

## Unit-level environment template (REF5b)

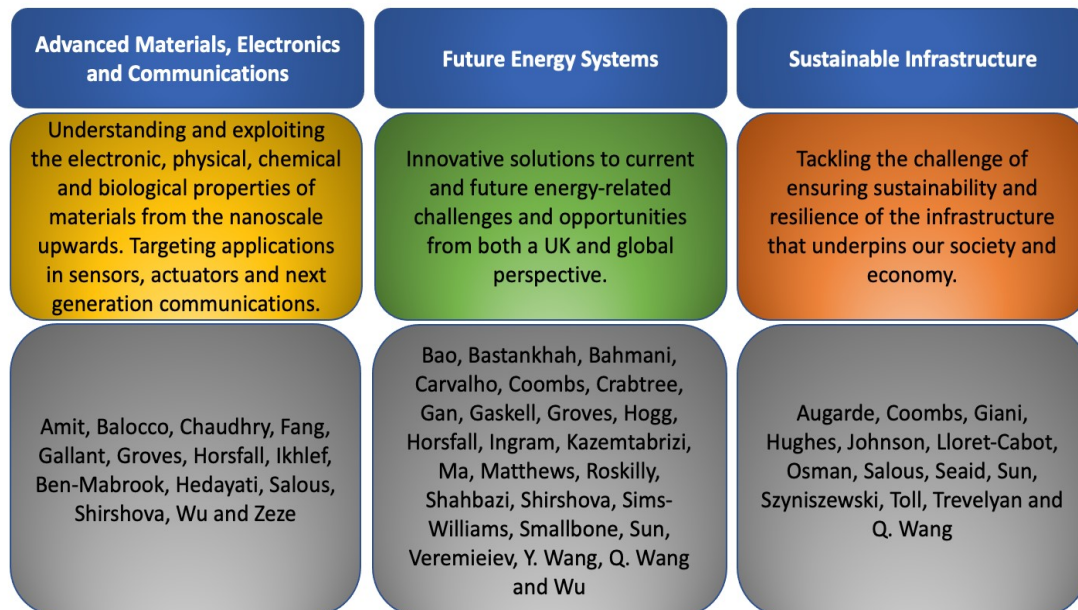
<b>Institution: Durham University</b>
<b>Unit of assessment: 12: Engineering</b>
<b>Section 1. Unit context and structure, research and impact strategy</b> <p>COVID-19 has caused significant disruption to the Department and University. The plans outlined in this document are accurate at the time of writing and are expected to be realised unless the duration or effects of the pandemic exceed current assumptions. Further details are available in the Institutional-level statement on COVID-19.</p> <p><b>Context</b></p> <p>Durham University has a long and distinguished history of delivering high quality research and teaching across the broad discipline of Engineering. It was the first UK university to run an Engineering degree programme, in 1838. Engineering research at Durham is delivered by staff and researchers housed in the Department of Engineering and is supported by two in-house technical workshops (electronic and mechanical) and a local administrative team.</p> <p><b>General Engineering</b></p> <p>The Department is one of eight departments within the Faculty of Science at Durham. Our strength is as a “General Engineering” department, where we pursue research and generate impact that spans across the traditional engineering disciplines and beyond into policy and industry. We work closely with several University Research Institutes to develop an interdisciplinary culture enabling environmentally, socially and economically sustainable research that addresses key global challenges.</p> <p><b>Staffing</b></p> <p>Within the sector we are a small department, with an academic staff headcount of 30% of the median for Russell Group Engineering Departments for the majority of the REF assessment period. The Department has 47 academic staff (45.25 FTE), including 17 Professors, 13 Associate Professors and 17 Assistant Professors.</p> <p>Our staff have a broad range of discipline expertise covering the traditional Engineering disciplines as well as Chemistry, Physics and Mathematics, and they come from diverse backgrounds, e.g. with just over 40% of Category A staff identifying as BAME. Although our structure has allowed us to maintain a high level of collegiality which enhances our ability to undertake innovative research beyond the traditional discipline boundaries, our present size is susceptible to the effects of staff movement when trying to maintain the critical mass required for world leading research. In response to this, the Department is now in the early stages of a period of strategic growth increasing our academic staff numbers to 80 FTE by 2024 including taking positive action to make a step change in our gender balance.</p> <p><b>Facilities Investment</b></p> <p>Engineering staff have shared space with Durham’s Department of Computer Science throughout the REF period. At the last REF, we were a joint School of Engineering and Computing Sciences. Durham University carried out a Meta-Review of its Science Faculty in 2016 in order to identify opportunities for restructuring and growth. The Meta-Review was strongly informed by the REF2014 outcomes which identified the need to focus our attention on producing world-leading publications and also to take action to strengthen the research environment supporting the production of these outputs. This included substantial investment</p>

in facilities, significant engagement with external partners such as Nature publishing group as well as actions to increase grant capture and PGR student numbers to bring these metrics in line with our competitors. This has been achieved; during this REF assessment period, the Department has received over GBP11M of direct infrastructure and facilities investment from the University which has supported our well-resourced laboratories and provided a vibrant working environment, where all staff have engaged with our research culture of “quality rather than quantity” in publishing.

### Restructuring

A key outcome of the Meta-Review was the recommendation to split the School, forming a separate Department of Engineering. The split from Computing Sciences was completed in 2017 and included a split in administrative support. Leadership roles that were previously shared across disciplines, for example the Director of Research and Head of Department, became Engineering specific. This provided an opportunity for the Department to develop a new Engineering-focused structure and vision as part of a 10-year plan for growth and investment.

The restructure provided the platform for the Department to develop a research portfolio which moved away from our traditional teaching-led groupings outlined at REF2014, i.e. Electronics, Mechanics and Energy, to become Global Challenge focussed: **Sustainable Infrastructure (SI)**, **Advanced Materials, Electronics and Communications (AMEC)** and **Future Energy Systems (FES)**, as below.



**Figure 1 – Durham Engineering Research Challenges and affiliated staff (many staff are members of more than one Challenge).**

This change has enabled us to maintain our multidisciplinary General Engineering ethos, but our research has become more clearly aligned with the key global challenges represented in both the UK’s Industrial strategy and the UN’s Sustainable Development Goals agenda. This has allowed us to better showcase our areas of strength. This problem-focused approach helps to promote collaborative research, both within the Department and also as part of large research consortia, with external partners from academia and industry. Strong multi-

departmental links to industry and policymakers often facilitated by our University Research Institutes, are our bridge to impact and have been maintained by establishing the Department's Strategic Advisory Board.

### **Expansion**

A 10-year expansion programme is now underway, and the Department is undergoing substantial headcount growth, ultimately aiming for 80 FTE compared to just 34 FTE Category A staff returned in REF 2014. One of the first steps taken to deliver this strategic growth has been to recruit **Professor Tony Roskilly** (former Director of the Joseph Swan Institute at Newcastle University) and colleagues and students from his wide research team. They joined the Department in 2019.

This new team includes four other academic/research track permanent staff hires, plus approximately 20 research assistants, technicians, and PhD students, which has resulted in an additional six Category A staff. The research team has brought new expertise in the decarbonisation of heat, hydrogen as an energy vector, energy storage and biomass combustion to the Department, along with significant new laboratory facilities, which are described in Section 3. Several active research grants were transferred from Newcastle with **Roskilly's** team. During the 12 months following their transfer, the team were successful in securing an additional GBP5.5M of new external research grant awards, of which over GBP3M will be spent at Durham on research that will be carried out within the Department.

### **Structure**

As a relatively small department, we have to be highly strategic and focussed in order to maintain the critical mass required to consistently deliver world-leading research on top of our major commitments to teaching a range of undergraduate and postgraduate courses. Delivery of the Department's research agenda is led by the Director of Research (**Johnson**) supported by a dedicated Senior Research Administrator (**Schindler**). The key strategic aims over this REF period have been: globally, to increase our impact on society; and locally, to improve the research culture within the Department.

We have used both strategic staff recruitment and development as a way of focussing these efforts in four main ways through:

- i) Increasing the number of outputs that can be classified as world leading as well as publishing with more international colleagues. We have achieved this by holding regular workshops both within Engineering and the Faculty of Science, three of which were with Nature publishing group to deliver our key message to research active staff and students of "quality over quantity". This message has been reinforced by the University assessing only four outputs for promotion.
- ii) Increasing PGR numbers through the identification of new funding streams to make our research environment more vibrant. We have spent time building PGR opportunities that are interdisciplinary and aligned with UK's Industrial Strategy and the UN's 17 SDGs.
- iii) Enhancing the Department's international visibility through securing and leading major collaborative grants. We have achieved this by working closely with both the Durham Energy Institute and Institute for Hazard and Risk and Resilience, so that we bring not only engineering expertise but also strong links with national and international policymakers.

- iv) Targeting recruitment at individuals, and groups, that not only fit in well with an existing Research Challenge but, importantly, build strength in the other challenges and in other departments at Durham to deliver interdisciplinary, environmentally, socially and economically sustainable research.

These strategic aims are fully supported by the University and align with many of the recommendations from the Meta-Review mentioned above. In fact, with our DoR, **Johnson** as Chair of the University SDG Group, we have been working closely with the PVC-Global on delivering the University's Global Strategy. Our [Research Challenge](#) structure ensures that the Department's core strengths and strong links with social science departments and our research institutes can better contribute to global challenges, and more accurately represent the interdisciplinary nature of much of our key work.

The Challenges, as shown earlier in Figure 1, are designed to clearly show the alignment of the Department's research portfolio with the UK's Industrial Strategy as well as with the [UN's 17 SDGs](#) which are an important part of Durham University's [Global Strategy](#). The Research Challenges cover the five "Foundations" of the UK's Industrial Strategy, with specific foci on "Infrastructure" and "Clean Growth". They also reflect our developing track record in winning and executing research programmes funded through UKRI's Global Challenges Research Fund. Areas of research excellence highlighted in REF2014 (Energy, Cleanroom Activities and Computational Mechanics) have been successfully absorbed into the Challenge structure via FES, AMEC and SI respectively.

This structure has facilitated an environment that encourages interdisciplinary research conversations to take place. These involve academic staff from different engineering and many other disciplines on common research themes, often including academic colleagues, policymakers and industrialists who are visiting us from across the globe. An important feature of the Challenge structure is that each academic staff member can belong to one or more Challenges. This ensures that staff whose research spans across the Challenge remit are supported. As an example, **Horsfall** (Associate Professor, joined in 2018), has research activity in both solid state transformer technology and microfabricated harsh environment devices (leading to a recently formed spin-out company, Nascent Semiconductor). These are areas which span the AMEC and FES Challenges. **Sun** is another example of one of our cross-cutting academics. He carries out research which ranges from Electric Vehicle charging (FES) to Smart Grid communication infrastructure (AMEC).

Our Senior Research Administrator, **Schindler**, produces a tailored [weekly research digest](#) which often features interviews with our staff and highlights upcoming social events. Each Challenge uses Departmental funds to host interdisciplinary research events, planning meetings and research seminars with external speakers from policy, industry and academia. These funds are accessible to research staff as well as academic staff in the interest of developing and supporting future independent researchers as well as existing and future collaborations.

### **Challenge leadership**

The Challenges are led by Directors (**Zeze, Toll and Gaskell**) all of whom are recognised international experts in their areas of research, with support from Deputies (**Gallant, Osman and Horsfall**). The Challenge Directors and their Deputies report to the Department's Research Committee which meets once a term and is chaired by the Director of Research. A Research Challenge progress report and plan is developed annually with input from all

members who feed into it using Personal Research Plans, which encapsulate their 5-year vision for their research as well as research environment and training needs.

### **Research and impact strategy**

The Department has a strong track record in leading and participating in large, collaborative, multi-partner research consortia (see Section 3 for examples). The Research Challenges have allowed us to strengthen and grow this activity.

The ongoing growth of the Department enables a strengthening of the existing Challenges where, for example, the Roskilly team have joined the FES Challenge. The Department's close links with industry as well as engagement with external partners through international research consortia and the University Research Institutes and Centres and funded PhD studentships, all contribute to dissemination and impact creation from the outputs of our research. To help guide development of our future research strategy, during the REF period, the Department of Engineering formed a Strategic Advisory Board which acts as a critical friend to help guide us going forward. The Chair is Professor Brent Cheshire CBE, the founder of Ørsted's UK operations and their Country Chairman and Managing Director up until his retirement in 2017. The Board membership includes Clark Macfarlane, Managing Director of Siemens Gamesa Renewable Energy Ltd, Ashley Ibbett, Acting Director General for Trade, Europe and Analysis, Department of Business, Energy and Industrial Strategy and Professor Sarah Hainsworth PVC & Executive Dean, School of Engineering & Applied Sciences at Aston University.

### **Impact**

In REF 2014, the Department was ranked fourth out of 62 submissions to the General Engineering UoA for Research impact, with 70% 4\* impact for case studies spanning biomedical, mechanical and electrical engineering. In this REF period, the Department has continued to place importance on identifying and supporting impact generation and case studies through a variety of activities. Impact strategy is determined by the Research Committee and led by the Director of Impact (**Augarde**). Impact is incentivised and recognised via the Department's workload allocation model (WAM), which allocates credits to the leaders of case studies and then limits their other teaching or administrative duties.

In a technically diverse department such as ours, keeping track of potential impacts is key and has to include those generated by staff who have left as well. The Impact Director maintains a "longlist" of potential case studies and oversees the training of staff in understanding and recognising impacts, via Departmental continuous professional development (CPD) seminars individually working with case study leads. The Director also works closely with REF colleagues from the University's Research and Innovation Services (RIS) central professional support team.

For REF2021, the selected case studies are all new, and, as in REF2014, are drawn from a broad spectrum of engineering specialisations, once again demonstrating the breadth of the research undertaken in the Department.

- The **SI Research Challenge** supports two impact case studies, 'Soil Health' (**Johnson**) and 'Rail Support Systems' (**Coombs**). 'Soil Health' exemplifies the Department's commitment and success in delivering impactful interdisciplinary research in a major project that involves working with social scientists and policymakers from outside the University in order to affect change in Government policy. Significant support and input for this work has been received from two of the University's research institutes, the Institute of Hazard, Risk

and Resilience (IHRR) and the Durham Energy Institute ([DEI](#)). “Rail Support Systems” is quite different and, unusually for Civil Engineering, shows economic impact associated with improved manufacturing processes of concrete railway sleepers. The impact has been enabled through Durham's long-standing strength in computational solid mechanics which dates back to Bettess' work in finite elements in the 1990s and 2000s, on to contributions in boundary element analysis (**Trevelyan** since 1995) and geomechanics (**Augarde, Osman** since 2000). Coombs, the impact case lead, studied for an EPSRC-funded PhD at Durham (2008-2011) under the supervision of Crouch, in computational geotechnics, and then took up a Lecturer post in 2011. **Coombs** is now an Associate Professor in the Department.

- The **AMEC Research Challenge** supports the ‘Radio propagation for 5G wireless networks’ case study. This has arisen from the pioneering work of **Salous** at Durham since 2005 and is now about to become highly significant with the roll out of 5G technology worldwide. This work has been underpinned by **Salous'** development of state-of-the-art radio sounders and RF anechoic chamber facilities, supported by the Department's Electronic and Mechanical workshops and Ofcom. **Salous'** findings have been incorporated into several ITU recommendations and also implemented in network planning software tools (e.g. RanPlan Ltd).
- The **FES Research Challenge** supports the ‘Vehicle Aero-Acoustics’ case study, led by **Sims-Williams**. It is built on long term investments in facilities (such as the Durham 2m Wind Tunnel) and staff with strong foundations dating back to the 1990s which have developed into robust partnerships with leading industrial players. For example, both Jaguar Land Rover and Nissan have made direct use of Durham's work on the impacts of unsteady on-road flows on wind noise.

Beyond the submitted case studies, during the REF period, SI Challenge research has had impacts in development of geotechnical test equipment (**Toll**), earthen construction (**Augarde, Hughes**), flood resilience (**Toll, Johnson**) and computational methods (**Augarde, Coombs, Giani, Trevelyan**). FES Challenge research has led to many non-academic impacts in electrical engineering for renewable energy generation built on the early 2000s by Tavner and successors, and linked to the DEI, for example test methods for assessing wind turbine blade fatigue (Dominy, **Ingram**). Members of the AMEC Challenge have carried out research for funded industrial projects with multinational companies such as Jaguar Land Rover (glass cleaning technology, EPSRC iCASE), BAE Systems (microwave materials, EPSRC iCASE) and Senstronics (industrial pressure sensors, Innovate UK KTP) as well as SMEs such as Viper Electronics (THz communications, ERDF studentship) and Teraview (THz optics, Technology Strategy Board). The outcomes from these and other such projects will lay the foundations for impact cases post-REF2021.

The Impact Director is also the Departmental contact for University-level schemes to help staff improve pathways to impact for ongoing research. These include the Global Impact Acceleration Account, leveraging GCRF monies, the University's own Research Impact Fund and the EPSRC Impact Acceleration Account. Engineering has been very successful in securing funds from these sources in this REF period. Examples of projects include:

- Manufacturing processes for collagen-based scaffolds (**Wu**, AMEC) which led to a successful patent;
- Field trials for flood-resilience of remediated soils linked to the “Soil Health” case study (**Johnson**, SI);
- A reliability test facility for wind turbine power electronics (**Crabtree**, FES).

The University also runs an annual award scheme and ceremony highlighting the top impact case studies across the University.

### **Research Integrity and Ethics**

The Department is committed to maintaining excellent standards of research integrity and ethics and sharing the results of its world class research through open access publications and datasets. Durham University Library staff and the Department's Library Representative (**Wang**) have also presented to staff on open access requirements and helped with compliance monitoring throughout the REF cycle. An open access publishing fund is accessible to all staff for UK Research Council funded outputs. Probationary staff receive training in integrity and ethics through their induction process. Additionally, all staff attend regular in-house continuous professional development courses related to these areas. This includes, for example, Responsible, Research and Innovation workshops run by an ORBIT approved trainer (**Groves**) and Ethics workshops led by the Department's Ethics Representative (**Carvalho**). Carvalho sits on the Science Faculty Ethics committee, handles the Department's Ethical Approval process and reports to the Board of Studies (the top decision-making body in the Department comprising all academic staff).

## **Section 2. People**

### **Staffing strategy**

As part of the University's 2017-2027 Strategy, and as described previously, the Department is undergoing a period of substantial growth. The core strategy to date has been to appoint new staff to strengthen or extend the research undertaken within the three Research Challenges providing critical mass. Examples of recent appointments for each Challenge (and their previous institutions) are given below:

**AMEC Challenge:** Strengthening and extending our expertise in: Optical metamaterials, Organic Light Emitting Transistors; low dimensional semiconductor devices; supported by the Department's cleanroom facilities; and also communication networks, devices and channel characterisation.

- **Amit** (Marie-Curie Research Fellow, Exeter)
- **Chaudhry** (COFUND Junior Fellow, Durham)
- **Hedayati** (Marie-Curie Fellow, Technical University of Denmark)
- **Fang** (Research Associate, Manchester University)
- **Ben-Mabrouk** (Assistant Professor, Al Ain University, Abu Dhabi)

**FES Challenge:** Strengthening and extending our expertise in: Harsh Environment Electronics, Solid State Transformers and the Decarbonisation of Heat; supported by the Department's cleanroom facilities, electrical engineering and thermofluids laboratories as well as current infrastructural new builds.

- **Bastankhah** (Postdoctoral Researcher, Ecole Polytechnique Fédérale de Lausanne)
- **Horsfall** (Royal Academy Senior Research Fellow, Newcastle)
- **Roskilly** (Professor and Director of the Sir Joseph Swan Centre for Energy Research, Newcastle) along with four further permanent appointments from his group (**Smallbone, Wang, Ma and Bao**)

**SI Challenge:** Strengthening and extending our expertise in fracture and contact mechanics, unsaturated and saturated soils and multi-scale composite lattices. Supported by the Department's computational solid mechanics expertise and civil engineering laboratory.

- **Lloret-Cabot** (Researcher, Newcastle, Australia and Marie-Curie Fellow, Glasgow).
- **Szyniszewski** (Assistant Professor, Surrey)

The majority of appointments in the REF period have been made at Assistant Professor (formerly Lecturer) level which has helped to ensure that the Department has maintained a well-balanced age distribution, to ensure its staff profile is sustainable for future REF periods. The median age of Category A staff is 42.

For new appointments, selection is carried out by a departmental selection committee which oversees the search process, longlisting and shortlisting stages. The search process is reported on before longlisting with confirmation that the applicant pool is sufficiently diverse, one member of the selection committee is specifically tasked with monitoring this aspect. To encourage diversity, committee members typically contact potential female and other minority group applicants directly. If diversity is not achieved at this stage, then posts are re-advertised. Shortlisting is guided by a REF-like assessment of, typically, four research outputs published or submitted within the current REF period. This process has ensured that our new recruits have strengthened the world-leading nature of our research portfolio in line with our strategic aims.

## **Staff development**

### **Mentoring**

The Department runs a mentoring scheme that supports both new and established staff members with separate mentors for teaching and research. This support includes assistance with grant writing and mentoring for Durham's Postgraduate Certificate in Academic Practice programme, PGCAP. All new academic staff are required to complete the PGCAP programme unless they have an equivalent qualification from another institution. The PGCAP is delivered through the Durham Excellence in Learning and Teaching Award (DELTA) pathway. The Department is committed to the Concordat to Support the Career Development of Researchers and the DELTA pathway courses are also open to postdoctoral staff and postgraduate students, aimed at those who intend to pursue an academic career. This leads to associate membership of the HEA.

### **Induction and training**

Department specific training, led by the Department's Mentoring Coordinator (**Veremieiev**) is delivered through a term-time, weekly continuous professional development (CPD) sessions which are timetabled to enable all staff to attend and, as of October 2020, they are also recorded.

### **Grant writing support**

Faculty research grant writing workshops are run twice yearly by Faculty of Science colleagues who have experience of UKRI panels. Engineering staff are invited on an individual basis, and all early career staff attend these workshops during their probation period. All external grant applications made by staff in the Department are peer-reviewed (by someone who is not a Co-Investigator) prior to submission. The University's Research and Innovation Services (RIS) provides support for grant costings and advice on compliance with funding body regulations.

RIS staff are available to meet face-to-face within the Department at least twice a week and also provide valuable comments on applications and check alignment with funding criteria and regulations. Academic staff are supported to undertake appropriate consultancy work, recognising that it can lead to wider publicity for research, new collaborations and impacts. The 'Rail Support Systems' case study provides a good example of the benefits of staff undertaking consultancy, where initial routine work for a manufacturer of railway sleepers by **Coombs** led



on to the application of advanced computational methods developed at Durham to impact specifically in terms of greatly-improved sleeper design.

### **Support for postdoctoral staff**

Postdoctoral staff are supported through their line manager and (separate) Annual Development Review (ADR) lead. The line manager and ADR lead can recommend training courses to assist with career progression. The cohort is also supported by an academic champion (**Johnson**). One key aspect is involvement with funding proposals: either for a fellowship or as a named Researcher Co-Investigator, e.g. within an UKRI proposal. The Department recognises that our postdoctoral staff play a crucial role in the Department, including assisting with PGR supervision and training, developing grant applications and generating high quality research outputs. To this end, we regularly support members of research staff to attend the [Aurora Leadership Programme](#). The last member of postdoctoral staff to attend this course has since progressed to take on a permanent academic position at the University of Delft in 2020. To assist in the early development of proposals (e.g. for network formation or for exploratory experiments) the University offers a seedcorn funding pot which can be accessed, typically up to a value of GBP5k per proposal. This utilises the 20% of their time which is allocated by UKRI for them to spend on their own research development, allowing these staff to gain direct experience of being a Principal Investigator. The last member of postdoctoral staff to win this funding has since progressed to take on a permanent academic position at the IIT in Delhi in 2020. One-to-one support is provided by colleagues from RIS. The Department (or University, for major applications) arranges mock-panel interviews. These procedures and support opportunities are available to academic staff as well as PDRAs and PGR students who are seeking Fellowship type funding.

### **Research Leave**

To give newly appointed academic staff time to develop their research careers, they are given a reduced teaching and administration load through the Department's workload allocation model, typically for three years but tailored to individual needs. Durham is now unusual in still allowing all post-probationary staff the opportunity to apply for Research Leave every one-term-in-seven when they are relieved of teaching and administrative duties. The Department is supportive of staff who may choose to accumulate, and take up, more than one term of leave (up to one year) and as a departmental convention, which extends above and beyond University policy. Engineering staff Research Leave covers the vacation time either side of the leave period. Research Leave is used in a variety of ways including prolonged overseas visits to collaborators, industrial placements to develop impact and proposal writing. Research Leave is automatically given to our staff who return from maternity or paternity leave.

### **Research Students**

Analysis of the REF2014 data showed a need to bring the number of research students per FTE within the Department in line with our competitors. To address this, we have placed an increased focus on attracting industry and government funding streams for PhD and MSc studentships. This strategy has resulted in many more research students now being funded in this way. For example, this has included Ørsted (formerly DONG Energy), BAE Systems, Jaguar Land Rover, GE, the Offshore Renewable Energy Catapult, Rolls-Royce as well as North East based SMEs such as OGI Groundwater Specialists, TRL9, Viper RF and AVID Engineering. The SME route has been supported by the Durham University led ERDF funded Intensive Industrial Innovation programme. Significant efforts have gone into coupling this approach with the University's internationalisation strategy in developing joint agreements for funding PGR students with several countries, including Mexico and China.

The Department has been particularly active and successful in attracting Mexican students through their Government's CONACyT programme, which is currently providing funding for 20 research students in the Department. This effort has been simultaneously fruitful in aiding the diversity and vitality of our PGR community and the Department overall. The EPSRC Prosperity Partnership (EP/R004900/1) includes four PhD studentships that are being fully funded by Ørsted. Our relationship with Ørsted goes back to 2011 when they began funding a Chair in Renewable Energy (currently **Hogg**) in the Department. The Company's involvement in the Prosperity Partnership project has secured this relationship through to at least 2022. Academics from the Department are also involved in two successful new UKRI Centres for Doctoral Training that have won funding through the most recent round.

- ReNU CDT in Renewable Energy Northeast Universities, led by **Groves** for Durham and aligning to our AMEC Challenge.
- Aura Offshore Wind CDT, led by **Coombs** for Engineering and supporting the FES and SI Challenges.

Both CDTs have a large number of industry partners and secure funding for PhD studentships in the Department in future years. The effect of the boost in PGR students from the CDTs and other funding streams is not yet evident in the REF4a completion data but will be after 2020 with, for example, 23 students scheduled to complete by the end of the 2021 academic year, and a further 32 by the end of 2022. The REF4a completion data does, however, help to highlight the Department's interdisciplinary research activities with around 20% of completed PhD students having had a member of their supervisory team from another Durham Department (e.g. Mathematics, Biosciences, Chemistry).

### **Overseeing Postgraduate Research**

Postgraduate Research in the Department is overseen by the Research Committee via the Director of Postgraduate Research (**Coombs**). The Department adheres to the guidelines of the University regarding Progress, Confirmation and Completion reviews (which take place at 9, 21 and 33 months). Every PGR student has a supervisory team comprising at least two members of staff, and a two-member, independent review team. A key part of non-technical supervision is an ongoing training needs analysis for all students to enable them to reach their potential as both students and post-PhD. The Department makes considerable use of the Durham Centre for Academic Development (DCAD) for training related to general academic skills, such as technical writing, presenting and teaching skills. The Department also leverages the relevant CDT training opportunities for subject-specific training materials. The voice of the Engineering PGR community is heard through a Staff Student Consultative Committee which meets once a term. It has a representative who sits on the major Departmental Committees, including the Board of Studies.

### **Department-wide Equality and Diversity**

Delivery of the Department's Equality, Diversity and Inclusion (EDI) agenda is handled by its EDI Committee, which reports to the Board of Studies through the Director of EDI (**Gallant**) who is a member of the Department's Strategic Leadership Group. All new staff receive EDI related training, e.g. in unconscious bias. The Director of EDI has oversight of training records, funding applications and REF output submissions to monitor for any bias against minority groups. For REF output selection, this has included ensuring a representative balance of papers versus the profile of Department in terms of gender, ethnicity and early career status.

We foster a welcoming, respectful environment for all staff, students and visitors to the Department. Such an environment is conducive to attracting new staff and produces the

widest, and most diverse, talent pool when recruiting to posts. The Department has become significantly more diverse during the REF period; just over 40% of Category A staff identify as BAME (up from 20% in REF2014) and 15% as female (up from 8% in REF2014).

The Department holds an Athena SWAN Bronze Award, valid until 2022 when we will apply for a Silver award, as recognition of our commitment to the advancement of gender equality: representation, progression and success for all. We continue to work hard to improve our gender balance and this is of foremost importance in our research staffing strategy. As an example of a gender-related initiative within the REF period, the Department purchased Sheryl Sandberg's "Lean In" book for all first-year engineering students. This helped to generate broad discussion about the topic of diversity, led to external publicity (including in [Nature News](#)) and a [Lean-In group](#) now exists within the University.

To ensure fair and equitable career progression for all within the Department, the promotion process considers a range of factors which are clearly defined through the role expectations for academic staff, assessed by Department and Faculty Progression Committees. When considering staff progression and promotion, the Department (and University) has moved in the REF period from an "apply for promotion when ready" approach to an "apply annually" approach via submissions of CVs to a Departmental Progression and Promotions Committee (DPPC). This change was enacted to ensure that all staff are considered and promoted when they meet the University's progression criteria, supporting female and other minority group staff who may be less willing to put themselves forward. In terms of senior promotions within the REF period, the Department has three female Professors (versus one in REF2014) and 29% of Professorial staff identify as being from BAME backgrounds (versus 10% in REF2014).

The Department's Workload Allocation Model (WAM) is used to ensure that academic staff members receive a balanced teaching and administrative load that allows them to devote sufficient time to delivering excellent research either through managing existing grants or developing funding proposals. In designing the WAM, great care was taken to ensure that it does not disadvantage staff who are at early career stages, or who have taken career breaks. In particular, it is recognised that successful senior academics can build significant research groups, and that the staff who have not had the opportunity to do this should not be penalised by having to take on more teaching and administration to compensate.

Each member of academic staff receives an annual allowance to spend on research activities (e.g. conference attendance). To reduce barriers to travel for staff with caring responsibilities, up to GBP200 per day can be claimed to cover, for example, childcare when attending a conference. Academic staff can also arrange flexible working through timetabling requests.

The Department organises two flagship public lectures annually (Higginson and Sir Gareth Roberts, jointly with the Department of Physics) and uses them as an opportunity to invite outstanding STEM role models to the University. Recent speakers have included Professor Dame Ann Dowling on her work on Aeroacoustics, and the Athena SWAN Charter founder, Professor Dame Julia Higgins.

### **Section 3. Income, infrastructure and facilities**

#### **Income**

The annual research income for the Department has remained stable throughout the majority of the REF assessment period at an average of GBP50K per annum per FTE. Of this, 58% of the reported spend over the period can be attributed to Research Council Grants; 20% from

EU funded projects; with the remainder primarily from UK industry and government grants. However, from 2019-20, the growth of the Department is reflected in the REF4b/c figures with the annual spend rising to GBP2.8M (versus a GBP2.1M three year rolling average). In 2018/19, we focused efforts on improving our postgraduate research income. These efforts have been successful, and we have brought in GBP1.26M in our Aura and ReNU CDTs. This is in addition to the large number of PGR students that we now have funded through the CONACyT scheme and industry through major projects such as the Prosperity Partnership Programme. We are also engaged with Durham University's Global Challenges Research CDT, where the Department currently has had three of the 26 PhD students funded through this initiative (a UK first).

The Department benefited from substantial internal investment in infrastructure since 2014. This includes over GBP11M of investment by the University in Infrastructure and Facilities. We have also established a new research laboratory in a rented building on a business park on the outskirts of Durham, that provides some additional laboratory space for **Roskilly's** team. This investment by the University has resulted in significantly enhanced research space for students, staff and undergraduates, throughout the Department.

### Major Grants

The vitality of Durham Engineering is evidenced not just through research grant income but also by our input to a large number of >GBP1M research projects and collaborations, often in a leading role. Since 2014, the Department has been involved in capturing grants with a combined project value of greater than GBP40M, including a number of large collaborative grants. Examples of major world-leading collaborative research programmes (total project values > GBP1M) in each Research Challenge area that have been awarded and launched in the current REF cycle, are given below:

#### FES Challenge:

- EPSRC Prosperity Partnerships (EP/R004900/1) "A New Partnership in Offshore Wind". A 5-year GBP7.5 million collaboration launched in 2017 and involving international industry partners Siemens Gamesa, Ørsted and the Universities of Durham, Hull and Sheffield (lead). Durham University's contribution (**Hogg, Matthews, Crabtree, Ingram, Augarde and Coombs**) aims to reduce the operation and maintenance costs of offshore wind turbines (SDG7) to ensure the efficient running of wind farms, and aspects of civil engineering infrastructure provision offshore such as foundations and anchoring. Technologies being developed at Durham include new methods and sensors for earlier detection of emerging faults before the turbines need to go offline, better turbine blade and tower inspection techniques, improved understanding of the impact of blade erosion on wind turbine performance and better designs for seabed anchors. All of these developments are aligned with the overarching aim of the collaborative project, which is to reduce the costs of energy from offshore wind. This consortium formed the underpinning basis for the UKRI [AURA CDT](#).
- A Network for Heating and Cooling Research to Enable a Net-Zero Carbon Future (EP/T022906/1). Durham University (**Smallbone, Chin, Bao**) leads the GBP1.16 million international research and innovation network on behalf of UKRI. It will be bringing together researchers, technology developers, managers and policymakers to facilitate learning, share progress and new knowledge, and to fund new research projects for [decarbonising heating and cooling](#) (SDG 7 and SDG13). A wide range of universities, industrial bodies and governance organisations are also partners in the project including BEIS, Energy Systems Catapult, European Energy Research Alliance, Durham County Council, GE (General

Electric Company), E.ON Energy Solutions Ltd, North East Process Industry Cluster (NEPIC), Narec Distributed Energy.

### **AMEC Challenge:**

Challenge members have shown significant success in the capture and delivery of major EU-funded projects, totalling over Euro14M during the REF period.

- EU ITN INDEED (GA 722176). A Marie Curie Innovative Training Network (ITN) project on “Innovative Nanowire Device Design”. This is a 4-year project led by Durham Engineering (**Zeze and Gallant**) which involves 12 academic institutions and 13 industry partners from across Europe training 17 PhD students (15 funded by the EU and 2 by Russia). This project aims to progress the translation of nanowire-based technology to more customer-oriented scientific R&D. In addition to leading the project, the Durham Engineering contribution is in the development of pressure sensitive materials and architectures for ZnO based nanowires which have applications in H<sub>2</sub> and O<sub>2</sub> splitting from water, a fundamental mechanism for sustainable future energy supplies (SDG7). The consortium builds on the success of the earlier EU FP7 funded Initial Training Network, *Nanoembrace* (also led by **Zeze and Gallant**).
- EU ITN WAVECOMBE mmWave Communications in the Built Environment (GA 766231) which involves five European countries including four universities and three industrial partners, training 11 early stage researchers (ESR’s) with 2 ESRs registered for PhD studies at Durham University. Durham (**Salous**) leads WP2: Characterisation and modelling of radio propagation channels at mmW bands with input into the International Telecommunications Union recommendations on rain statistics in the UK and its impact on 5G radio links and propagation models for indoor environments.

### **SI Challenge**

- Challenge members lead the GBP4.9M Achilles (EP/R03457/1) research consortium which works to develop tools to assess, monitor and repair the ground beneath or around infrastructure systems (e.g. pylon, pipe or rail track); the GBP1.8M CACTUS (EP/R005834/1) project which addresses the effect of climate change on the urban geo-infrastructure and the GBP1.3M GCRF WindAfrica project (EP/P029434/1) which is accelerating the uptake of wind energy (SDG7) through foundation development in Africa.
- EPSRC (GCRF) (EP/P029671/1) “Sustainability and Resilience of Transportation Infrastructure in African Countries” is a 3-year project led by Durham which addresses the global challenge of providing sustainable and resilient transport infrastructure for African countries. It brings together Durham University (**Toll, Johnson and Hughes**) with Kwame Nkrumah University of Science & Technology (Ghana), University of Pretoria (South Africa) and Nyaoro & Associates (Tanzania). The research investigates (i) the use of sustainable (locally occurring) construction materials (SDG12) in road construction and (ii) the impacts of climate change (SDG13) on transportation infrastructure. A key enabling element for (ii) is the high suction tensiometers technology developed at Durham and commercialised by a spin-out company, [Durham Geo-Technologies](#) (founded by **Toll**).

### **Infrastructure and Facilities**

The Department has been successful in securing University funding through capital equipment rounds for targeted (either underpinning or strategic) investments in several specialist research facilities spanning all three Research Challenges. These include the following which have been funded and/or opened during the REF period.

- The establishment of the state-of-the-art **Vadose facility** in the geotechnical lab (GBP300k). This unique-to-the-UK facility is built on the Department’s existing experimental

capabilities in partially saturated soil mechanics. It includes the creation of a test environment for near surface soils (material within the Vadose Zone) which form a critical component within our engineered and environmental infrastructure, including vital work to support the 'Soil Health' impact case study.

- **Geotechnical lab** (Advanced Automatic Soil Testing Systems) (GBP180k). During the REF period, the Department's success in GCRF and EPSRC funded grant capture led to existing triaxial and shear test systems reaching operational capacity. This funding augmented our Advanced Soil Mechanics testing capabilities.
- **Electrical engineering research laboratories** (GBP352k). Addressing an identified need to ensure Durham was competitive in the UK: This investment delivered a major upgrade to the Electrical Engineering R&D facilities supporting the innovative designs of future flexible AC/DC power networks; design and testing of control methodologies for advanced power electronic converters; design and validation of novel electrical machine topologies for special applications in renewables, aerospace, electric vehicles and wider industries; improved real-time simulation of ultra-fast power system phenomena; condition monitoring and reliability evaluation of electrical machines and drives for renewable energy systems (supported by the DEI and Ørsted).
- **Smart Energy Tech Hive** (SETH) (GBP500k). An experimental low voltage distribution network with GBP400k RTDS which was upgraded in this case. It is a new technology demonstration platform capable of demonstrating various smart energy technologies such as blockchain based peer-to-peer energy trading, Internet of Things (IoT) based smart home, energy-powered markets and a smart fish farm. SETH supports engagement with industrial partners and other stakeholders to allow them to test their new products and services.
- **Nanoengineering for Renewable Energy and Scanning Microwave Microscope** (GBP829k). This funding introduced new tooling for nanoscale film growth and patterning within the Durham cleanroom and has been used to underpin both the Department's EU ITNs and EPSRC funded projects (e.g. EP/K016857/1 Electronic nanodevices for energy harvesting: a novel approach to thermal-energy conversion). The scanning microwave microscope (SMM) enables the advanced study of morphology and electronic properties of nanomaterials and related devices.
- **Terahertz testing laboratory** (GBP400k). This brought world class Terahertz metrology facilities to the Department of Engineering through the creation of a new laboratory equipped with a THz Time Domain Spectroscopy system and one of the few THz Vector Network Analysers in the world. The laboratory has supported the researchers employed by the EU NOTEDEV ITN as well as SMEs (e.g. Teraview Ltd).

These facilities complement, or strengthen, our established experimental infrastructure in cleanroom based micro- and nanofabrication tooling (200m<sup>2</sup> class 1000 facility), wind tunnel testing (2m and a member of SATA - Subsonic Aerodynamic Testing Association), communication network characterisation (e.g. anechoic chamber and radio sounders up to 90 GHz) and XRCT imaging (funded by EPSRC). Many facilities have or continue to support non-academic impact generation; as described earlier, the anechoic chamber is linked closely to the "5G" case study and the 2m Wind Tunnel to the "Vehicle Aeroacoustics" case. The Department has access to the University's GJ Russell Electron Microscopy Facility, for which **Gallant** is the Facility Director. The Facility houses a Transmission Electron Microscope (used for nanomaterial characterisation) and three Scanning Electron Microscopes (including Variable Pressure / Environmental systems which are particularly relevant for studying wet soil samples). For computational work, Durham University's *Hamilton* cluster is available which is a Linux based High Performance Computing facility.

The expansion of the Department includes major structural work to support the experimental needs of the **Roskilly** team. This includes the formation of two new laboratories (described below) which are scheduled for completion in 2021 and establishing the new rented laboratory facility for the team, as mentioned earlier. This represents an additional GBP500k of investment by the University in the Engineering Department's research facilities.

- **Thermochemical System Laboratory:** This laboratory is designed to accommodate a range of test equipment and cutting-edge research facilities for developing and implementing innovative thermal-driven low carbon technologies. We are creating an interdisciplinary endeavour on a spectrum of low carbon technologies including thermochemical heat pump, drying and desalination and energy storage, liquid and solid desiccant systems, phase-change-materials (PCM) thermal energy storage, through the development of novel thermodynamic processes, advanced energy materials and efficient heat exchanger/reactor, operation controlling strategy and so on. The Thermochemical Lab will be further extended with the funding from three newly awarded EPSRC projects worth around GBP2.2M in total, growing our world-leading research and innovation infrastructure.
- **Zero-Emission Laboratory:** The Government's 10 point green revolution highlights the need to decarbonise heat and to accelerate the "hydrogen economy" to underpin both the transport and heating sectors. Hydrogen from renewables offers highly scalable and flexible demand which can be managed to exploit renewable wind electricity generation capacity to balance the daily, weekly and seasonal dynamics of the wider energy system. The Zero-Emission Lab is designed and equipped with advanced research facilities to allow a wide range of development and testing of new technologies for operation with or for compatibility with hydrogen. The primary research activity currently in the Zero-Emission Lab involves hydrogen-based zero-emission engine generators for decarbonising heat and transport, supported by a variety of collaborative projects funded by EPSRC, Innovate UK and North East Local Enterprise Partnership, worth around GBP3M in total. The world's first prototype system of the patented design for a high efficiency free-piston engine (FPE) generator is under development and testing through a GBP500k project funded by Innovate UK. As the next evolution of the FPE, a 25kW zero-emission closed-loop linear Joule cycle engine (ZECCY) generator prototype will be designed, built and demonstrated through a GBP1million EPSRC project. With EPSRC funding support (GBP1million), Durham coordinates a UK national future hydrogen fuelled transportation network, bringing together all relevant stakeholders and leading technology developers from across a number of cross-cutting themes, further extending and reinforcing our research facilities and capability in the Zero-Emission Lab.

#### **Section 4. Collaboration and contribution to the research base, economy and society**

The Department has worked closely with Durham's Research and Innovation Services (RIS) to help strengthen existing and to develop new interdisciplinary and international research collaborations across all of our three Research Challenges. This research is facilitated by our University Research Institutes ([URIs](#)) and [Research Centres](#). The URIs bring together individuals and groups from across the University with industry and policymakers to create the interdisciplinary critical mass needed to address global challenges. In contrast, our Research Centres are typically more thematically focussed than the URIs.

The most relevant of the URIs to Engineering are the Durham Energy Institute ([DEI](#)) and the Institute of [Hazard, Risk and Resilience \(IHRR\)](#). Because of this facilitation by URIs and RIS our research projects stretch beyond the pure technical, and into the social and economic aspects of the research undertaken.

The Department's staff are active in, and contribute to, the leadership of several of the URIs and Centres. During the current REF period, **Hogg** has been Executive Director of the DEI, **Wu** has been a Co-Director of the Biophysical Sciences Institute, **Johnson** has been a co-Director of the Institute of Advanced Study and **Roskilly** is a current Co-Director of the DEI. **Salous** leads the University's Research Centre for Communication Systems and **Groves** leads the Centre for Molecular and Nanoscale Electronics.

As described previously, we are leading multidisciplinary consortia with other world-leading Engineering departments, key industrial strategic partners and policymakers across the world. The GBP1.27M "Developing performance-based design for foundation systems of wind turbines in AFRICA (Wind Africa)" project led by **Osman** and working with policymakers in Tanzania and Sudan to transform energy production in these countries, is one good example of this. Here the team is working closely with the African Union Development Agency to accelerate the development of sustainable infrastructure for renewable energy (SDG7) in Africa by providing reliable and economical foundation solutions combining our expertise in experimental, computational and policy aspects of wind energy. The GBP1.72M CACTUS "Climate Adaptation Control Technologies for Urban Spaces" led by **Toll** is another example of a collaborative project from our Sustainable Infrastructure Challenge, where Durham University is leading the way in a transformational collaborative project which brings together Queen's, Cardiff, Dundee, Durham, Imperial and Newcastle Universities and Northumbrian Water Group. Together, they are exploring how to transform the way engineers work with soils (SDG15) in our urban spaces, to both mitigate and adapt to climate change (SDG13).

Durham University's involvement as a founding partner in Hull University's Project [Aura](#) has been led by **Coombs and Hogg**. Project Aura is the first regional cluster which will support research development and innovation, skills development and supply chain development for the rapidly expanding offshore wind industry (SDG7) and the first to consider the impact of this industry on the marine environment (SDG14). The founding partners were Hull, Durham and Sheffield Universities, Siemens Gamesa (the world's largest Wind Turbine OEM), Ørsted (the world's largest offshore wind farm developer) and the Offshore Renewable Energy Catapult. The Aura partnership has already led to two large RCUK investments during the last two years. These are the EPSRC Prosperity Partnership "A New Partnership in Offshore Wind", and the EPSRC/NERC Aura CDT. The Offshore Wind Sector Deal announced by BEIS in March 2019, includes the establishment of several regional clusters around the UK, including one in the North East (NE), based on the model established by Aura. The NE cluster, Energi Coast, was formed immediately following the announcement of the Sector Deal. **Hogg** is a member of the Energi Coast Management Board and, with support from the DEI, formed and leads the Cluster's Innovation Group. The Group has a leadership team consisting of over 20 members drawn from local industry partners, global wind farm developers and an OEM with interests based in NE, NE Universities, Aura, ORE Catapult and the NE and Teesside local enterprise partnerships.

The [National Centre for Energy Systems Integration](#) is another example of a major collaborative research project that the Department contributes to under our Future Energy Systems Research Challenge. This GBP5.4M collaboration involved the Universities of Newcastle, Durham, Edinburgh, Herriot Watt and Sussex. There are many industry partners headed by Siemens who have made a major investment in the project. In addition to Engineering, the DEI, Departments of Anthropology, Mathematics, Earth Sciences and DUBS, are all involved from Durham University, underlining our interdisciplinary engagement in support of major collaborative projects of this nature.



Members of the Advanced Materials, Electronics and Communications Challenge have led two EU Innovative Training Networks (ITNs) during the REF period, focusing on PGR training in THz device and technology development (NOTEDEV); and nanowire growth and exploitation (NanoEmbrace and INDEED). These ITNs have dedicated training programmes which support the personal and professional development of the PGR students and include research engagement with a range of partner universities and companies. Regular training events have been organised throughout the REF period, with workshops and conferences held in places such as Morocco, St Petersburg, Iceland, Prague and Paris.

Many of these collaborative research projects that we have led and the facilities that we have invested in within this last REF period have been used by engineering academics throughout the world. Our recently improved Geotechnical laboratories and the XRCT lab (which is available for use across the N8 HE Institutions) have been accessible to postgraduate students and academics from across Southern Africa in **Osman's** Newton funded "Unsaturated Soils Mechanics for Engineering Practice (UnsatPractice)". This collaborative use of our equipment and facilities has allowed us to further develop our links and work more closely with this global south region.

### **Collaborative Development of Early Career Researchers**

Durham Engineering has a track record of leading international collaborations for the training and development of early career researchers. As an example, within the UnsatPractice doctoral exchange scheme with South African Universities supported by the Newton Fund, Durham researchers (**Osman and Toll**) ran Doctoral Schools in Durham and Sun City, South Africa on geotechnical engineering, specialising in tropical and unsaturated soil behaviour. **Osman** also organised a Workshop in Kuala Lumpur, Malaysia in January 2018 on "Increasing Climate Resilience of Urban Infrastructure" to which **Toll** contributed. It was funded by the Newton Fund Researcher links with Malaysia scheme. In all, 20 young researchers from Malaysia and 20 young researchers from the UK attended the Workshop. Johnson also ran an online workshop in July 2020 for researchers from her GCRF network on SDG7/SDG12/SDG15 disconnects. This was attended by 30 international researchers who created short [animations](#) which are being used by all partner institutions to educate and engage staff and students on the SDGs

Linked to the Sustainable Infrastructure Challenge, Durham was also a leading member of the ITN, TERRE ("Training Engineers and Researchers to Rethink geotechnical Engineering for a low carbon future", 2015-9) which organised bi-annual Schools for early stage researchers (ESRs) in Durham, Delft, Naples, Lausanne, Barcelona and Glasgow. TERRE was innovative in that every ESR spent time at, and was jointly supervised by, two institutions via Cotutelle agreements, receiving dual awards.

### **Contribution to the Research Base**

Beyond winning research income and writing outputs, Durham Engineering staff contribute to the research base, economy and society across the academic spectrum as follows:

#### **Discipline Service and Leadership:**

Just under a fifth of our staff are full EPSRC College Members; over two thirds of staff have reviewed research proposals for national and international funding bodies (e.g. US National Science Foundation, German Research Foundation, Australian Research Council, Israel Science Foundation, Canadian Research Council, EU H2020) within the REF period. Augarde became a Fellow of the Institution of Civil Engineers in 2015 joining our other Institution

Fellows: Toll (FICE), Hogg, Trevelyan (FIMEchE), Salous (FIET), Zeze (FIET) and Gaskell (FIMA).

Both **Zeze** and **Horsfall** have held RAEng Senior Research Fellowships. **Zeze's**, which was co-funded by the Leverhulme Trust, (2014) explored nanoscale characterisation and an integration platform for nanowires, **Horsfall's** (2017) focused on electronically readable quantum sensors. **Wu** was awarded the Rosetree's Trust Interdisciplinary Award for Bioengineered Lenses; the first such award for Durham, recognising excellence in biomedical research. **Amit, Chaudhry, Hedayati, Lloret-Cabot** have all held Marie Curie Fellowships within the REF period, prior to their appointment at Durham.

Eighteen staff members have given over 40 invited, plenary type talks during the REF period. This has included participation at major public research outreach events such as **Shirshova** presenting at the invitation-only European Foundation Sharing Science: Towards New Horizons in 2018. Linked to one of the impact case studies, **Salous** gave invited talks on recent ITU propagation models for millimetre waves at EUCAP 2017 and 2020.

As examples of international recognition of our outputs, **Augarde** and **Coombs'** paper, "*Parallel computations in nonlinear solid mechanics using adaptive finite element and meshless methods*" published in Engineering Computations was selected by the journal's editorial team as a Highly Commended paper in the 2017 Emerald Literati Network Awards for Excellence. **Coombs** and **Giani's** paper won an award in 2019 from the International Journal for Numerical Methods in Engineering recognising one of the journal's most downloaded recent papers. **Lloret-Cabot** won the best paper award in Georisk (2015) and the most cited paper in 2018 from the same journal.

Durham Engineering staff have chaired the following national and international committees:

- **Augarde:** President, UK Association for Computational Mechanics (UKACM) 2016-19 and was also a member of the IStructE Northern Counties Committee and ICE Northern Geotechnical Group Committee (until end of 2016)
- **Salous:** International Chair of Commission C on Radiocommunication Systems and Signal Processing of the International Union of Radio Science, (URSI) (2014-17), Chair of Correspondence Group CG 3k-5 providing guidelines for measurement equipment and procedures for data contributors to the International Telecommunications Union, which is a UN agency. Salous was the only academic contributor worldwide to the model adopted for 5G propagation in the recommendation ITU-R 1411-9 in preparation for the World Radiocommunications Conference, WRC-2019. Salous also co-chaired the largest working Group in the EU COST action, IRACON (2016-date) and is a member of the IET Antennas and Propagation Committee.
- **Sims-Williams:** Chair, Society of Automotive Engineers Road Vehicle Aerodynamics Committee (2012-2018)
- **Toll:** Chair of Technical Committee TC106 on Unsaturated Soils of the International Society of Soil Mechanics and Geotechnical Engineering (ISSMGE). Chair, Institution of Civil Engineers North East (2013-14). Chair, Joint Technical Committee JTC2 of the Federation of International Geo-Engineering Societies (representing ISRM, ISSMGE and IAEG) (2005-2017)
- **Ikhlef** was co-organiser of IEEE WCNC'2016 Workshop on Wireless Powered Communication Networks, Doha, Qatar, 2016, Co-Chair IEEE ICC'2017 Workshop on Emerging Energy Harvesting Solutions for 5G Networks. Held in Durham in 2018, he co-organised a full day EPSRC CommNet 2 workshop on Communications and Signal Processing for beyond 5G.

- **Q. Wang** was Conference Chair for ASME, 22nd Design for Manufacturing and Life Cycle, Cleveland, Ohio, 2017 (also was a Program Chair the year before) and Vice-Chair for the Design for Manufacturing and Life Cycle Technical Committee, ASME, 2019 (formerly Secretary in 2018).
- **Ingram** is Point Contact for the ASME Turbo Expo Steam Turbine Committee and is in charge of coordinating the session organisers.
- **Coombs** is the UK Representative for the European Community on Computational Methods in Applied Sciences (ECCOMAS) Young Investigators Committee.
- **Roskilly** is the Director of Network H2 - A network for hydrogen-fuelled transportation and also the Thermal Energy Challenge Network.

Academics from the Department are active in bringing major international conferences and workshops to Durham. For example:

- **Osman and Toll** organised the British Geotechnical Association's biennial conference that will be held in 2021 (Piling 2020, delayed by COVID-19). The Department was scheduled to host the 2020 International Conference of the Engineering Mechanics Institute (EMI) of the American Society of Civil Engineers (ASCE). The conference was also postponed due to COVID-19 with likely rescheduling in 2022. Recent meetings have been held at MIT (2018), Tongi University (2018), CalTech (2019), and INSA Lyon (2019).
- **Sun** is Chair of the International Workshop on Integrating Communications, Control and Computing Technologies for Smart Grid (ICT4SG) which has been held annually since 2015. He has also chaired International Workshops on Connecting All Things for Enabling Smart Cities (CONTEST) since 2015.
- **Salous** organised Commission C programme for the Union Radio-Scientific Internationale (URSI) General Assembly and Scientific Symposia held in 2014 (Beijing) and 2017 (Montreal); each with over 1500 attendees, TPC organising committee of the European Conference on Antennas and Propagation held in London 2018, and two sessions involving the IET Antennas and Propagation Committee and the EU COST action IRACON, in EUCAP 2019 and 2020. As a member of the IET antennas and propagation committee she also co-organised the IET Antennas and Propagation conference in 2019 and 2020 and a joint workshop IET/IRACON held in Durham in 2016.
- **Amit** won a UK-Israel Synergy grant from the British Council to hold a symposium on "Disordered and Defect-Rich Nano-Materials for Electronics" in Durham in September 2019. **Amit** is also co-Chair of the Institute of Physics Early Career Researcher's Group.

Our staff hold, or have held, visiting academic positions internationally. For example:

- **Balocco, Gallant and Zeze** (ITMO University)
- **Gaskell** (University of Canterbury, Christchurch NZ, Bayreuth University and Technical University of Heilbronn)
- **Giani** (Umea University, Sissa International School, Aalto University)
- **Hughes** (Newcastle and Loughborough)
- **Ingram** (Royal Military College Ontario)
- **Matthews** (Ørsted, Copenhagen)
- **Seaid** (University Paris 13, Aachen University, Universidad Rey Juan Carlos, University of South Pretoria)
- **Shirshova** (Visiting Academic at the Max-Planck Institute of Colloids and Interfaces, Potsdam, Germany, June-July 2016 and Poitiers University)
- **Sun** (Chinese Academy of Sciences, Sichuan University)

- **Roskilly** (Beijing Institute of Technology and Zhejiang University)
- **Trevelyan** (Colorado School of Mines, Universite de Technologie de Compiegne)
- **Q. Wang** (Tsinghua University)
- **Wu** (MIT)

### Journal Editorships / Board Members

Engineering staff hold, or have held, positions on editorial boards of the following international journals:

- Computers and Geotechnics
- Computers and Structures
- Energy Reports
- EURASIP Journal on Wireless Communications and Networking
- Geotechnical and Geological Engineering
- Géotechnique
- Géotechnique Letters
- ICE Proceedings - Geotechnical Engineering,
- IEEE Communications Letters,
- IEEE Transactions on Emerging Topics in Computational Intelligence
- IET Smart Grid (Editor in Chief)
- International Journal of Optimisation and Control: Theory and Applications
- International Journal of Research in Computer Science.
- Journal of Communications and Networks
- Journal of Materials Science: Materials in Electronics
- Radio Science (Editor in Chief) a publication of the American Geophysical Union, Communications Systems,
- Soil Security
- Springer Nature
- Theoretical and Applied Fracture Mechanics
- Underground Space

### Contribution to Economy and Society

Highlighted specific contributions to policy where RIS and the DEI and IHRR have facilitated the Department to have policy impact include:

- **Adam's** work (**Adams and Bell** 2015) supported by the DEI advocates interdisciplinary collaboration and community engagement for planning energy projects and has been used by workers considering energy justice in other countries, Nepal (Damgaard, et al., 2017) and Canada (Keilty et al., 2016). **Adams** continues to lead the way in championing geothermal energy as a potential resource in the UK. The research approach has been debated in Westminster and led to changes in policy. **Adams** won a Geological Society medal for her work on ultra-low enthalpy geothermal energy and an "Energy Champion Award" by the UK Energy Institute for her research into the potential of using geothermal energy as a low-carbon heat source.
- Working closely with RIS and IHRR, **Johnson's** work in soil health helped launch the UK's first Soil Health Inquiry. **Johnson** has worked with a wide range of audiences including artists and public health regulators around soil health since 2014 after completion of her GBP1M EPSRC ROBUST grant. Johnson's support by the DEI and IHRR has enabled her input of 4 lots of written evidence to 4 separate Governmental Environmental Audit Committee inquiries as well as one lot of oral evidence.
- Coordinated by the DEI, with input from **Carvalho, Hogg** and **Sun**, written evidence (BES0013) was submitted to the Parliament EU Energy and Environment Sub-Committee's Inquiry on Brexit: Energy Security. This written evidence was cited five

times by the House of Lords European Union Committee 10th Report of Session 2017-19. "Brexit: Energy Security".

- Highways England's 2018 Briefing paper "Resilience of the Strategic Road Network" identifies *impacts of severe weather and climate change on geotechnical assets* as a knowledge gap that they are addressing through working with the iSmart project (EP/K027050/1, GBP1.67M), with Durham researchers **Hughes** and **Toll**. Highways England are responsible for motorways and major (trunk) roads in England, a network totalling 4,300miles. They will deliver GBP15billion of investment on the UK road network as described in the government's Road Investment strategy, including GBP11billion of capital funding between 2015 and 2020. Highways England continue as partners of the ACHILLES programme grant (EP/R034575/1, GBP4.9M). **Hughes** is co-author for the Committee on Climate Change's Risk Assessment Evidence Report 2017 which was put before Parliament in January 2017 and informed 5-year climate change adaptation policy. **Hughes** is a section author on the next Risk Assessment Evidence report, which is scheduled to be released in 2021.