

<p><b>Institution: University of South Wales</b></p> <hr/> <p><b>Unit of Assessment: B15</b></p> <hr/> <p><b>a. Context</b></p> <p>Since 2008 the University has increased its commitment to the energy and environment research agenda through the development and construction of new research and demonstration infrastructure, state-of-the-art laboratories, research facilities and new staff (REF5). The University's research activities have always been conducted in collaboration with non-academic user groups and beneficiaries including; small to medium enterprises (SME) to multi-national industrial partners; regional, national and international government bodies and policy makers; trade associations and international. The research activity areas cover:</p> <ul style="list-style-type: none"> <li>• <b>Bioprocess Engineering</b> (see case study 1), resource recovery, waste and wastewater treatment (<b>Dinsdale, Esteves, Guwy, Kedia, Patterson &amp; Premier</b>) involving national governments and industry such as; Imtech, AMEC Global Renewables, Thames Water, Welsh Water, Yorkshire Water, TAMAR Energy, NCH, Insource Energy, and Projen Bioenergy, the Anaerobic digestion and Biogas Association (ADBA) and Renewable Energy Association (REA) Biogas Group, as well as representation on the International Water Association AD Specialist Group (see REF5). Biopolymers (PHA) production from wastes and low value biomass involving Aber Instruments, AMEC Global Renewables, Axiom Process, Excelsior Technology, FRE-Energy, Kautex-Textron, NCH, Nextek, SciTech (supported by BASF), Thames Water, Waitrose and Welsh Water.</li> <li>• <b>Energy efficiency and low carbon emissions</b> (see case study 2) for industrial combustion systems (<b>Tan &amp; Wilcox</b>) involving Doosan Power Systems, EDF, ENEL, EON, GDF Suez, Global Combustion Systems Ltd., (REA), Gas Natural fenosa, Indra Systems, Tata Steel, International Flame Research Foundation and the Institute of Power Engineering.</li> <li>• Battery and fuel cell development (<b>Laycock &amp; Liu</b>) is a rapidly developing area within the UoA that is planned to result in significant impact over the coming period and involves Johnson Matthey, McLaren Automotive, Zytec Automotive, Drayson Racing, TATA, Yuasa, Atraverda. Specific impact includes work through the Centre for Automotive and Power Systems (CAPSE) under the direction Jonathan Williams on McLaren's P1 Sports Car kinetic energy recovery systems with Johnson Matthey, Audi R8-etronelectric propulsion system via Zytec Automotive and Drayson Racing and their successful electric vehicle land speed record.</li> <li>• <b>Hydrogen and energy systems (Guwy &amp; Maddy)</b> involving Shell to establish effective conversion of renewable biogas to hydrogen, BOC, Air liquide, ITM Power, Hardstaff Ltd., Honda, Air Products, and International Energy Agency Annex 21. For example work on optimizing electrolysis with ITM Power has resulted in significant inward investment to Wales and strengthened future research with the company.</li> <li>• <b>New materials for energy storage and efficient use</b> involving Hydro Quebec, General Motors and Chrysler, for hydrogen storage materials research and BASF/Johnson Matthey for new materials for fuel cell membranes (<b>Antonelli</b>). LOMOX Ltd. has funded research on light emitting materials and Oclaro, Digital Projection, and Covision have supported research in illumination technology carried out by <b>Copner</b>.</li> </ul> <hr/> <p><b>b. Approach to impact</b></p> <p>The University has an overriding Innovation and Engagement strategy which is an integral part of the university's core mission and over the REF census period has invested its HEIF funding from the funding council to support this agenda. The university encourages strong links between research, knowledge exchange and consultancy activities with the international community. The activity is steered and supported by the Innovation, Commercialisation and External Engagement groups consisting of representatives from corporate departments (Commercial Services, European Development, Research Office and Finance Office) together with faculty representatives. Within the Commercial Services Office a dedicated knowledge transfer team supports business interaction and maximises economic impact through commercialising, IP protection, licensing and Spin-out activity. The St David's Day Group (SDDG) is collaborating on an Intellectual Property Commercialisation Project that is led by Aberystwyth University. It seeks to commercialise intellectual property by bundling (aggregating synergistic IP from different HEIs) and rolling out to market through licensing or spinout creation. Each SDDG partner has a responsibility for a different</p>
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## Impact template (REF3a)

strand of the initiative, building on the different strengths of the HEIs.

Research and development in the field of Energy and the Environment is strategically important for national and international funding bodies. The University has committed strongly to this agenda through the development of large scale infrastructure such as the construction of state-of-the-art laboratories and the establishment of a research institute. The Energy and Environment Research Institute (EERI) led by Professor Alan **Guwy**, has a focus on innovating for engineering solutions for problems and draws on expertise from experienced academics in the well-established research centres, the Sustainable Environment Research Centre (SERC) and Engineering Research Centre (ERC). EERI's hydrogen energy research follows a similar approach to achieving impact. Collaborative engagement with industrial and government stakeholders is long established, and provides the basis for much of the Institute's research activity. The University is a member of the UK Hydrogen and Fuel Cell association and **Premier** and **Guwy** are Scientific Advisors to the EPSRC SUPERGEN Hydrogen and Fuel Cells Hub together with over 50 other non-academic representatives from industry, industrial associations and government bodies. **Maddy** is a member of the Welsh Government's Low Carbon Vehicle Steering Group, involving government, academic and industrial partners, and an advisor to Welsh Government (WG) for their engagement with the UK H<sub>2</sub> Mobility Government/Industry hydrogen infrastructure initiative. Kevin Hammett was seconded from WG to assist in forming the industrial, governmental and academic relationships. As a result of these interactions, specific research with industry partners has been conducted, including **Maddy's** work on PEM electrolysis of hydrogen with ITM Power and biogas/bioliquid reforming for hydrogen with Shell.

**Antonelli's** work on room temperature hydrogen storage materials is the subject of a US provisional patent application (61/570,977) filed in December 2011 and a second filed in 2012. He is the UK representative for the COST Action committee on Nanostructured Materials for Solid-state Hydrogen Storage (MP 1103). This committee has a 4 year plan to bring together researchers, industry partners, and government policy makers across Europe to create a think-tank in hydrogen storage materials. **Antonelli** has strong contacts with the automotive industry funded by both General Motors and Chrysler. His most recent work with Chrysler is sponsored by Mr Tarek Abdel Basset (1.6 M USD project over 5 years to start in 2014), an engineer who worked on the FreedomCar (a H<sub>2</sub> test vehicle in the US). Plans for the future include developing new concepts in conformable tank design in collaboration with Chrysler and BASF/Johnson Matthey in close consultation with industrial advisors in the automotive industry. Chris Wright, ex-CEO of IP2IPO, a leading intellectual property commercialization investment business, was hired to aid in the exploitation IP on novel hydrogen storage materials, a good example of how specific commercial expertise is used to help develop impact.

**Tan & Wilcox** specialize in mathematical modeling of the heat transfer within a furnace using the zone modeling technique first expounded by Hottel in 1958 and acid-alkali modeling of the transient phenomena of furnaces. Examples of this collaborative work include two Carbon Trust supported projects (2002-6-8 & 2004-6-1330), in collaboration with Gaz de France (now GDF Suez) and Global Combustion Systems, a leading UK supplier of combustion equipment to the glass industry on the development of alternative firing techniques for glass melting furnaces. GDF Suez has taken out patent protection (French Registration Number 06 55 571) and (PCT/FR2007052518) on behalf of all three partners and licensing arrangements have been agreed for exploitation of the technology.

Through the research conducted by **Thomas**, Pontypool-based manufacturer GTW Developments, which designs and produces Airbond splicing machines for the textile industry, has received the Queen's award for innovation in 2013. This enables manufacturers in sectors including aerospace and automotive to splice materials such as carbon and glass effectively and economically for the first time.

The staff in EERI have worked with non-academic stakeholders through funded programmes such as EPSRC Case Awards, KTPs and TSB where industry leads the R&D. In addition, significant non-academic engagement is an intrinsic part of research funded projects through EU Framework and Research Fund for Coal and Steel, IEE & ERDF, EPSRC and NERC where industry are both partners and beneficiaries which is a key strategy for impact development. These industrial partners operate at a regional, national and international level and include: Tata Steel, Thames Water, AMEC, Global Renewables, Doosan Power Systems, EDF, EON and GDF Suez on long term projects that have been funded over, in general, more than one grant. It is this long term view

to collaboration with key industrial partners that has been at the core of the two centres since their inception. The Institute seeks to patent technology where possible and then to develop a means to exploitation, through start-up companies or licensing agreements with major partners. One key strategy to the development of new industrial links during the period has been through the appointment of the external Professors Tony Davies (Product Innovation Manager Waters Corporation, Cologne) and Neil Fricker (Deputy Superintendent of Research for the International Flame Research Foundation) who have been instrumental in expanding the number and breadth of contacts for the unit of assessment. In order to develop and maintain the collaboration agreements and protect IPR, the Centres make extensive use of internal support within the University. This comes from the commercial services and the European Office to ensure that robust enforceable agreements are in place. SERC and ERC both have industrial facing knowledge transfer centres, for example the AD Centre, Hydrogen Research and Demonstration Centre at Baglan and the Centre for Automotive and Power Systems (CAPSE).

**c. Strategy and plans**

The strategy for achieving impact adopted by both the SERC and ERC consists of the following;

- a) Prior to undertaking a collaborative piece of research with any organisation the institute will identify any prior intellectual property and through a collaboration agreement will identify this to its partners.
- b) Then through the piece of research conducted in collaboration, an assessment of the commercial intellectual property is made. Often on large projects this takes place through a steering committee which has representation from key stakeholders, e.g. David Clarke, Director of Energy Technology Institute, on the LCRI steering group panel.
- c) Any IPR identified is then protected through an initial patent filing and if appropriate a suitable organisation is identified to hold that patent. For example, the work patented with GDF Suez and Global Combustion Systems is jointly owned by all three partners but is defended by GDF Suez as the largest commercial entity.
- d) Once an appropriate patent has been filed then, if appropriate, papers will be produced to publish the work to the broader community. Occasionally publication is not suitable as it may be difficult not to disclose 'know how' and therefore publications maybe withheld. In any case the publication(s) will not be released until approved by all the stakeholders.
- e) Following this the University will, with its partners, seek to demonstrate or develop the technology so as to ensure commercialisation.

In order to enable impact in future projects the SERC and ERC will ensure that future bids for funding will have embedded, where appropriate, finance to support the initial filing of patents and that, in addition, the University has received and initiated funding for a number of projects which have outputs related to delivering impact to stakeholders outside the academic arena (AD Centre, H2Wales, CAPSE) building on the work funded through the research councils and the EU framework programmes since 1993. Staff from both Centres hold more than 30 patents and it is expected that these will lead to new areas of substantial impact over the coming review period.

**d. Relationship to case studies**

The case studies demonstrate how the UOA achieves impact, following the approach outlined in the 'Strategy and Plans', thus informing our distinctive areas of research in energy and environment. The case studies are based on research that is at least of 3\* quality and are embedded in the Unit of Assessment's wider approach to impact. Case Study 1 (CS1) 'Optimisation of Anaerobic Process Technology' is closely linked to the SERC whilst Case Study 2 (CS2) 'Industrial Modelling and Monitoring' is closely linked to the ERC. The case studies provide excellent examples of how researchers across the UOA have collaborated closely with their industrial partners on projects that in general have followed the approach outlined in the 'Approach to Impact'. In the CS1, the impact is based on the area of developing analytical tools, improved hydrolysis, microbial population analysis for improved reactor understanding and improved energy recovery. In CS2, the patent filing in collaboration with GDF Suez and Global Combustion Systems arose out of a Carbon Trust feasibility study within which a robust consortium agreement was established prior to the commencement of the work. This led to a further Carbon Trust grant that established the science behind the novel NOx reduction technique and at the current time this partnership is now demonstrating this at the glass manufacturers Owens Illinois and SiseCam as part of a FP7 Energy demonstration project.