Institution:	University of Northumbria at Newcastle
Unit of Assessment:	15 - General Engineering

a. Overview

The Faculty of Engineering and Environment organises its research on a multidisciplinary basis to achieve research connectivity with high quality and to maximise the effectiveness of its resources. The General Engineering research includes staff from the Department of Physics and Electrical Engineering, and Mechanical and Construction Engineering and has three research groups:

i) **Sustainable and Renewable Energy Systems** (**S&RES**) – Photovoltaics, Wind Energy, Micro CHP Technologies and Thermal Management;

ii) **Advanced Materials and Manufacturing** (**AM&M**) – Materials and Thin Films, Polymers, Surface Engineering and Manufacturing Technologies; and

iii) **Communications, Control and Instrumentation** (**CC&I**) – Free Space Optics, Microwave Holography, Signal Processing, Control Engineering and Liquid Optics.

This strategy has led to significant internal investment in both facilities and staff with a growth from 14 FTE in RAE2008 to 23 FTE in REF2014.

b. Research strategy

b1. Current research position with reference to RAE2008

Following RAE2008, our strategy was to grow high-quality research with critical mass in selected areas – renewable energy, materials and communications engineering – to extend the capability and capacity of the three research groups. In fulfilling this strategy, the specific objectives were to:

i) expand the academic base with appointment of high-quality staff from across the best candidates in the world (*as evidenced by a 64% increase in cat.A staff from 14 to 23*);

ii) focus on quality of research outputs via promotion of publications in top quartile journals as determined by subject field category (*as evidenced by the outputs returned in REF2*);

iii) create new distinctive research topics in advanced materials, wind energy and micro-CHP technologies, manufacturing and visible light communications (*as evidenced by the external Professorial appointments and internal Awards and Titles promotions*);

iv) develop physical and financial resource structures to support strong multidisciplinary focused research groups (*as evidenced by the investment in research equipment and laboratory facilities*);

v) create a vibrant research environment for staff and PGR students (*as evidenced by 72 registrations, as of 01/08/2013, equating to ~3 per cat. A FTE staff*);

vi) cultivate a research-rich and extended people environment via appointment of Emeritus Professors (5), Visiting Professors (10), Visiting Academics (7) and University Anniversary Research Fellows (UARF) (2).

b2. Achievement of strategic aims and objectives during 2008-2013

Since 2008, three experienced external Professorial appointments (**Mahkamov**, **McHale** and **Postlethwaite**) and 13 Lecturer/Senior Lecturer appointments including 11 early career appointments (**Azimov**, **Beattie**, **Birkett**, **Dai**, **Gao**, **Inam**, **Le-Minh**, **Lewis**, **Shyha**, **Trabi**, **Wells**, **Xu** and **Zoppi**) have been made. **Mahkamov** joined from Durham bringing expertise in Wind Energy (e.g. EP/F061811/1), **McHale** joined from Nottingham Trent bringing expertise in Materials (e.g. EPSRC Platform grant EP/E063489/1) and **Postlethwaite** joined from Leicester bringing expertise in Control Engineering (e.g. EPSRC Platform grant EP/D029937/1). The supporting investment in research facilities has included new laboratories in Wind and Power Energy to complement existing Solar Energy laboratories and new Materials and Instrumentation laboratories to complement thin film deposition and communications laboratories (detailed in section d).

The assessment period has also witnessed a marked improvement in the volume and quality of research outputs with over 357 publications and a policy of publication in top quartile and top 10% journals by subject field category (Thomson-Reuters JCR Index).

The structure and exemplars of achievement of the three research groups are given below. As these are multidisciplinary, some staff are members of more than one group.

S&RES – Professor **Mahkamov**; L/SL/Reader: **Beattie**, **Forbes**, **Jovanovic**, **Zoppi**: The original focus on photovoltaics (**Forbes**) has been strengthened by additional expertise in materials for solar energy conversion (**Beattie**, **Zoppi**) and complemented by research in wind energy and micro-CHP technologies (**Mahkamov**), together with research into the control and management of electrical grids (**Jovanovic**). The group has been a core member of EPSRC SUPERGEN and European (FP6 and FP7) projects. Two exemplars of world-class excellence are:

- EU project within the period: EU Interreg E-mobility North Sea Region research project started in September 2011 for three years involving partners from seven European countries with a total grant of €6.7million (Northumbria grant is €641,000).
- EPSRC projects within the period and extending to 2018: STAPP (EP/H040331/1) and SUPERGEN (EP/F029624/2) (c. £8.7m with £1.5m at Northumbria and involving 13 Universities and 21 industrial partners) and PVTEAM 'Materials Substitution for Safety, Security and Sustainability Call' (award notified Nov 2013, c. £2.6m with £400,000 at Northumbria and involving five Universities and five industrial partners).

AM&M – Professors: **Mahkamov**, **McHale**; RF/L/SL/Reader: **Azimov**, **Beattie**, **Birkett**, **Forbes**, **Gao**, **Inam**, **Kozhevnikov**, **Lewis**, **Shyha**, **Trabi**, **Wells**, **Xu**: The original focus on materials (**Beattie**, **Forbes**) has been complemented by expertise in manufacturing processes (**Birkett**, **Gao**, **Mahkamov**, **Shyha**) and advanced materials (**Azimov**, **Inam**, **Kozhevnikov**, **Lewis**, **McHale**, **Trabi**, **Wells**, **Xu**). Two exemplars of world-class excellence are:

- Grants within the period: EPSRC Platform Grant (EP/E063489/1) and EU TEMPUS Programme Project (511069-1TEMPUS-2010-1-IT-JPCR MANSUR) where Northumbria is the PI on this project with five partners (two EU and three Jordanian Universities).
- EU FP7 Marie Curie Actions and EPSRC project within the period and extending to 2016: 'Bio-Green-IC-Engine— Novel multizone thermodynamic model and specialised software for rapid optimisation of working process strategies and design parameters of Internal Combustion Engines run on advanced biofuels' (IID-328361) with a total of £254,000 and 'Dielectrowetting: Controlling Oleo- and Hydrophilicity and Shaping Liquid Surfaces' (EP/K014803/1), in collaboration with three industrial partners and Technical University Darmstadt, Germany, worth £350,000 (ranked number one at panel).

CC&I – Professors: **Busawon**, **Danaher**, **Ghassemlooy**, **McHale**, **Postlethwaite**; RF/L/SL/Reader: **Dai**, **Le-Minh**, **Ng**, **Trabi**, **Wells**: The original focus on microwave technology and free space optics (**Ghassemlooy**, **Ng**) has been strengthened by additional expertise in optical communications (**Le-Minh**) and liquid-optics (**McHale**, **Trabi**, **Wells**) while control engineering (**Busawon**) and nuclear instrumentation (**Danaher**) has been strengthened by expertise in theory (**Postlethwaite**) and embedded control (**Dai**). Two exemplars of world-class excellence are:

- Grants within the period: EPSRC Platform Grant (EP/D029937/1) and ACoRNe (Acoustic Cosmic Ray Neutrino Experiment), a collaboration between Sheffield University, UCL, Imperial College, Lancaster University and Northumbria, with funding from PPARC/DSTL.
- Three FP7 COST Actions within the period and extending to 2016: IC0802 (23 European Countries), IC1101 (23 EU countries and partners from Australia, China, Korea, Pakistan and Taiwan), and MP1106 (31 EU countries and partners from Australia, Canada, USA and New Zealand), where Northumbria provides leadership via UK representatives on the Management Committees and the Vice Chair for IC1101.

During the period, the number of registered PGR students is 72 (~3 per staff FTE, as of 1 August 2013) whilst there have been 33 Ph.D. completions since 2008 (given our investment in ECR staff, completions per staff FTE is a lagging indicator). The Unit is committed to an investment strategy as evidenced in 2013/14 capital spend where a total of £563,000 has been committed to research facilities and equipment.

To cultivate a research-rich and extended people environment, the Unit has appointed visiting Professors from a range of Universities and countries (e.g. University of Buffalo, USA, Technical University of Graz, Austria and Hong Kong Polytechnic University).

b3. Future strategic aims

In 2012, Northumbria University set out a new 'Vision 2025' to guide its transformation into a research-rich, business-focused, professional university with a global reputation for academic quality. Since inspiring, research-excellent and entrepreneurial staff are the key building block of academic quality, investment will be made in attracting, developing and retaining talent.

The Unit's strategy from 2008-2013 has resulted in three distinctive research groups with complementary fundamental and applied themes. We intend to maintain and develop this structure in the 2014-2019 period. Our plans for the next five years will support research sustainability and future development at the highest level within the framework of the University's Vision 2025 thereby ensuring University-level priority and flow of resources. The three groups are well-aligned to the EPSRC future national and international priorities in Energy, Engineering, Information and Communication Technologies and Manufacturing for the Future. The specific objectives are to:

1. Increase capacity by increasing staff from 23 to 36. This will be via new posts, targeted voluntary severance within departments, and securing external funding for Fellowships.
2. Increase capability by capital investment in research equipment and laboratory infrastructure to support the expanded staff base and development of research groups.
3. Expand our international collaborative research networks (academia and industry) via joint research grants and a visiting academic scholar programme.
4. Promote publication in high-quality and high-impact journals with top-10% ranking by subject field category (according to Thomson-Reuters categorisation).
5. Increase the number of research students funded by external sources and ensure on-going healthy Ph.D. student completions within a four-year registration period.

c. People, including:

c1. Staffing strategy and staff development

c1.1 Staffing strategy relating to research strategy and physical infrastructure

The objectives of the staffing strategy have been to:

i) stimulate a high-quality research culture amongst academic staff;

ii) extend and revitalise the academic staff base with high-quality appointments from across the best candidates in the world;

iii) build upon three distinctive groups (S&RES, AM&M and CC&I).

To achieve the first objective we have used the annual appraisal system to agree individual targets and raise output quality using journal subject field category as an objective proxy indicator of quality. We have also revised financial models to invest HEFCE QR funding in postgraduate research (PGR) activities aligned to quality research, and developed an overhead sharing incentive model to ensure we re-invest in areas of success as they grow.

To create the flexibility for the second objective we have used a Voluntary Severance Scheme and the University Strategic Investment Fund (SIF) to replace and extend the research staff base. In making appointments we have used a mixture of both senior and junior appointments to ensure a balanced research development. The recruitment process has been revised to include a greater focus on the quality of research outputs and the use of Skype screening interviews to attract quality applicants across the world (e.g. **Azimov** from Malaysia, **Xu** from USA).

The appointments during the period have extended and redefined the original research themes of 'Energy Systems, Materials and Manufacturing' and 'Communication Engineering and Modelling' thereby allowing a natural growth and effective use of the research facilities. As part of our global reach, all newly appointed staff are mentored to develop, retain and expand their external links. We have used the University's Visiting Fellows and Professors scheme to bring in international expertise working with researchers (e.g. Dr. N. Calabretta, Eindhoven University of Technology, Netherlands). In addition, University and Faculty-wide sabbatical schemes are in place to allow staff to develop their research and to improve their international profiles by visiting external centres of excellence (e.g. **Le-Minh** visits to National Taiwan University of Science and Technology).

c1.2 Career development support

Staff within the three research groups meet regularly to discuss progress, funding opportunities,

staff development matters, new projects and PGR progress. Heads of research report on the progress of the team to the Faculty Research Committee (FRC) four times per year. Performance of research groups is monitored and evaluated by the Research Performance Monitoring Group which is a sub-committee of FRC, while a second sub-committee of FRC, the Research Grant Promotion Group, supports bidding development via Mock Panels, Fellowship preparation and pre-submission proposal reviews. Individual staff development support and opportunities include:

i) **Mentoring scheme** – all staff are given advice on developing their career via an experienced mentor and by a grant development officer. They also receive support through lighter teaching loads (25%-50% for their first year) to build their research;

ii) **Funding** – HEFCE QR, Overhead Sharing Reward, Staff Development, University Research Capital and PGR funding are in place for staff to apply for equipment, achieve PGR support, and attend international research related meetings and conferences;

iii) **Sabbatical Scheme** – the Faculty offers an annual research sabbatical scheme for one semester allocated based on a competitive application process informed by the track record of high quality publications, record of external funding, plans for external engagement and strategic development, for example **Le-Minh**;

iv) **Promotion** – there is an annual Awards and Titles call informed by external review of the research track record. During the REF period, **Busawon** was promoted to Professor and **Forbes** was awarded a Readership.

At the University level, there is a firm commitment and provision for staff development:

i) **Research Staff Training Development Programmes** (76 in 2011/12) - these cover research bidding, ethics/governance, commercialisation of research, measuring impact, skills for PGR supervision, how to publish in quality journals and open access publishing.

ii) **An Annual Research Conference and Research Forum** – allows staff and PGR students to network across disciplines. Five staff and 25 PGR from the Unit participated in 2013.

iii) **A Weekly Funding Opportunities Bulletin (*The Nugget*)** – this is tailored to individual Faculties and their research areas.

iv) **A Postgraduate Certificate in Higher Education Practice** – this is a development programme in HE teaching and research practice for new academic and research staff with the research module requiring attendees to complete a draft of a first grant proposal.

v) **A Personal Research and Innovation Plan (PRIP)**– this allows staff to plan and manage their annual research activities. Data derived from the PRIP system provides a means at the Faculty and University levels to plan and manage research activities strategically, thus enhancing the research environment and staff career.

c1.3 Implementation of the Concordat to Support the Development of Researchers

Since 2008 the University has developed and implemented an action plan in line with the Vitae Concordat, which sets out the expectations and responsibilities of stakeholders in researcher careers. This action plan has recently been recognised by Vitae and the University has been awarded the EC badge of HR Excellence in Research. This acknowledges our alignment with the principles of the European Charter for Researchers and Code of Conduct for their Recruitment.

c1.4 Competitively awarded Personal Fellowships

The Unit has several personal fellowship awards: Reddy (British Commonwealth Fellow, 2008/9); **Dai** (EPSRC UK-China Science Bridge, 2011); **Dai** (Postdoctoral Fellowship from the Japan Society for the Promotion of Science, 2009/11). **Lewis** and **Wells** hold University Anniversary Research Fellowships won via open competition of external candidates across all disciplines.

c1.5 International staff appointments and visiting scholars

The Unit is committed to employing top quality academics (see sections b2 and c1.1). For example, in the recent appointments with the unit, **Azimov** from Curtin University, Malaysia and **Xu** from CONTE National Research Centre, USA. The Unit has a policy of extending its academy and has 5 Emeritus Professors, 10 Visiting Professors and 6 Visiting Fellows, e.g. Professors Qiao (University of Buffalo), Chao (Hong Kong Polytech) and Leitgeb (Technical University of Graz).

c1.6 Achieving equality and diversity

The University is committed to promoting and supporting equality and diversity within Research. This is reflected in several initiatives; research staff are included within the Equal Pay Audit and where appropriate, actions identified, work-life balance opportunities are available and promoted and the Concordat Action Plan is supported. A Daphne Jackson Trust Fellow is being sponsored by the University and should join the S&RES group in 2014 to work on quantum-dot solar cells.

c2. Research students

University and Faculty procedures, which govern the Unit's PGR processes, are compliant with the QAA Quality Code for HE for Research Degrees (Chapter B11; published June 2012).

c2.1 PGR recruitment

A PGR Director is responsible for the PGR recruitment process, with all projects externally advertised via the Graduate School. Applications are distributed to the Head of Research group for evaluation, interviews are held (in person or by Skype) by the prospective Principal Supervisor and one other academic. The interview includes a checklist on qualifications (academic at a minimum 2.1 standard and English language at a minimum IELTS 6.5), project concept/originality, supervision expertise requirements, resources (facilities required and source of stipend, fees and consumables), and also includes a training needs analysis.

c2.2 Training and support mechanisms for PGR

All students have at least two supervisors, who must attend the Graduate School-provided PGR supervision and examination training, to ensure sufficient specialism and academic support. The team may also include an external supervisor (from academia or industry) to enhance the student's experience and/or collaboration links. Students have a structured training programme, organised at University (via a dedicated Graduate School) and Faculty level consisting of workshops on the research environment, research management, research skills and techniques, and transferable skills (communication skills, time management, personal effectiveness and career management).

The Unit provides weekly subject specific seminars for PGR students with external speakers; each PGR student is required to provide a seminar during their third year and posters at the University Annual Research Conference; 25 PGR from the Unit participated in 2013. All PGR students have access to desk facilities in the same building as their research laboratory locations.

The University subscribes to the HEA's Postgraduate Research Experience Survey (PRES) which evidences an upward trend across the three surveys conducted in 2008, 2009 and 2011, including many areas that were already high scoring, (e.g. supervision and skills development). Some of the largest improvements were intellectual climate, teaching opportunities, and career opportunities.

c2.3 PGR progress monitoring

Each PGR student, within three months of registration for a research degree programme, identifies and develops with their supervision team a PGR Development Portfolio. This Portfolio and student progress is annually reviewed by an independent panel via the Annual Progression process which reports to the Faculty Research Committee. Supervisors monitor student progress throughout, and provide regular feedback to the student to ensure that progress is maintained.

d. Income, infrastructure and facilities

d1. Provision and operation of specialist facilities

***Facilities and Infrastructure*:** Research in the Unit is supported by specialist laboratory space and cross-cutting technician supported/operated facilities:

- ***Surface characterisation facilities*** include scanning electron microscope, secondary ion mass spectroscopy, surface profilometry, atomic force microscopy, X-ray diffraction, photoluminescence spectroscopy and transmission reflection spectroscopy.
- ***Materials deposition facilities*** include sputtering system, thermal evaporation system, electron beam evaporation system and nanoparticle chemical deposition system.
- ***Wet processing areas*** include fume cupboards, centrifuge and vacuum oven.
- ***Additive manufacturing and rapid prototyping suite*** include multijet liquid 3D printing system, 3D coloured ceramic printing system, digital light manufacturing system, fused deposition modelling system and personal 3D printers.

- ***Printed circuit board/electronic device manufacture workshop*** and PCB prototyping.
- ***Design and modelling software*** include 3D modelling (SolidWorks®), finite element analysis (Ansys), computational fluid dynamics (Fluent) and dynamic simulation (Elfin).

In addition, each research group has a number of specialist laboratories and facilities. Examples include a 5G Ltd sponsored electric battery, power and wind energy laboratory (S&RES), a photovoltaics building test façade (S&RES), a materials and instrumentation laboratory (AM&M), an Agilent Technologies-sponsored test and measurement communications laboratory (CC&I), environmentally controllable (humidity, temperature and turbulence) test facility for free space optical communications (CC&I) and a microwave holography facility including a 18m^2 anechoic chamber (CC&I). These facilities also have two co-located PhD study rooms with a capacity for 45.

d2. Current and planned investment in infrastructure and facilities

***Recent Investment in Equipment/Facilities*:** During the period 2008-2013, the Unit has been extremely successful in securing capital funding within the University with bids of value c. £**5million**. During 2012/13 alone, the total capital invested, excluding estates work, was around £**500,000**. This has been used to renew essential equipment, extend the equipment base of existing research groups and support new activities and staff. Larger items include a multisource evaporation system (£100,000; AM&M), materials production and characterisation equipment (£75,000; AM&M), visible light communications equipment (£70,000; CC&I), solar/biomass plant (£300,000 in equipment and estates conversion; to support new Chair Mahkamov within S&RES). During 2013/14 the University has approved equipment requisition worth £**303,000** for AM&M and CC&I, including high-speed video and contact angle goniometry (£40,000) to support the most recent senior appointment (**McHale**), Laser Doppler Anemometry (**Azimov**, **Xu**; £75,000) and optical communications equipment (**Ng**; £40,000).

***Investment in Laboratory Estate*:** In 2013/14, the University is investing £260,000 in the Unit. To support **McHale**, **Trabi**, **Wells** and **Xu**, an office (floor space 37 m^2) adjacent to the CC&I free space optics and microwave research laboratories (**Dai**, **Ghassemlooy**, **Le-Minh**, **Ng**) has been converted to a materials and instrumentation research laboratory. The research laboratories for thin film/photovoltaic materials deposition (**Beattie**, **Forbes**, **Zoppi**) have been refurbished. To support advanced materials and manufacturing (**Azimov**, **Birkett**, **Inam**, **Mahkamov**, **Shyha**) the mechanical engineering workshop and the rapid prototyping suite has been refurbished and combined with model making facilities shared with colleagues in UoA16. The total research laboratory areas for the unit at the end of 2013, not including workshops, are 692 m^2.

***Future Intentions for Laboratory Estate*:** The Unit has the support of the Faculty to invest in facilities for the planned 50% expansion in research staff. The CC&I and adjacent new materials and instrumentation labs partially occupy one floor. Our intention for summer 2014 is to convert the remainder of this floor to provide additional research lab space (68m^2) and co-located PGR and postdoc office space (49m^2) for the entire level. Within the five-year estates plan, we will relocate and extend the thin film deposition facilities of the AM&M research to a co-location alongside the surface characterisation suite (used by S&RES). We also intend to redevelop and extend lab space for S&RES, particularly for anticipated growth in electric vehicle battery technology research.

d3. Research funding portfolio

***External Funding within the REF Period*:** Within this period staff within the Unit have held two EPSRC Platform grants in Materials (EP/E063489/1) and Control Engineering (EP/D029937/1) stated by EPSRC to be only awarded to world-leading groups, have been an integral part of collaborative EPSRC SUPERGEN projects within Materials/Photovoltaics (GR/S86341/01, EP/F029624/1, EP/F029624/2, EP/H040331/1) and have led major EU projects. Staff have also been successful with international collaborative awards *via* EPSRC with China (EP/F061811/1), with India and with multiple EU partners (EU COST P21, MP1106, IC0802, IC1101). Of note are McHale's nine EPSRC grants as PI (EP/K014803/1, EP/H000704/1, EP/G057265/1, EP/E063489/1, EP/I016414/1, EP/E043097/1, EP/D03826X/1, EP/C536630/1, EP/D500826/1). Within the external funding portfolio, funding for photovoltaics (EP/H040331/1) and materials (EP/K014803/1) extend into the post-REF2014 period and so provide a firm basis for the future.

d4. Consultancies and professional services

Staff have been awarded KTPs and consultancies to promote knowledge transfer from academia

to industries. The S&RES group provided consultancy to Feedback Ltd to develop educational training modules (PV75-100 Photovoltaic Principles Trainer) in renewable energy. Two completed KTP projects within AM&M; **Renown Engineering Ltd** and **Ascendant Access Ltd** have been rated by TSB as "Outstanding" and "Very Good", respectively. The Unit has a current KTP with Safinah Ltd. (2012-2015). CC&I has designed a unique atmospheric chamber to advance the field of free space optics communications and through COST Action IC1101 has helped partners to setup atmospheric chambers in Germany, Austria and Czech Republic.

e. Collaboration and contribution to the discipline or research base

e1. Summary of Unit research collaborations evidenced by joint outputs

One of the Unit's strategies is to encourage staff to embark on high quality collaborative research. The 365 publications from the Unit reflect the active collaborations with international institutions, where there are joint publications with 48 countries and 237 national and international institutions and companies, for example Cambridge, Imperial College, Oxford, UCL, Eindhoven University of Technology, McMaster University (Canada), Samsung (Korea), France Telecom, QinetiQ and Siemens AG (Germany) (Web of Science Search on 22 November 2013).

e2. Exemplars of support and interdisciplinary research

The University provides a platform for interdisciplinary research via the University Research Forum and the Unit's staff are well-engaged with examples of **Ghassemlooy** with mathematical science staff in wavelet-denoising techniques (e.g. Rajbhandari et al, 2013, *Optics Express*, **21**, 13779) while **Kozhevnikov** and **Lewis** collaborated chemical scientist to develop phosphorescent materials and organic ligands, respectively (e.g. **Kozhevnikov** et al, 2011, Inorganic Chemistry, 50 (13), 6304 and **Lewis** et al, 2011, JACS, 133 (33), 13093).

e3. Summary of Unit collaborations with research users have informed research activities

The Unit's staff are actively engaged in collaborations with research communities across the world. For example, Professor C. Qiao of University of Buffalo (Visiting Professor) who is a Fellow of IEEE and a leading figure in fibre wireless has stimulated new research (Radio-over-Fibre) at CC&I while **Kozhevnikov's** collaboration with Professor D.W. Bruce of York University, a world-leading Professor in Materials Chemistry, has initiated phosphorescent material research in the Unit.

e4. Summary of Unit leadership in the academic community

The staff within the Unit have been pro-active in contributing to the health of their disciplines, for example organising six international conferences since 2008 at Northumbria (e.g. CSNDSP 2010, NOC 2011 and EFEA 2012), leaderships at professional bodies (e.g. IEEE UK&RI Communications Chapter), national and international research review panels (e.g. REF2014 sub-panel UoA13, Romanian REF equivalent, Science Foundation Ireland International Review of the Dublin Biomedical Diagnostics Institute, and the Italian Ministry for Education, University and Research), four EPSRC Peer Review College members, 36 invited keynote talks, eight editorships and 16 editorial board memberships.

e5. Exemplars of leadership in the academic community via individual esteem indicators

The esteem indicators are listed below by career stage and then alphabetically by member of staff. Between one and five items have been selected as exemplars as appropriate for career stage (Professors, Established Academic (EA) and Early Career (EC)).

Busawon (Professor): i) Visiting Professor (Uni. Valenciennes, France); ii) Editorial Board, Med. J. Meas. Control; iv) Keynote/Invited Talk at EFEA 2010 and CIAM 2011; iv) Organising Committee, 7th IEEE IET Intl. Symp. Commun. Syst., Networks & Dig. Sig. Proc. (CSNDSP) 2010.

Danaher (Professor): i) Referee for MIUR (Italian Ministry for Education, University and Research) for the Programme 'Future in Research 2012'; ii) International Advisory Board for the 5th & 6th International ARENA Conference at Erlangen Germany 2012 & Annapolis USA 2014; iii) Invited Seminar at Rome Unversity, La Sapienza, 2008, DESY Zeuten (Berlin) 2010, University of Erlangen (Bavaria) 2010.

Ghassemlooy (Professor): i) Editor, Med. J. Electron. Commun. (MEDJEC); ii) EPSRC Peer Review College (2009-Present); iii) Member of the Romanian RAE panel 2011; iv) UK Rep. EU COST Management Committee (IC0802: 2008-12; IC1101: 2011-15), Vice Chair of IC1101.

Mahkamov (Professor): i) Editorial Board, *Renewable Energy Journal*; ii) Member of International Stirling Engine Technical Council; iii) Invited external referee for The Foundation for Science and Technology (FCT), Portugal; iv) IMechE Harold Disney Prize, 2009; v) Organising Committee, 14th

(2009) and 15th (2012) International Stirling Engine Conferences.
McHale (Professor): i) Ed. Board of Adv. Colloid & Interf. Sci.; ii) REF2014 – Member of UoA13; iii) EPSRC Peer Review College (2010-Present); iv) UK Rep. EU COST Mgmt. Comm. (P21: 2008-11; MP1106: 2012-16); v) Member, Science Foundation Ireland (SFI) Intl. Review Team for the Biomedical Diagnostics Institute, SFI Centres for Science, Engineering and Technology. (CSET) Programme (2008).
Postlethwaite (Professor): i) Fellow of the Royal Academy of Engineering, IEEE, IET and InstMC; ii) Chair of Steering Group for £5.5million Programme Grant on Control for Energy and Sustainability; iii) EPSRC Peer Review College; iv) EPSRC Strategic Advisory Team (Materials, Mechanical & Medical Engineering Programme), 2008-11; v) Steering Group member of the Royal Academy of Engineering's programme on Research Exchanges with China and India, 2007-12.
Forbes (Established Academic (EA)): i) Invited by Institute of Physics to contribute to BERR consultation on UK Renewable Energy Strategy (2008) and their response to House of Commons US Committee's inquiry into renewable electricity-generating technologies as part of The House of Lords Economic Affairs Select Committee inquiry into 'The Economics of Renewable Energy' (2008); iii) Invited to join EU projects to stimulate research into Kesterite materials; KESTCELLS.
Gao (EA): i) Editorial Board of IEEE Trans. Contr. Syst. Technol. since 2009; Recent Patents on Space Technol., since 2010; ii) Editor of *IEEE Transactions on Industrial Informatics*, special issue on 'Data-driven Approaches for Complex Industrial Systems', 2012.
Jovanovic (EA): i) Associate Editor of Intl. Journal. Electr. Energy Syst. (IJEES), since 2008; ii) Invited lectures at: Scientific Institute Nikola Tesla, Serbia, 2009-11; iii) Senior Member of IEEE.
Kozhevnikov (EA): i) Ph.D. examiner at University of Central Lancashire, 2012; ii) Reviewer for *Springer's Transition Metal Chemistry Journal*; iii) Member of Royal Society of Chemistry.
Ng (EA): i) Guest Editor of *IET Communications*, vol. **6** (5) 2012; ii) Chair, IEEE UK&RI Comms. Chapter; and IEEE UK&RI Section Committee (2010-present); iii) Technical chair for the 7th IEEE IET CSNDSP 2010, UK and 16th NOC 2011, UK. iv) Org. Comm. IEEE ICC 2015, London.
Beattie (First Lectureship 2008) i) Invited consultancy to Arup Ltd. on concept design for building integrated photovoltaic project in Kuwait, Oct 2010; ii) Associates Committee (2009-12), Discovery Museum, Newcastle, to provide strategic direction including content related to academic research.
Azimov (Early Career (EC)): i) Editorial board, American J. Energy Res.; ii) Felix Weinberg Award for best paper presentation from Combustion Physics Group, Institute of Physics (IOP), 2011.
Birkett (EC): i) Royal Commission for the Exhibition of 1851 'Industrial Fellowship' award, 2006-09; ii) Invited talk, 22nd Annual CARTS Europe 2008, Helsinki, Finland.
Dai (EC): i) EPSRC Visiting Research Fellowship (UK-China Science Bridge, B4G), 2011; ii) Visiting academic at Institute for Infocomm Research (I2R), A*STAR, Singapore (2010) and Shanghai Research Center for Wireless Communications, Chinese Academy of Sciences (2011).
Inam (EC): i) IoM3 Materials World Award, '08; ii) Invited talk at HiPerNano '08 and DCREN 2010, UK; iii) Composites Programme Leader – Airbus Adv. Composite Training & Dev. Centre (2011-13)
Le-Minh (EC): i) Vice-secretary, IEEE UK&RI Comms Chapter (2011-present) ii) Guest Editor, MEDJEC; iii) Visiting Professor at Graz Uni. of Tech., May 2012.
Lewis (EC): i) Assistant Editor for the UK Editorial Office of the journal *Synlett* (2008-2012); ii) Invited speaker at first ACSEPT Intl. Workshop, Lisbon, Portugal, 2010 and ATALANTE Conference on Nuclear Chemistry for Sustainable Fuel Cycles, France, 2012.
Shyha (EC): i) Invited talk in The International Academy for Production Engineering (CIRP) January Meeting 2010 – Scientific Technical Committee (STC)-C, Paris, France; ii) Austin Rover Prize in Manufacturing Engineering, University of Birmingham 2010.
Trabi (EC): i) Session chair, Nottingham Trent University, School of Science and Technology Research Conference
Wells (EC): i) Society for Information Displays (SID) Sharp-SID Best Student Award 2010, UK/Ireland Chapter.
Xu (EC): i) Invited talk at APS Meeting, Baltimore, US, March 2013 and Haerbin, China, July 2010; ii) Reviewer for international journals: *Polymer Degradation* and *Stability and Nanoscience*.
Zoppi (EC): i) Reviewer for the Estonian Science Foundation research grants since 2010; ii) Invited workshop at second International Symposium on Environmentally Friendly Energies and Applications (EFEA 2012, UK).