Institution: University of Plymouth

Unit of Assessment: UoA 13 Architecture, Built Environment and Planning

1. Unit context and structure, research and impact strategy

1.1 Context and Structure

We are a thriving and productive unit, with highly motivated researchers attracting significant research funding income. Our high-quality research addresses social and environmental challenges through cross-disciplinary methodologies and civic and industry partnerships. This approach has enabled the Unit to achieve significant growth income in high quality funded research, with four projects in the area with a full value of between £1 and £3 million; EU Cobbauge (PI Goodhew value £3.5 million), EPSRC EViz (PI de Wilde value £1.5 million), EU Energware (PI Fuertes value £1.4 million) EU Green Minds (CoI Willis value £3 million). Alongside these major grants, we have a buoyant and diversely funded range of smaller, prestigious grants from funders including AHRC, ESRC, EPSRC, UKRI and European Cultural Foundation. Staff actively participate in research networks and collaborations; all indicative of a productive, engaged and dynamic research culture. For example, since 2014, academics have produced over 50 peer-reviewed Journal Papers, 5 Monographs, 4 Edited books, 15 Book Chapters, 35 Conference Papers, 2 Journal Special Issues, 57 other research outputs and 5 reports. Our high-quality research is supported by a wide range of collaborations and partnerships including from the energy and sustainable materials sector such as EDF Energy (France), the Eden Project, Hudson Architects and from the civic sector such as The British Red Cross, The National Trust and Citizen Consumer and Civic Action Group (India). The Unit is underpinned by a research strategy that is forward-thinking and inclusive and is focused on building our research through securing funding income, supporting our ECRs and PGRs to be future research leaders and building sustainable and productive research partnerships through networking and collaborations. This is shown by the fact that 100% of eligible staff are being REF returned (13 FTE). Diversity and gender equity are integrated into the School research strategy and the Unit is proactively working towards achieving several ambitious gender and diversity targets.

The research in Unit 13 is supported within the School of Art, Design and Architecture by the UoA Coordinator (Willis) and Area Research Leads (deWilde, Willis), responsible for mentoring and overseeing future researcher development and led by Associate Head of School for Research (Goodhew). The unit is structured into two research areas that have distinct profiles, both of which are described in more detail below;
- An established and leading research environment in the Built Environment (BE)
- A thriving, diverse and ambitious research area in Architecture (ARA)

1.1.1 Built Environment Research Area (BE)

BE conducts research in the areas of building performance simulation, measurement and monitoring, and construction innovation, connected by a common environmental agenda. The main research concentrations of this group are in the fields of building performance analysis and sustainable construction. Projects deal with a breadth of sub-topics, including: building performance simulation; thermography; laboratory and in-situ measurements of thermal and humidity properties of building materials; building operational conditions and control (including occupant behaviour and climate change).

The research is recognised as world-leading in methods to visualise the thermal performance of buildings that address the relationship between building physics and occupant behaviour. The BE area's focus on energy visualisation has enabled multiple aspects of the complex interaction between people and buildings to be better understood, bringing together occupant behaviour and choices with the thermal properties of buildings, simulation design, and housing management. De Wilde is a recognised research leader in the field of building performance simulation and serves as board member and secretary of International Building Performance Simulation Association-World (IBSPA-World) (2014-present). Goodhew's building physics research uses thermal probes

and thermal imaging informs the development of sustainable building materials and wider challenges in relation to the energy use in buildings. Evidence of the recognition of the leading nature of the research was a prestigious first place for the Cobbauge research project in the 2019 European Commission Regiostars Awards: Europe's awards for the most innovative, regional projects in Europe.

The research area has built, and maintains, close links with other research groups within the University, such as the Sustainable Earth Institute (SEI) and the School of Psychology's Sustainability Group. Internationally the BE research area has partnered and co-authored outputs with the Polytechnic University of Catalonia (5 outputs), UNIVPM - Universita Politecnica delle March, Ancona, Italy (1 output), Beijing University of Technology (3 outputs), Leiden University (3 outputs), the University of Hong Kong (3 outputs) and the Vienna University of Technology (2 outputs). National research collaborations include Newcastle University, University of Bath, University of Birmingham, Edinburgh University and Loughborough University, Funding projects include the Interreg EU CobBauge 1 and 2, EU Energaware, ESPRC e-Viz and two KTP projects. (BE researchers: Goodhew, Basavapatna Kumaraswamy, Bruce-Konuah, Fuertes, Jones, de Wilde) (f=2, m=4) Research Lead: de Wilde (m).

1.1.2 Architecture Research Area (ARA)
Researchers in the ARA area investigate the ways in which we inhabit space, and how this is shaped by social, technological, geopolitical and cultural spatial factors. Areas of work include critical approaches to spatial challenges around spatial displacement; smart cities and inclusion; and the role of placemaking and ICTs in the Global South and research on film and practice. The research typically takes a cross-disciplinary approach to address these topics and is characterised by engagement with the wider civic and cultural contexts of architecture. Consequently, the research is also characterized by collaborations with a diverse range of industry and third sector organisations in the UK and internationally. Staff have successfully published several major monographs in the last five years, primarily with publisher Routledge. Two volumes by Willis and Aurigi are key texts in the Smart Cities field and Bobic's monograph on Balkanization and Global Politics is cited as a 'powerful inquiry into the way global politics are enacted spatially through architecture and urban design'. The work in the smart cities field has also delivered outcomes at policy level through invited evidence to policymakers such as UK Greater London Authority (GLA), European Innovation Partnership (EIP) – AGRI, UK Department of Work and Pensions and Openreach (Willis). National research collaborations include outputs and research partnerships on funded projects with UCL, University of Edinburgh, Cardiff University, University of Durham and Oxford Brookes University. Funded projects include: EU Urban Innovation Actions: Green Minds; AHRC 'Whose Right to the Smart City'; ESRC 'Augmented urbanity and smart technologies'; European Cultural Foundation 'Creative Recovery: Mapping Refugees' Memories of Home as Heritage' and the UKRI Enhancing Place -Based Partnerships for Public Engagement.
(ARA researchers: Aurigi, Bobic, Brown, Murrani, Troiani, Veliz Reyes, Willis) (F=4, M=3) Research Lead: Willis (f)

1.2 Research Strategy
Our research strategy over the REF period has been to support high-quality research, to enable collaborations and networks and to develop capacity for interdisciplinarity and can be broken down as follows:
- High-quality research that addresses societal challenges
- Collaborations and Partnerships with industry and public sector
- Capacity building through inter-disciplinary research and methods
- Research culture of Inclusivity, diversity, ethics

The Unit has undergone some major developments over the REF period. In 2016 the School of Architecture, Design and the Built Environment was restructured and combined with the School of Art and Media to create the current School of Art, Design and Architecture. Concurrently, at University level, there was a change in strategic objectives led by the new Vice-Chancellor and the increased institutional support for research together with the wider school research base enabled a step-change in our research activity. In REF 2014 our focus was to '*to create a*

sustainable, research-rich environment within the School' and '*to build a reputation outside of the School for world-class research',* both of which objectives have been delivered over this REF period.

The Unit research and impact strategy over the REF period as defined above has been actioned in the following ways:

1.2.1 High-quality research that addresses societal challenges
A core aim of research in the area is to address societal challenges such as climate change, sustainable and smart cities through high-quality research. Underlying this is the University ethos of a 'Civic University' where we seek to address real-world challenges to effect social and environmental change. These goals are also closely linked to the University's Research Strategy which aims to '*embrace real-world challenges'*, and to '*advance and translate knowledge'*.
Impact pathway: Informing both policy and practice in national and international industry and civic sectors.

1.2.2 *Partnerships with industry and public sector partners for Impact and Innovation*
A strategic concern has been to expand collaborative projects with industrial and civic partners and this research strategy has contributed to impact with reach and depth. Our research is increasingly engaged in collaborations and partnerships with other universities and industry partners. Research funding secured over the REF period has at least one external non-academic partner and a number of projects have multiple partners from across civic society and industry.
Impact pathway: partnerships with stakeholders to deliver significant long term impact.

1.2.3 Capacity building through Inter-Disciplinarity
Researchers in Unit 13 aim to tackle the most challenging research issues within the built environment – and it is recognised that much of this work sits on the boundaries between conventional disciplines, and thus requires methodological and conceptual innovation. A total of c.75% of our research income comes from jointly-funded projects and a growing proportion of our research outputs are being co-authored with colleagues in other academic institutions. Research collaborations and knowledge exchange with researchers from the disciplines of Engineering, Psychology, Geography, Mathematics, Computer Science and Urban Planning.
Impact pathway: cross-disciplinary methods such as co-design, participatory practice and developing tools for industry that have societal benefit.

1.2.4 Research Culture: Inclusivity, diversity and ethics
The research areas are committed to supporting diversity and inclusivity in the research culture. In May 2019 the School of Art, Design and Architecture was awarded Athena Swan Bronze. Our Athena Swan Action Plan, which we are implementing across the School in a four-year plan that informs our research strategy and planning. Impact pathway: championing inclusive and ethical research practice

1.3 Impact strategy
Impact underpins work across the Unit, with researchers addressing societal challenges including climate change (BE) and inequality and spatial displacement (ARA) which is underpinned by a track record of excellent research. Pathways to impact have both reach and significance through long term work with stakeholders over the life cycle of their research programmes, from identifying the need for research and formulating research questions, to co-creation of new knowledge, evaluating and communicating the research findings, following and evidencing the uptake and resultant benefits in society. Our impact strategy is embedded within our research strategy (See Section 1.2).

Through the deployment of this strategy, researchers in the Unit have developed pathways to impact with a wide range and number of non-HEI partners. World-leading energy visualisation research in BE has informed household engagement strategies for energy efficiency by Influencing the UK Government guidance on energy efficiency advice to households; directly informing Vancouver City Council's Greenest City Action Plan; through a gamified energy tool

developed with EDF (France) changed domestic energy saving behaviours (Goodhew, de Wilde, Fuertes, Jones and Bruce-Konuah) (see also Section 4.2.1). Digital Placemaking and smart cities research in ARA has informed policy in UK and EU; achieved social inclusion through long term partnerships with rural communities in South West UK and internationally in Brazil and India; and worked with at scale with civic sector and local government partners to address health inequality (Willis, Aurigi) (see also Section 4.2.2).

Through our wider commitment to the Civic University strategy staff are involved with a wide range of ongoing engagement activities including yearly participation in the University Research Festival and through annual events as part of the ESRC Festival of Social Science (see also Section *4.2.3)*.

1.4 Five Year Future Research and Impact Strategy (2019-2024)
The School of Art, Design and Architecture revised their five-year strategy in 2019 with a new aim of '*Sustain a vibrant research culture across the School with clear frameworks and processes that raise both the confidence and ambition of the School's research active staff and encourage a greater volume of grant capture and partnerships*.'

This aim is divided into four actionable objectives:
- Generate research of the highest quality that benefits the advancement of our own fields of practice or makes valuable contributions to other disciplines through interdisciplinary research collaborations.
- Partnerships and Knowledge Exchange: Partnerships with industry and public sector partners to enhance impact, income generation and knowledge exchange activities
- Interdisciplinarity and research collaborations to increase large scale grant capture
- Equality and Diversity: Promote diversity and equal opportunity in research and enable (or create opportunities for) people from all backgrounds to contribute to the research excellence of the School; so that the research we undertake has equal benefits for all.
- Research Leadership: Increase the research intensity of School staff and optimise the way staff currently use their time to undertake research.

These objectives align with University of Plymouth strategic objectives to be a '*broad-based, research-intensive university, delivering excellent interdisciplinary research, and civic engagement*'.

1.5 Research Governance
1.5.1 *Research Management*
Research in the Unit is structured around the two research areas which align with staff research topics and are supported by Research Area leads (de Wilde, Willis) who report to the Associate Head of School for Research (Goodhew). The REF Unit Co-ordinator works with the HoS Research and is responsible for managing the REF process and submission. Both the AHoS and the Unit Research Co-ordinator sit on the Faculty Research and Graduate Committee. The Faculty Research and Innovation team support the management and administration of research activities. Research committees at the level of Faculty and School produce plans that are reviewed annually. This structure ensures alignment of research strategy across the Faculty. Research activities are a standing item subject area in team meetings, which facilitate a collective awareness and ownership of the Unit's research strategy.

1.5.2 *Research Governance*
Researchers in the Unit are committed to the highest level of research integrity, as part of the University research governance structure that maintains and promotes standards of integrity and probity in scientific research. The University is a signatory to the Universities UK Concordat to Support Research Integrity and has a set of fundamental principles to ensure good scientific practice (including publication ethics, general principles of data confidentiality and access) across all research activities. The University is working towards compliance with the Concordat on Open Research Data.

All staff and research students are committed to and responsible for ensuring that their work complies with the University Code of Practice on Ethics and Data Integrity as well as subject-specific ethical guidelines. All research that involves human subjects requires ethical approval from the Faculty Research Ethics and Integrity Committee (FREIC). The University Research Data Policy provides guidelines for good practice in research data management and open access to research data. Staff and PGR students are required to submit a Research Data Management Plan (RDMP) prior to the commencement of the research project, and the University works with the National Digital Curation Centre (DCC) to build skills for research data management. The University operates an open access research repository (PERL) that comprises Symplectic Elements, deployed to manage and publish as part of an open research culture that maps on to the Vitae Researcher Development Framework. Dedicated Information Specialists in the University Library Team provide discipline-specific advice on a broad spectrum of open research matters, including funder policies, open data, open author profiles and open licensing.

2. People
2.1 Staffing Strategy
2.1.1 *Research Leadership*
There has been an expansion of research-related roles and responsibilities for ECRs and junior staff and new research-active appointments and promotions for current staff to recognise researchers growing profiles. This is reflected in the fact that 100% of our eligible staff members are being submitted to REF 2021 (REF submitted staff FTE=13), and demonstrates the commitment with which we have been proactively nurturing staff in regard to their research potential. Of the thirteen staff submitted, 100% are on permanent contracts, five are ECRs (38 % of submitted staff FTE) and we have been proactive in supporting our ECRs over the REF period to be included in our REF2021 submission.

The HESA contract level profile of our REF submission is:
- Professor – 6* (Aurigi, Brown, Goodhew, Troiani, de Wilde, Willis. *Miles retired in 2018)
- Senior Lecturer/Associate Professor – 2 (Fuertes, Murrani)
- Lecturer – 5 (Basavapatna Kumaraswamy, Bobic, Bruce-Konuah, Jones, Veliz Reyes)

In the last five years since REF 2014, we have made six strategic new research appointments, five at Lecturer level (Jones, Bobic Bruce-Konuah, Basavapatna Kumaraswamy and Veliz Reyes) and one Professorial appointment (Troiani), each of which strengthens our international research profile and supports existing and emergent research themes. Over the same period, the support for staff development of staff research has led to three promotions; one from Lecturer to Associate Professor (Murrani), two from Associate Professor to Professor (de Wilde, Willis). The University of Plymouth has fully implemented the Concordat to Support the Career Development of Researchers, and members of the Unit engage fully with its requirements. The School's staffing policy has been devised both in response to a research strategy review and University of Plymouth Human Resources policies, guidelines and procedures.

2.1.2 *Early Career Researchers*
The staffing strategy of the unit in this REF cycle has focused on ways to embed and commit to specific research leadership programmes and career progression of new staff, especially ECRs. Since REF 2014, we have taken on more ECR staff, with c.50% of new appointments during the REF period at Lecturer grade (Bruce-Konuah, Bobic, Jones, Veliz-Reyes) and with a balance in female/male recruitment, and all are being returned to REF. While the School has no formal system for PGR students to transition to post-doc work or other academic posts, three of our post-docs (f = 1, m = 2, both in the Built Environment area) have been appointed following the end of their fixed-term contracts on external funding projects.

2.1.3 *PGR students*
Our PhD students are supported at a University level by the Doctoral College (DC) which facilitates doctoral work across a range of disciplines by fostering rigorous and genuinely enriching doctoral training, in line with national and international best practice and guidelines. The Doctoral College facilitates cross-disciplinary work and exchange and provides an international profile to facilitate

externally funded studentships. Skills and career development training in Arts and Humanities Research is managed and provided by the Faculty, which offers over thirty hours of workshops each year. These activities complement the research skills training sessions offered by the University's Doctoral College Researcher Development Programme, which is mapped against Vitae's Researcher Development Framework and offers approximately 160 sessions per year. As our PGR community has expanded, we have developed methods of peer-peer support within the unit, with workshops on research-in-progress led by students, for students.

The School offers competitive funding opportunities for PGRs to attend conferences and training events and to undertake primary and/or collaborative research. All PGR students have access to a work-space including desk space, a lockable space for personal items, computing (a personal netbook), printing and photocopying facilities.

2.1.3 *Equality, Diversity and Inclusion (EDI)*

The School of Art, Design and Architecture was awarded the Athena Swan Bronze Award in May 2018 (with the University of Plymouth holding Bronze since 2013). The School Athena Swan submission provided detailed analysis of the gender and diversity issues in the Unit including a detailed review of our REF 2014 and future REF strategy. Of our REF2021 returned staff, 40% are female and 60% are male (f=6, m=8), with the gender balance being more equal at ECR level. The Athena Swan Action Plan in the School includes several specific actions related to research which are being proactively implemented and are embedded within the Unit and School Research Strategy as KPI's (see Section 1.2.4 and 1.4 above). These include a target of gender balance for staff on leading funding bids and assessing internal research funding to ensure gender balance in how it is distributed.

The School refreshed its Equality, Diversity and Inclusion Committee in 2018 with representatives from across the School, and in 2020 a new role of Associate Head of School (EDI) was created which reflects the commitment to diversity and inclusion at a senior management level. The School works closely with HR to provide support and advice governed by policies such as the University of Plymouth's Equal Opportunities Policy on recruitment and promotion, and the Flexible Working Policy, which also incorporates University of Plymouth's statutory responsibility to consider requests for flexible working to enable staff to care for young children or dependent adults. All staff are required to complete Unconscious Bias training and are offered a range of diversity training opportunities.

We recognise that we can do more to raise diversity across the staff cohort as BAME staff represent only 30% of REF staff (BAME= 3, non-BAME=10) (UoP benchmark is 8%), and this is part of our future research strategy and recruitment practice. We do have cultural diversity and staff representing a range of ethnicities including Iraqi, Spanish, Chilean, Italian, Australian, American and Dutch (c. 70%) with only two members of staff identifying as White British (c. 15%). Several staff have published research in a second language and also build on their cultural backgrounds to enable research collaborations internationally. We monitor and report on equality and diversity data for visiting lecturers and guests and aim for a gender and ethnicity balance to ensure that there is diverse representation in visiting academics.

According to the University of Plymouth Gender Pay Gap Report (2019), the University has a larger proportion of women in both professional service and academic roles compared to the sector. However, the mean hourly rate of pay for women at the University of Plymouth is 19.5% lower than men, and the median hourly rate of pay for women at the University of Plymouth is 24.6% lower than men. This does vary across pay grade and the Mean Pay Gap in Quartile 2 is 3.4% in favour of men, in Quartile 3 is -0.2% in favour of women, and in Quartile 4 is 3.6% in favour of men. The University is addressing this in its Athena Swan Action Plan through a number of actions including improving the numbers of females in our senior roles within Quartile 4.

2.2 Staff development

Staff development takes place at various levels and includes mentoring, access to School research funding through a competitive application process, and research support for funding applications and impact through two dedicated School Research Assistants. The support structure

covers four areas as follows:

2.2.1   Researcher support programme and mentoring

In 2017 the School Introduced two Research Area Lead roles, who mentor and support staff in the respective research areas (BE and ARA). The School operates a mentoring system for research staff, and ECRs and new researchers are assigned an appropriate mentor aligned with their research topic. All researchers are required to produce and regularly update a Five-Year Research Plan with clearly identified REF objectives, facilitating planning of Teaching Relief and workload. Research plans are reviewed with the Research Area Leads and then discussed as part of the annual Performance Development Review (PDR) and objectives prioritised with teaching and management responsibilities. Research Away days aimed at training and development are held at Subject, School and Faculty levels, and the staff development budget is held at a school level, to support staff research development.

The introduction in 2016 of a sabbatical programme, that enables structured Teaching Relief, has been instrumental several ECRs achieving higher quality outputs and an elevated success in funded grant applications. Staff can access the funding for a dedicated six-month period to work on research through a competitive internal process. Three members of staff have taken a period of Teaching Relief (f=2, m=1) which has enabled them to achieve research successes including producing monograph books (Bobic), writing and publishing Journal Papers and securing research funding (Murrani, Basavapatna Kumaraswamy). As a result of the development of her research profile, Murrani was promoted to Associate Professor in 2018.

The University has instituted a research leadership programme, which ran for the first time in 2018. This year-long programme consisted of an intensive three-day summer course, followed up by four half-day workshops, and a series of one-to-one phone meetings with the instructors across the year. Two members of Unit 13 were accepted for the programme (f=1; m=1), and are now recognised as Research Leadership champions in the Faculty. In addition, staff development workshops for PGR supervision, grant applications and sources of external funding among other subjects are offered at a University level.

2.2.2   Funding income generation and Impact

The organisation of research activities under the umbrella of School Research and Graduate Committee (Chair; Goodhew) facilitates flexible directing of resources targeted in accordance with the School research strategy. The Committee manages the Teaching Relief programme and competitively awards a pot of funds (c.£40K p.a.) to support conferences, research trips, publication costs, and other individual, collaborative and Centre research initiatives. This competitive internal funding is managed mirroring AHRC application, peer review and reporting. In addition, the Research Areas have dedicated funds to support a range of research such as networking activities and conference attendance (c. £4K per research area). Within this institutional framework the research areas are supported by the university's Research and Innovation Office, which advises on grants; and provides administrative support for conference organisation, PGR support, funding and grant applications. The University finance and legal teams provide administrative guidance on delivering and managing grants and research partnerships. Grant application rates have benefited from the support offered, and this has significantly increased the number of bids submitted as well as the range of staff submitting funding applications. Application rates in 2020 were gender equitable and there is a year-on-year growth in the number of overall applications.

As a result of investment in training, and with the support of the Faculty Impact Case Study Officer, the Unit has developed and deployed impact delivery methods that meet the specificities of each case study. This has included a range of training and workshops around capacity building to deliver highly impactful research.

2.2.4   Supporting Inter and Cross Disciplinarity

At a Faculty level, The Arts Institute organises and delivers a wide programme of training sessions for Arts and Humanities researchers (catering for people at all stages of their careers from PGR

to Professor), which extended from REF strategy, impact and Open Access through grant writing, impact training, publication, social media and presenting research on the TV and radio, and podcasts. These sessions have either been delivered internally or by external trainers, working in collaboration with the Doctoral College, as well as other UoP institutes, and has been part of UoP wide inter-institute workshops on impact and public engagement. The Arts Institute has developed a series of cross- and interdisciplinary research which receives financial and administrative support from the AI and includes the Displacement Studies Research Network led by Murrani (ARA); an interdisciplinary network of researchers, policy-makers, academics and aid workers whose work covers the many facets of displacement. The Urban Dialogues Network led by Professor Brown (ARA) is a network that brings together both internal, academic partners and external community-based partners to share and enable best practice and identify and develop synergies on community-based learning.

2.3 Postgraduate Research Student (PGR) development
2.3.1 PGR Profile
In the current REF census period, 14 PhD awards have been made (f = 9, m = 5). This represents a 180% increase on PGR completions in REF2014 (REF 2014 = 8 PhD completions). At present, we have a total of 12 FTE PhD students enrolled. This growth in PGR numbers was achieved through a range of initiatives; through staff support and through securing externally funded studentships, and the support of a new Associate Head of School for Graduate Affairs who was appointed to oversee PGR students in the School in 2017. The Faculty of Arts and Humanities introduced a Doctoral Training Award (DTA) enabling PGR students to have their fees supported, and 2 PGR students were awarded DTA scholarships in 2017 and 2018. We have secured 2 industry-funded studentships from a KTP/ Innovate studentship with Wates Construction (2012-2016), a Superfast Cornwall Postgraduate PhD studentship (2013-2017). We aim to ensure PGR supervisory and examining teams have gender and diversity balance.

2.3.2 Integrated Research Culture
Postgraduate students are fully integrated into a rich research culture of specialist seminars, conferences, public lectures and reading groups at the subject, School and Faculty level. In 2015 The ARA hosted the Architectural Humanities Research Student symposium which was led by Murrani and co-organised with the PhD cohort. A successful workshop Flows of Entanglement 2019, initiated and organized by the PGR cohort was co-located with the Association for the Study of Literature and the Environment's Biennial Conference at University of Plymouth. Doctoral students are active members of the research areas and cross-disciplinary research strands within the Faculty and also benefit from interacting with students in the wider University.
Research students are provided with a Director of Studies and at least one other supervisor, with whom they work closely in developing their projects. Supervisory team members are active researchers within their field and are well-placed to provide relevant support. Where possible supervisory teams also include an ECR member. Cross disciplinarily is further supported by including supervisors from the wider Faculty and other faculties in supervisory teams. In the Unit, postgraduate researchers have research teams including supervisors from Geography, Psychology and Education who provide valuable interdisciplinary expertise.

3. Income, infrastructure and facilities

3.1 Research Income
Our research strategy has led to a significant increase in our research income over the current REF period. We have invested in research support for funding bids, and developing staff capacity which has resulted in a significant increase in research activity and in particular grant income over the last five years. As a result, we have more than doubled the value of FEC research funding secured to ca. £5.5 million FEC over the REF period, up from a figure of £2.5 million from the previous REF period. This represents research income to the value of £1,281,820 distributed across seventeen research projects (Table 1). There is an international and national collaborative nature to funded research projects with European and International partners from a range of academic, industry and third sector organisations.
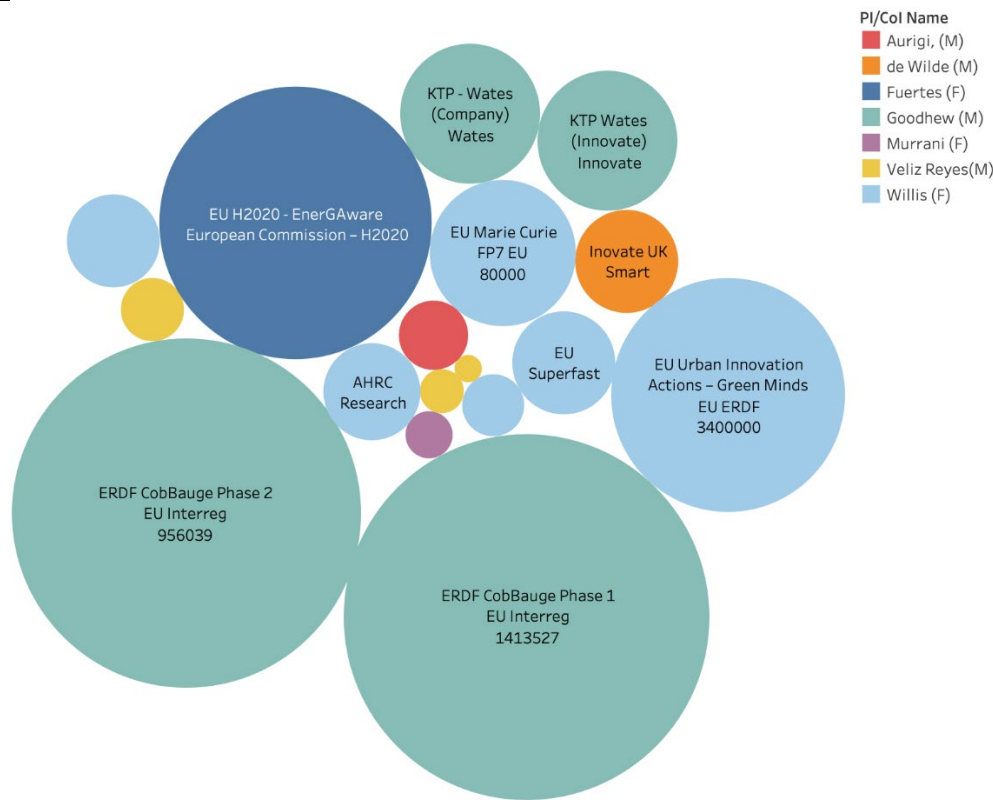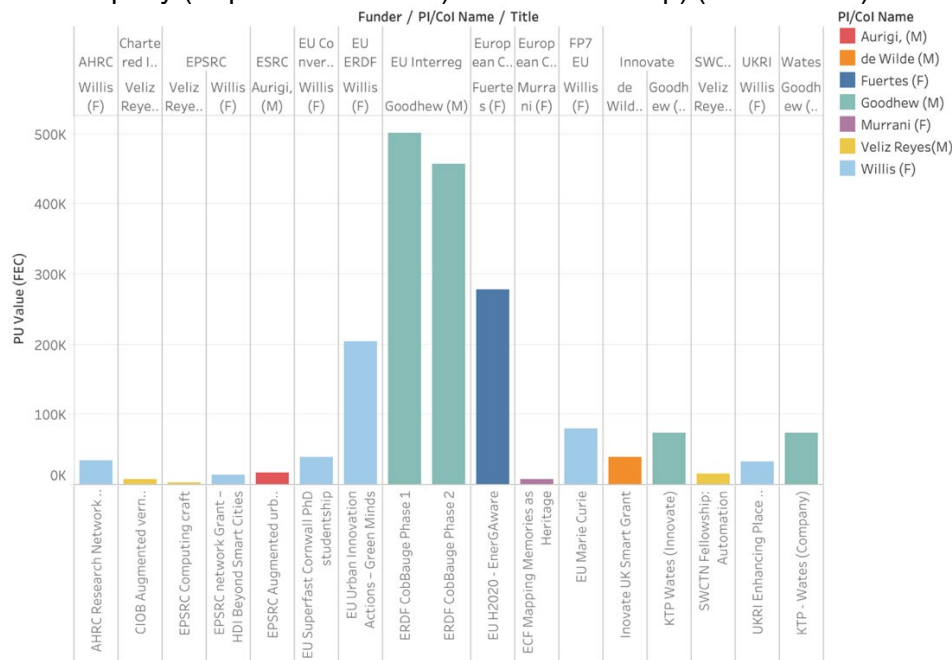
Title, Funder and Full Value. Colour shows details about PI/CoI Name. Size shows sum of PU Value (FEC). The marks are labelled by Title, Funder and Full Value. Details are shown for PI/CoI Name.

Table 1: Funding Awards 2014-2020 ordered by FEC value.

3.1.1 Research Income: Cross disciplinarity and Innovation
We have diversified and broadened the range of funding bodies through which we secure income, in part through our strength in cross disciplinary collaborations (See Table 2). From primarily AHRC and EPSRC funding in previous REF period, we now have secured grants from a diverse range of UKRI (AHRC, EPSRC, ESRC), EU (Horizon 2020 and Interreg/ERDF), external Funding bodies (European Cultural Foundation) and Industry (KTP/Innovate UK and a Cornwall Development Company (Superfast Cornwall) PHD studentship) (see Table 2).

Sum of PU Value (FEC) for each Title broken down by Funder and PI/CoI Name. Colour shows details about PI/CoI Name.

Table 2: Research Income 2014-2020 by funder, value and PI/CoI

Income from the EU made up a large proportion of our grants (by value), notably:

- Interreg Cobbauge (Phase 1) (BE – PI Goodhew) (FEC £1,413,527, Award value £501378) 2016-2021
- Interreg Cobbauge project (Phase 2) (BE – PI Goodhew) (FEC £956,039, Award value £456,920) 2017-2023
- EU Urban Innovation Actions: Green Minds (ARA- PI Willis) (FEC £3,463,841, Award value £205,000) 2019-2023
- EU Horizon 2020 Energaware (BE- PI Fuertes) (FEC £1,200,00, Award value £278,151) 2014-2018
- EU FP7-PEOPLE-2012-CIG, LINC-UPS: Local Inclusion in Networked Communities (ARA - CoI Willis) (FEC and Award value £86,693) 2014-2017

We have secured grants from UKRI across three research councils:

- EPSRC Eviz (BE – CoI De Wilde) (FEC £637,619 *, Award CoI Value £161K. *Please note that this sum is not included in the REF reported income for Unit 13, but in REF Unit 4 as PI was Pahl) 2011-2016
- AHRC AH/N004264/1 Whose Right to the Smart City? International Research Network (ARA -PI Willis) (FEC £40,633, Award Value £35,276) 2016-2018
- ESRC ES/N000013/1 Augmented urbanity and smart technologies (ARA-CoI Aurigi) (FEC £60,000, Award value £18,623) 2016
- EPSRC Network Plus: Computing Craft (ARA- CoI Veliz Reyes) (Award value £2,822)
- EPRSC Network Plus: HDI Beyond Smart Cities (ARA-PI Willis) (FEC £18,630, Award value £14,400)
- UKRI Pop Up centre for health technology in Stonehouse (ARA- PI Willis) (FEC £32401.00 Award value £51311)

This is balanced by funding from public organisations:

- European Cultural Foundation (ARA-Murrani) (FEC and Award value £8,333)
- Chartered Institute of Building (CIOB) (ARA-Veliz Reyes) (FEC and Award value £7,235)

Industry-led funding has also developed from industry collaborations including:

- KTP Wates project (BE-Goodhew), KTP (FEC and Award value £146,702)
- Cornwall Development Company PhD studentship (ARA-Willis) (FEC and Award value £40,000)
- Research England South West Creative Technology Network (ARA-Veliz Reyes). (FEC and Award value £16,000)

The funding breakdown by value shows the distribution of funding sources, which shows an average income value over the REF period of £252,000 year on year (Table 3) with a weighting towards EU due to the relative size of grants secured (Table 4).
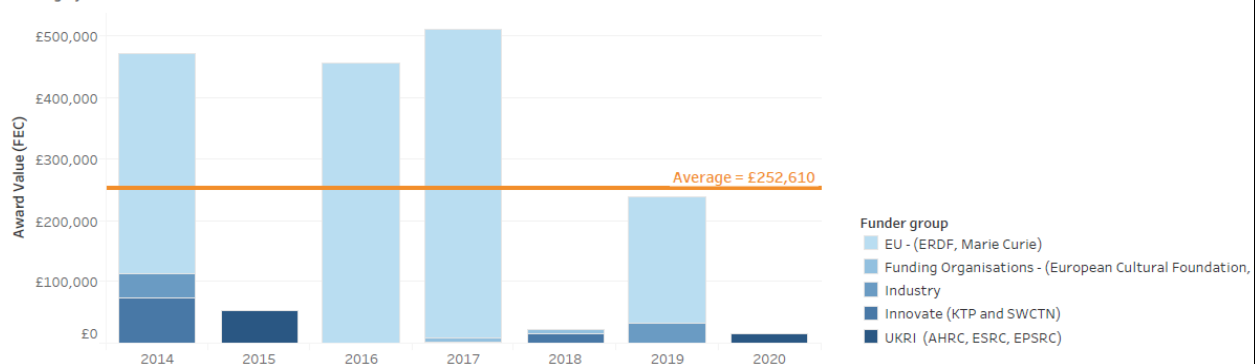

Table 3: Research Income 2014-2020 by funder and value

Number of Records
17

Funder 1
- AHRC
- CIOB
- ECF
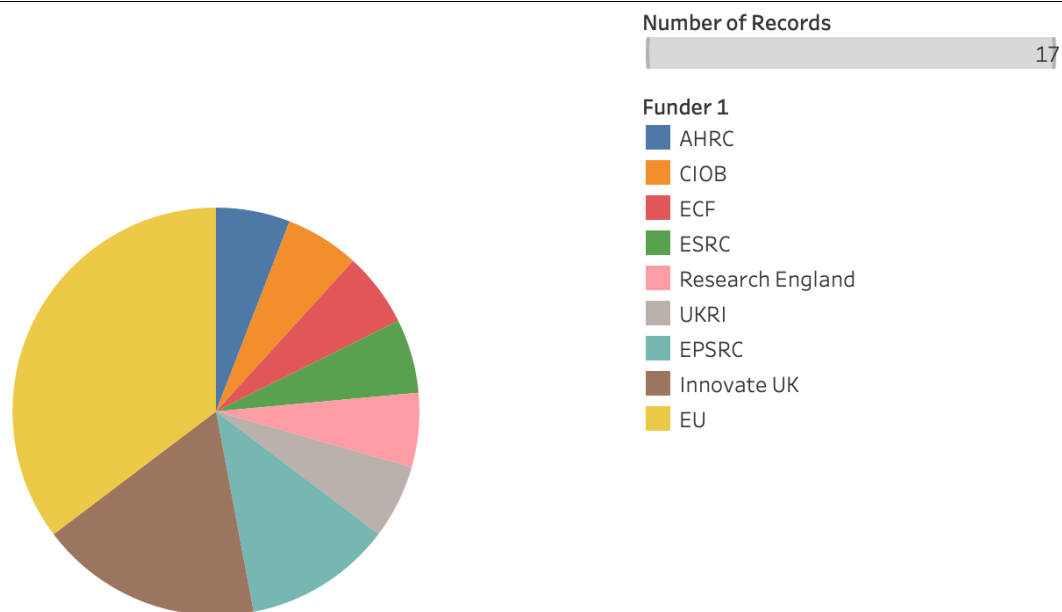- ESRC
- Research England
- UKRI
- EPSRC
- Innovate UK
- EU

Table 4: Research Income 2014-2020 by number of projects, project value and funder

3.1.2 Research Income: Research Partnerships with industry and public sector partners for Impact and Innovation

Partnerships include national, European and global academics, Industry and third sector. Both the BE and ARA have built strong and long-term partnerships with partners across the city of Plymouth and the local region. These include social housing providers (EU EnergAware - Devon and Cornwall Housing), Plymouth City Council (EU Green Minds), civic organisations (ECF Mapping Memories as Cultural Heritage) and Industry (Superfast Cornwall).

The BE Research Area has a sustained success with large scale funding bids in the field of energy visualisation and thermal performance of building materials that address the challenge of climate change:

- Goodhew- PI Interreg CobBauge Phase 1 and Phase 2 (Ecole Superieure D'ingenieur des Travaux de la Construction de Caen (ESITC), Syndicat Mixte du Parc naturel régional des Marais du Cotentin et du Bessin (PnrMCB), Earth Building UK and Ireland (EBUKI) and the Université Caen-Normandie (UCn), PI UKRI DeViz Defect visualisation via thermography (University of Oxford, Oxford Institute for Climate Change), KTP (Wates Group).
- Fuertes – PI EU Horizon 2020 EnergAware (Universitat Politècnica de Catalunya, Instituto Superior de Engenharia do Porto, Advanticyc , Devon & Cornwall Housing, FremenCorp)
- De Wilde – PI EPRSC eViz (Newcastle University, University of Bath and University of Birmingham), PI Innovate UK Smart Grant – HOSP (TCC-Casemix Limited, Salford Royal NHS Foundation Trust).

The AR Research Area has a diverse range of UKRI and EU funding with a strong international set of collaborations primarily with Global South and ODI countries. There is a growing focus on innovation-driven research through industry partnerships linked to investment in knowledge exchange:

- Willis – CoI EU Urban Innovation Actions (National Trust, Devon Wildlife Trust, Plymouth City Council, The Data Place, RIO, PCA); UKRI Enhancing Place Based Partnerships for Public Engagement (Nudge Community Builders, Plymouth City Council, Plymouth Community Homes, Crowdfunder), PI Whose Right to the (Smart) City? (with UCL, UFMG(Brazil) and CAG (India)); PI Superfast Cornwall PhD studentship (BT/ Superfast Cornwall), PI EU Marie Curie Integration Grant.
- Murrani – PI European Cultural Foundation: Creative Recovery: Mapping Refugees' Memories of Home as Heritage (with British Red Cross).

- Aurigi – CoI ESRC Augmented urbanity and smart technologies (University of Durham, PUCPR (Brazil), University of Salvador (Brazil)).
- Veliz Reyes – CoI EPSRC (University of Cardiff), PI South West Creative Technology Network (SWCTN) Automation Fellowship.

3.1.3 Research Income: Equality, Diversity, Inclusion
There is a gender balance in success rates across the externally funded research projects secured (f=8, m=8). By award value, there is a slightly higher value for male staff compared to female, with female staff securing 40% over of overall funding income compared to male staff at 60% (f= £694K m= £1,148K). Grant application success rates have fluctuated over the individual years, and for the last two academic years, grant application success rates for male members of staff have been higher than for female members of staff. However, there is a disparity in average award values, with value for award higher for male applicants (f= £86K, m = £191K).

3.2 Research Income: Innovation and Knowledge Exchange
The School of Art, Design and Architecture has established a broader culture of research innovation aligned to the UK Industrial Strategy. These knowledge exchange activities are supporting researchers in access to funding partners from industry, developing innovative technical methods and access to research networks. The School has secured a £3.5 million Cultural Development Fund (CDF) (2017-22) to develop the use of immersive and digital technologies to drive growth in the local creative economy and bring to life the cultural programme. The project is a partnership with Plymouth City Council, Destination Plymouth, Mayflower 400, Plymouth College of Art and the Real Ideas Organisation (RIO) and is to help the city's creative sector realise its potential, offering new opportunities, creative spaces and skills. The funding has enabled the creation of a dedicated specialist Knowledge Exchange team and resource; The Bridge (funded through the DCMS Cultural Development Fund). The Bridge provides a professional, business-facing infrastructure for knowledge-exchange and impact-related activities and is a nexus point for research staff across the faculty and external partners.

The School is a partner in a £6.5 million Research England funded project (2017-2021) the South West Creative Technology Network (SWCTN) with UWE, Falmouth and Bath Spa. This projected aims to expand the use of creative technologies across the south-west of England. The SWCTN network offers three one-year funded programmes around the themes of Immersion, Automation and Data and supports cohorts of researchers, creative producers, industry partners and young entrepreneurs. Several academics in the School have benefitted from funding for research through SWCTN in a competitive, peer-reviewed bidding process.

3.3 Research Infrastructure and Facilities
As part of the School future research strategy, there has been investment in building future-facing research infrastructure and facilities and the School has invested in a £1.5 million Digital Fabrication and Immersion Lab that opened in September 2019. The Lab has state-of-the-art digital fabrication and virtual reality suites and is also open to use by industry and civic organisations to support our partnerships in the city and regionally.

The University's Charles Seale-Hayne Library is located close to the Roland Levinsky Building on the main campus; Architecture and Environmental Building have a dedicated subject librarian and an allocated acquisitions budget. The library also has extensive online resources including e-books, image and map archives and subscribes to leading e-journal and online archive services (for example: Eighteenth-Century Collections Online, Environment Complete, JStor, Oxford Art Online, RIBA Catalogue, Times Digital Archive, Web of Science, Wiley Online Library, Science Direct). The library provides regular e-resource training sessions for staff and students and has 1,000 study places and 176 workstations.

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

4.1 Contribution to the Research Base
Researchers in BE and ARA are fully engaged with the industry bodies, third sector partners and academic societies. They conduct extensive peer review and external examining processes, generate discourse by organising and participating in conferences and pursue many other modes of dissemination and knowledge exchange inside and outside academia.

From 2014-2020, our thirteen staff held leading roles in 15 Professional Bodies, 11 roles as Conference Organisers, 6 Journal Editorships, 28 External Examiner roles, and 6 roles on Peer Review Colleges. They were involved as Peer Reviewers for 28 separate journals/publishers.
We work with academics nationally and internationally including long term collaborations with institutions such as Loughborough University, UCL, Durham University, Cardiff University, Federal University of Minas Gerais (Brazil), University of Caen and Universitat Politècnica de Catalunya (UPC).

4.1.1 Service on Research Councils
Researchers have carried out peer review activities for research councils, universities and other funding bodies. Five staff sit on UKRI peer review colleges including the AHRC (Aurigi, Willis) the EPSRC (Goodhew, de Wilde), the ESRC Global Challenges Research Fund (Murrani) and the UKRI Future Leaders Fellowship (Aurigi). In 2020 Willis was recognised for outstanding contribution to the work of the AHRC over the past year by Ian Henderson, Head of Operations at AHRC.

Staff are invited reviewers for a range of UKRI, EU Funding Organisations that demonstrate the cross-disciplinary expertise of our researchers. Funding reviews completed include Horizon 2020 Innovative Training Networks (Willis) EU Smart Cities and Communities (FP7 and Horizon 2020) (Willis), ESRC (Willis) EPRSC (de Wilde, Goodhew), AHRC (Aurigi, Willis, Murrani), The Royal Academy of Engineering (Goodhew), Europe ERC, ECF (Murrani), Austrian Science Fund (Murrani, Willis), NERC Canada, Leverhulme, SNF (Willis), Netherlands Organisation for Scientific Research (NWO) (Willis), NERC (Willis) and DFG (Willis).

4.1.2 Peer review
Staff hold positions on the editorial boards of Elsevier, T&F and Wiley Journals in the fields of Building Performance and Energy that reflect the specialisms of the BE area including, Applied Energy (Elsevier) (deWilde), Advanced Engineering Informatics (Elsevier) (deWilde), Journal of Building Performance Simulation (Taylor & Francis) (deWilde) and Journal of Building Appraisal (Springer) (Goodhew). Staff have significant review contributions for the following Journals in the fields of Energy Efficiency, Construction, Building Performance, Computing and Architectural Technology. Journals include: Advanced Engineering Informatics, Applied Energy, Automation in Construction, Building and Environment, Building Services Engineering Research and Technology, Journal of Building Performance Simulation, Journal of Performance of Constructed Facilities, Energy and Buildings, Environment and Planning A and D, Advances in Building Energy Research, Energy Policy, Facilities and Energy Efficiency, Renewable & Sustainable Energy Reviews, Journal of Cleaner Production, Measurement Science and Technology and the Journal of Low Carbon Technologies.

In ARA, staff contribute to peer-reviewing for a wide range of Journal and book publications in the fields of Architecture, Urban Studies and Geography. Troiani was co-founder and Lead Editor of the Journal of Architecture and Culture (2012-2017) and regularly contributes to editing special issues of the Journal. Other peer reviewing activity includes Space and Culture, City, Environment and Planning A, and Taylor and Francis Journals including Social and Cultural Geography, Architecture and Culture, Journal of Urban Technology, Migration and Society, Third World Quarterly, Interacting with Computers, Architectural Theory Review, Architecture and Design and Urban Science as well as Routledge volumes.

Staff sit on advisory boards for funding projects such as the AHRC "Smart Cities in the Making: Learning from Milton Keynes" (Oxford University), the AHRC-GCRF 'Interdisciplinary Network on Displacement, Conflict and Protection' (INDCaP)(University of London) and AHRC 'Gendering the Smart City' (KCL).

4.1.3 Conferences
Staff have given keynotes and invited talks internationally at Harvard University, University of Cambridge, University of Murcia, Tsinghua University, TU Berlin, Beijing University of Technology, Oxford Brookes University, Utrecht University, UFMG, City University of Macau, ESITC Caen, National University of Singapore and University of Malta.

Researchers in ARA have organised a number of conferences including the AHRC Right to the Smart City (AHRC Research Network) Conference 2018, Media City 2015, the AHRA Doctoral conference (2017), Flows of Entanglement 2019 (PhD organised) and Political Matters (2019).
In BE Staff have organised the Cobbauge Conference 2018, IBPSA-England/CIBSE SW Symposium 'High Performance Buildings', Plymouth, UK, May 10, 2018 and sessions at the CUE2015Applied Energy, Symposium and Summit, Fuzhou, China, November 15-17 2015.

4.1.4 External examination of Doctorates
Staff are invited nationally and globally to act as external examiners on PhD externals including University of Bath, Salford and Brunel (Goodhew), Queensland University of Technology (Willis), University of Oulu (Aurigi), Politecnico di Milano (Aurigi), UCL (Murrani, de Wilde, Willis), Loughborough University (de Wilde, Goodhew), Georgia Tech (de Wilde), City University Hong Kong (de Wilde, Goodhew), University of Edinburgh (Willis) and University of Nottingham (Willis).

4.2 Contribution to society and economy
As part of both our research impact and the Civic university strategy, we have established and grown collaborative partnerships to address societal challenges and contribute to civic society and the economy:

4.2.1. Climate Change and Sustainability
BE Research has informed household engagement strategies for energy efficiency adopted by UK Department of Business, Energy & Industrial Strategy (BEIS) and Vancouver's Greenest City Action Plan. Jones was an Expert Advisor to the former Department of Energy and Climate Change (DECC) on Costing Monitoring Equipment for a Longitudinal Energy Survey (2015). The research developed through the EU CobBauge project (PI Goodhew) was recognised at the European Commission Regiostars Awards 2019: Europe's awards for the most innovative, regional projects. CobBauge was voted winner in the Category: 'Connecting green, blue and grey'. Staff in BE have long term collaborations with civic organisations such as Eden Project and have been instrumental in the start up of initiatives such as the CIC 'Art and Energy' which engages people and children around climate change.

4.2.2 Professional Bodies
In the Built Environment area (BE), staff have made significant and long-term contributions to professional bodies, including CIOB (Chartered Institute of Building), RICS (Royal Institute of Chartered Surveyors), IBPSA (International Building Performance Association) and EG-ICE (European Group for Intelligent Computing in Engineering). Goodhew was a drafting member of ISO9869 'Thermal Insulation-Building Elements, in situ measurement of thermal resistance and transmittance'. De Wilde is Chair of EG-ICE and Secretary of the Executive Committee of the IBPSA-World Board of Directors.

In the Architecture Research Area (ARA), Brown serves and contributes several RIBA committees including the RIBA Education Committee (2014-), RIBA Research Grants Committee, Chair (2014) and RIBA Validation Panel (2010). He contributed to rewriting the RIBA professional validation criteria (2016-2020) as part of the Education Committee which has an increasing emphasis on ethics and governance. Brown is Chair of Research Grants panel, which funds 3-4 projects a year

through the main award, and others through PhD research, and contributed to the restructuring of the research awards enabling research to be more impactful.

4.2.3 Public and Third Sector; a Civic University
As part of our civic commitment to transferring benefit from our research, we work with the approach of the 'Civic University' that is a key strategic priority at the University of Plymouth. The University is one of the first universities to commit to putting in place a Civic Universities Agreement and supports the ways in which the University, working closely with key city partners, can benefit the city. Our public and third sector partnerships at city level include Plymouth City Council, Real Ideas Organisation (RIO), The Data Place, the Refugee Council, The British Red Cross (Plymouth), Plymouth Community Homes and Nudge Community Builders, all of whom are partners on funded projects bringing direct benefit to the city.

This strategy is exemplified by the *Centre for Health Technology Pop-Up* project*,* funded by a grant from UKRI, 2019-2020 (PI Willis) that partnered with community organisation Nudge Community Builders, Plymouth City Council and Plymouth Community Homes to create a digital and eHealth hub in Stonehouse (one of the most deprived communities in the country). Also in the city, Murrani's ECF project: Creative Recovery worked with the Plymouth branch of the British Red Cross to engage with refugees in the city and resulted in a public exhibition as part of British Refugee Week in 2018.

4.2.4 Innovation and Economy
Industry collaborations and partnerships include EDF Energy, Cornwall Development Company (Superfast Cornwall), C3 Resources and Freemencorp and Wates Construction around building energy use and climate change, as well as with professional partners including Hudson Architects and Earth Building UK. eViz research was key to the development of local company C3 Resources and theC3NTINEL's software platform. As a result, C3NTINEL gained industry recognition and in December 2015 the company was acquired by ENGIE, a global benchmark group in low carbon energy and services, employing over 170,000 people and located across the globe. C3NTINEL is now being used globally to deliver Engie Management and Energy Efficiency.

The digital game interventions developed through the EU EnerGAware research project with energy provider Électricité de France (EDF) and the software company Fremencorp included the game EnergyCat, which led to the development of EkoSmart for the domestic market.