Strategy Report, which identifies the barriers to the rapid deployment of bioenergy technologies. It also proposes policy and regulatory frameworks to allow the sector to grow, supporting UK policy objectives relating to the environment, energy security and economic development [S7].

5. Sources to corroborate the impact

S1. Focus Consultants. Summative Assessment and Evaluation of EBRI's "Business Investment in Research" Project. Final Evaluation Report, June 2019.

- S2.** Testimonial from Business Development Director from FuturEnergy Limited.
- S3.** Energy Innovation Zones Pilot in the West Midlands - <https://www.wmca.org.uk/news/cash-boost-to-power-up-energy-innovation-zones/>
- S4.** Regional Energy Strategy for the West Midlands adopted – Energy Capital
<https://www.energycapital.org.uk/a-regional-energy-strategy-for-the-west-midlands/>
- S5.** A Regional Energy Strategy for the West Midlands. November 2018. Energy Capital, WMCA, Black Country LEP, Coventry & Warwickshire LEP, Greater Birmingham & Solihull LEP.
- S6.** Terms of Reference – R20 Technical Advisory Group
- S7.** Renewable Energy Association (REA) – Phase 1: Bioenergy in the UK – The state of play.