

**Institution:** Anglia Ruskin University

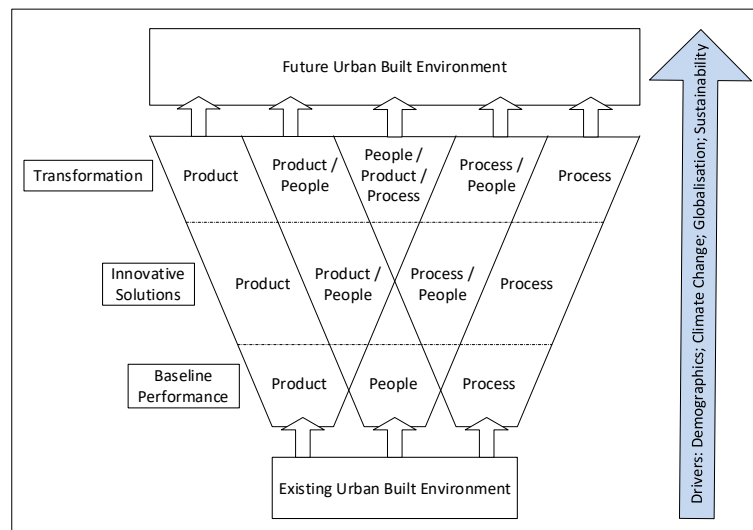
**Unit of Assessment:** 13 – Architecture, Built Environment and Planning

### 1. Unit context and structure, research and impact strategy

#### Context and Structure

UoA13 comprises 19 FTE staff drawn from the School of Engineering and the Built Environment, Faculty of Science and Engineering (18 FTE) and the School of Allied Health, Faculty of Health, Education, Medicine & Social Care (1 FTE) at Anglia Ruskin University. Together these staff constitute a multi-disciplinary team (architects, construction managers, engineers, facilities managers, sociologists, surveyors, town planners, and urban designers) who individually, and in groups, research issues pertinent to Future City living. This alignment to one of the Global Societal Challenges identified in the United Nations Sustainable Development Goals to Transform our World: Goal 11 (UNSDG11) – **making cities and human settlements inclusive, safe, resilient and sustainable**, is strategic for UoA13, and aligns also with the University's Sustainability Strategy. Over the current REF period UoA13 researchers have focused on researching the challenges posed to architecture, built environment and planning professions in transforming the **existing urban built environment** into a more resilient and sustainable **future urban built environment**.

The UoA 13 submission is structured around the work of the **Future Cities Research Network (FCRN)** which was established following REF2014 to provide an academic focus and research infrastructure to support the implementation of the **Future Cities Research Strategy**. The Future Cities Research Strategy (Figure 1) views the built environment as a complex system of buildings and infrastructure that exists to support the needs of society in a resilient and sustainable way. However, as the needs of society are constantly changing, so the solutions required by architects, built environment and planning professions need to change to meet changing demands.



*Figure 1 Towards a sustainable and resilient built environment*

To this end the Future Cities Research Strategy promotes research and development projects that seek to:

1. better understand the current built environment's performance (models and theories);
2. develop and test innovative solutions (products, processes and strategies) to improve its performance now and in the future for the benefit of society; and
3. support transformation through effective engagement with end-user stakeholders.

The FCRN brings together 3 Professors, 2 Readers, 3 Full-time Postdoctoral Researchers, 19 Senior/Principal Lecturers, 2 Visiting Professors (architecture and building surveying) and two Emeritus Professors (town planning and law) in seven themes (smart cities, urban resilience, sustainable communities, sustainable technology and manufacturing, building performance, adaptive reuse, and quality of life) organised in two research clusters: one focussing on built environment **resilience**; and the other on **sustainability**. Eighteen members of the FCRN carry Significant Responsibility for Research (SRR), as defined by ARU's Code of Practice, and are included in this submission; five are included in ARU's UoA12 submission. Four members of the FCRN do not yet carry SRR and as such have not been returned to REF2021; they are being

mentored in preparation for the next REF period. The remainder of this statement refers only to those 18 FTE members of the FCRN and the one FTE researcher from the School of Allied Health, Faculty of Health, Education, Medicine & Social Care (who has worked closely with FCRN researchers over the REF period) returned together to UoA13.

The FCRN is physically located within the Faculty of Science and Engineering on ARU's Chelmsford campus. All FCRN members have a dedicated workspace located in the Marconi building; in a space designed to support collaborative team working. In addition to its physical location, members of the FCRN also work in close collaboration with researchers from other research groups/institutes across the University (e.g. *the Global Sustainability Institute returned to UoA14; the Medical Technology Research Centre and researchers focussed on Healthy Ageing returned to UoA3; on Management returned to UoA17; and on Psychology returned to UoA4*) and with researchers from other UK (e.g. *UCL, University of Strathclyde*) and international (*Technical University of Delft, University of Naples Federico II, University of São Paulo*) universities at both a project and network level.

### **Development of The Future Cities Research Strategy: 2014-2021**

UoA13 has seen substantial growth in research activity over the current REF period as a direct result of decisions made following REF2014, where the feedback judged the “overall research strategy to be rather generic” and lacking focus.

Following the publication of results from REF2014 UoA16 Architecture, Town Planning and Built Environment, the then Head of School (*Jones*) of Engineering and the Built Environment (EBE), in conjunction with university senior management, instigated a review of research across the School to identify research synergies (both within the UoA and between UoAs) that could potentially form the basis of a coherent research and impact strategy for architecture, built environment and planning (**addressing point 1 of REF2014 UoA16 strategic goals - further develop our research culture**). The review drew evidence from a series of workshops and research sandpits from which the **Future Cities** research theme, and in particular the challenges (research, policy and practice) that the UN Sustainable Development Goal 11 posed to the way the built environment (both new and existing) was designed, procured, constructed, maintained, operated and refurbished emerged. Whilst initially, the Future Cities research theme was predominantly focused within EBE, its wider significance across the University was recognised and in 2018 Built Environment and Future Cities was adopted as a University-wide research theme (*ARU Research and Innovation Strategy 2018-2022*).

In 2016 the **FCRN** was established as the vehicle to operationalise the Future Cities Research Strategy. The FCRN used QR funding to employ a permanent fulltime Senior Research Fellow (*Rajendran*) to act as a focus for the work of the FCRN. *Rajendran's* role in the FCRN was twofold; firstly, to act as a catalyst to generate research ideas and project proposals amongst FCRN researchers; and secondly, to generate new areas of work based on her own research expertise. The formation of the FCRN **addressed point 6 of the REF2014 UoA16 strategic goals - establish a centre of excellence for the built environment**. Further, as the FCRN came under the academic leadership and direct line management of the Head of School of EBE it also provided a clear and effective research management process and structure (**addressing point 4 of the REF2014 UoA16 strategic goals - implement effective research management processes and structures**) that was fully integrated with, and supported by, the School of EBE (see People section for specific details of research management processes). The FCRN also provided an external focus and financial/time support to engage local/professional communities (e.g. *Future City sandpit for Essex County Council; research briefings to RIBA East and ICE*) and industry (e.g. *Ringway Jacobs KTP, Mid and Southeast Essex NHS Trust partnership*) in our research, dissemination and impact activities (**addressing point 5 of the REF2014 UoA16 strategic goals – engage effectively with our user communities**).

The success of the Future Cities Research Strategy and FCRN is evidenced by the improvements seen in key research metrics (Table 1) over the REF period (**addressing point 2 of the REF2014 UoA16 strategic goals - expand our research income generation and point**

**3 of the REF2014 UoA16 strategic goals - emphasise postgraduate research**) and in the range and scope of the research projects undertaken (Table 2).

*Table 1: Comparison of external research income, postgraduate activity and staff with SRR between REF2014 and REF2021*

Assessment Period	External Research Income	PhDs/Prof Doc completions	Staff with SRR (FTE)
REF2014	£207k	10	8
REF2021	£4.79m	17 (10PhD/7 Prof Doc)	19

*Table 2: Brief details of the main projects underpinning the UoA13 submission to REF2021*

Research Project	Project Structure and Objectives
<b>Resilience Project Cluster</b>	
LIQUEFACT (2016-2020): a €4.9m EU H2020 project (GA 700748) coordinated and led by <i>Jones</i> and involving <i>Morga</i> , <i>Pascale</i> , and <i>Wanigarathna</i> from the FCRN.	The project drew together an interdisciplinary team of 42 researchers / practitioners from 11 countries across Europe to research community resilience to earthquake induced liquefaction disaster events. The results from the project generated new academic knowledge and supported a commercial software tool currently under development.
TURNkey (ongoing): a €8m EU H2020 project (GA 821046) led by NORSAR (Norway) and involving <i>Jones</i> , <i>Morga</i> , <i>Pascale</i> , <i>Sherratt</i> , and <i>Wanigarathna</i> from the FCRN.	The project draws together an interdisciplinary team from 21 organisations across Europe who are researching the requirements of a European earthquake, forecasting and early warning system to support a rapid response to earthquake events to improve community resilience.
WQR <sub>GIS</sub> /WQR-ANN (2016-2017): a £20k UK Royal Academy of Engineering project (SF1617\1\42) led by <i>Imani</i> .	The project drew together an interdisciplinary team from UoA13 and universities/state agencies in São Paulo, Brazil, who researched water system resilience in Brazil. The results from the project provides input into one of our Impact Case Studies.
RVDSS (2017-2018): a £62.8k UK NERC project (NE/R008973/1) led by <i>Hajjalizadeh</i> and involving <i>Imani</i> , <i>Rajendran</i> and <i>Jimenez-Bescos</i> from the FCRN	The project drew together an interdisciplinary team from UoA13 and four industry/government agencies who researched water, transport, energy, and critical infrastructure systems resilience and vulnerability interdependency. The results of the research provide input into one of our Impact Case Studies.
RESoURce@Brandia (2018-2019): a £40.1k Research England funded project led by <i>Imani</i>	The project drew together an interdisciplinary team from the FCRN, universities/state agencies in São Paulo, Brazil; a UK City Council and a university in India, to research the challenges of incorporating Sustainable Urban Draining Systems in vulnerability and resilience planning. The results of the research provide input into one of our Impact Case Studies.
HERALD (2019): a £40k British Council Newton Fund - Research Environment Links Grants (439675771) led by <i>Rajendran</i> and involving <i>Coday</i> , <i>Miraglia</i> , and <i>Odeleye</i> from the FCRN	This project drew together an interdisciplinary team from UoA13 and the Centre for Urban Studies (CUS) at İstanbul Şehir University (Turkey) to research the requirements of a resilience-based approach to Heritage City development. The results of the research supported research exchange between the UK and Turkey.
<b>Sustainable Built Environment Cluster</b>	
Knowledge Transfer Partnership (2018): a £194.4k InnovateUK funded project led by <i>Sherratt</i> from the FCRN and involving	This project drew together an interdisciplinary team from UoA13, UoA4, and Ringway Jacobs (a major UK highways contractor) to develop a new approach to safety management to eliminate cable strikes during maintenance work. The results of the research generated

Pearson and Zawisza (returned to UoA4).	new academic knowledge and new operating procedures within the contracting organisation.
BIM informed BAM for the NHS Estate 2016-2017): a £9.3k Royal Institution of Chartered Surveyors (RICS) funded project led by <i>Wanigarathna</i> and involving <i>Jones</i> from the FCRN	This project drew together an interdisciplinary team from UoA13 and an NHS hospital to research the role of Building Information Modelling (BIM) in Built Asset Management (BAM) to improve the sustainable performance of their estate. The research generated new academic knowledge and facilities management guidance to the NHS partner.
DigiConCo-Op (2020): a £39.7k ESRC Transforming Construction Network project led by <i>Sherratt</i> from the FCRN and involving <i>Ivory</i> (returned to UoA17).	This project draws together an interdisciplinary team from UoA13 and UoA17 to research requirements to enable SMEs and micro-SMEs to digitally co-operate and collaborate in the delivery of micro construction projects in a way that maximises social and economic value.
Almshouses (various projects 2016–2020) funded by The Almshouse Association (£9.5k), RICS (£13.5k) and ARU (£27k – seed funding, sabbatical grant and RIDO) led by <i>Pooley</i> .	These projects draw together an interdisciplinary team from UoA13, professional architectural practices; the Delft University of Technology (The Netherlands); and the charitable sector to research the potential of the almshouse model to sustainably increase social housing provision in the UK and internationally. The results of the research provide input into one of our Impact Case Studies.
Mid and South Essex NHS Trust (ongoing): a strategic research arrangement between ARU and the Trust. The FCRN engagement with the Trust is led by <i>Jones</i> .	The strategic partnership draws together ad-hoc research teams from UoA13 as necessary to research issues pertinent to improving the sustainable performance of the Trusts NHS estate. To date, 3 projects have been initiated: a scoping study of the potential to decarbonise the Trust's energy supply; a study to gather lessons from the rapid reconfiguration of general medical wards into Covid-19 intensive care wards to inform future healthcare facilities management planning; and a study of the built asset requirements of alternative cancer care delivery models.

### **Support for Multi- and Inter-disciplinary research**

The Future Cities Research Strategy sought to establish a social, physical and economic environment to foster and enhance collaborative working between members of the FCRN; the wider University and international partners. At an institutional level, all the members of the FCRN are located in a single, open plan office that shares social and networking amenities, whilst providing a level of disciplinarity through the clustering of workplaces. The open plan space encourages different disciplinary teams to engage with each other to share their learning and experience from research projects and jointly explore the perspectives that their different disciplinary backgrounds provide to our research. The sharing of perspectives is also supported through regular FCRN and University research sandpits that are arranged on an ad-hoc basis in response to emerging research issues and themes that are of interest to Future City living (3 have been held during the REF2021 period; 2 of which have resulted in university seed funding for potential projects) and through Faculty/University workshops/conferences and network events.

At a national /international level, all members of the FCRN are supported (financially and time allocation) to actively participate in research networks (e.g. *ARCOM - Sherratt, CIB - Jones, Sherratt, EuroFM - Jones*) and pursue interdisciplinary funded research opportunities (e.g. RCUK sandpits and EU development workshops - *LIQUEFACT and TURNkey*) and doctoral student and researcher exchanges through ERASMUS (e.g. *with DTU, Denmark*).



**Open Access to Publications and Data**

The Future Cities Research Strategy encourages and supports members of the FCRN to provide open access not only to their publications, but also to the datasets used to generate these publications. All members of the FCRN are required to deposit a copy of any paper accepted for publication on the University's repository. Where journal constraints prohibit the immediate placement of a paper into the repository, or where long embargo periods would delay access, members of the FCRN are encouraged to apply for University funding to support gold (or equivalent) open access (£4,295 - *has been used by 3 FCRN researchers during the REF2021 period*).

In addition to open access to publications, FCRN members are also supported to provide open access to their primary research data. The H2020 LIQUEFACT project volunteered to be part of the EU open data pilot (2016-2020) which involved developing a detailed data management plan and lodging a copy of the projects primary data supporting publications onto an open access repository ([www.zenodo.org](http://www.zenodo.org)).

**Supporting Impact**

The Future Cities Research Strategy views impact as a change or benefit to the economy, society, culture, public policy or services, the environment or quality of life beyond academia achieved through a combination of the dissemination, communication and exploitation of research results outside of immediate project team members. To this end, each FCRN project proposal is required to explain how their project will address the following:

- activities to identify any new products, models and/or practices that would result from the research and how these would be developed (post-project if necessary) and presented to end-users, including addressing areas of commercial confidentiality and protection of intellectual property
- the inclusion of time within the project to write and disseminate practice guidance notes that translate research results into new working practices or guidance, including production of policy briefings and white papers where appropriate
- procedures to engage in public dissemination and debate through social, written and broadcast media
- funding to attend industry conferences and trade events.

For all internally supported projects (QR funds or University Sandpit funding), each project proposal is expected to address the above as part of a pathway to impact statement. For externally funded projects, the communication, dissemination and exploitation activities follow the format required by the funder. Examples of impact activities over the REF2021 period include:

- **LIQUEFACT:** all academic publications, including primary datasets have been made available in open access through [www.zenodo.org](http://www.zenodo.org). Also, UoA13 researchers involved in the project (*Jones, Morga, Pascale*) have given industry briefings; attended public engagement events with local communities and schools; presented international keynote lectures to both academics and policymakers; written an EU White Paper (*LIQUEFACT Policy White Paper, 2019*); and contributed to regular social media feeds.
- **TURNkey:** *Jones* has a management coordination role (in addition to his research role) as the Impact Lead for TURNkey with responsibility to develop the project's impact strategy.
- **WQR<sub>GIS</sub>/WQR-ANN, RVDSS, RESoURce@Brandia** projects developed post-project end-user software tools using funding by ARU and provided briefings (*Imani*) to the Institution of Civil Engineers.
- **Almshouse** projects have supported a UK press campaign (*Pooley*) and provided evidence through The Almshouse Association to inform UK Government debate (*16 citations in Hansard*).
- **Ringway Jacobs KTP** is providing training to company staff and briefings for the wider construction industry.

**Research Integrity**

The UoA follows the principles outlined in The European Code of Conduct for Research Integrity (2017). All members of UoA13 have successfully completed the Epigeum Research Integrity (Concise) course and courses in Research Ethics and GDPR data management. All the UoA's research projects, including PGR projects, have received ethics approval from either the School, Faculty or University Research Ethics Panels (level depending on specific project requirements). All data and analyses generated from our research projects are internally reviewed within project teams, either through a formal peer-review process or through the use of a project expert advisory board (e.g. LIQUEFACT, TURNkey) or informally by colleagues as part of the writing group (see next section) or weekly research seminar series. All data generated by research projects is stored and handled in accordance with GDPR regulations. Less experienced staff are mentored in all aspects of research design and methodology by more senior colleagues (*Jones, Sherratt, Vogiatzaki*) and all project proposals are subject to formal internal peer-review before they are submitted for funding. Where practicable, all research data is published in open access form. All PGR students receive formal research training either through Epigeum or through research methods modules. Wider activities supporting the development of good research practices are described in the People section of this submission.

**Research and Impact Strategy: 2021 onwards**

The past 6 years have been very successful for UoA13 researchers. From 2021 UoA13 will build on this success, focussing on the interactions and interfaces between the physical built environment and those who live and work in it.

**Strategic Objective 1 – Enhance the work of the FCRN in: Sustainable Built Environment; and Resilient Built Environment (to be achieved by the end of 2023)**

The Future Cities Research Strategy originally envisaged 7 research themes, however over the REF2021 period, these themes coalesced around two separate, but interrelated areas: Sustainability and Resilience.

In strengthening the strategic focus of our work in urban resilience, the FCRN will build directly on our work on natural disasters (earthquakes and flooding) and extend this to include the impacts of climate change on both the built environment and citizens. In particular, we will develop strategic research partnerships with UK and international research/industry partners to identify the technical, social and economic challenges that natural and manmade disasters place on the built environment and identify solutions that can mitigate these challenges and improve citizens' quality of life. Success will be measured with the establishment of a Centre for Built Environment Resilience.

In strengthening the strategic focus on sustainability, the FCRN will consolidate our work around adaptation and mitigation of the existing urban environment to support the transition of existing built assets to net zero-carbon over their life cycle. In particular, we will focus on strengthening existing relationships across ARU (e.g. with the *Global Sustainability Institute*, the *Business School* and *School of Psychology*) through joint research bidding and with industry through strategic research partnerships. Success will be measured by the number of projects won.

**Strategic Objective 2 – Ensure FCRN research fully engages with the Horizon Europe and UKRI programmes**

UoA13 has been very successful in winning H2020 projects and we will seek to build on this success through full and effective engagement in Horizon Europe. Resilience is a fundamental expectation of the Horizon Europe vision, and also forms part of the civil security for society pillar (the same societal challenges that funded the LIQUEFACT and TURNkey projects), whilst sustainability is represented through the climate, energy and mobility pillar. The FCRN will build on existing networks to coordinate/lead and participate in Horizon Europe projects. The FCRN will also increase its bids to UKRI programmes, in particular NERC, EPSRC and Innovate UK. Success will be measured by the number of FCRN researchers involved in external funded project from 2023.

Strategic Objective 3 – Raise the profile of the FCRN in our local region

The Oxford-Cambridge ARC covers a region of the UK that is home to over 3.7 million people and contributes about £110 billion in Gross Value Added to the UK economy. The Oxford-Cambridge ARC Universities Group comprise the 10 universities geographically located in the ARC who are supporting sustainable and resilient development through the application of the United Nations Sustainable Development Goals and the UK government's 25-year environment plan. The FCRN will play a major role in both the management of the Oxford-Cambridge ARC Universities Group (*Jones* is currently a member of the Environment Management Board) and in research, dissemination and exploitation activities with ARC organisations and communities. Success will be measured through the number of research, dissemination and exploitation activities undertaken.

Strategic Objective 4 – Increase the number of PhD and Professional Doctorate students doing research in sustainable and/or resilient built environments

The Future Cities Research Strategy has provided a clear focus to UoA13's work over the current REF period and this has begun to influence both the subject matter and number of research students studying PhDs and/or Professional Doctorates. The FCRN will seek to double the number of research students studying sustainable and/or resilient built environment topics over the next 5 years.

Strategic Objective 5 – Strengthen support for impact from past projects

With regards to our impact strategy, we will continue to develop applications to translate our research outputs into practical tools, including working with industrial partners, for use by built environment practitioners. The tools, along with training guidance, will be made available through the FCRN web site.

Strategic Objective 6 – Contribute to the implementation of ARU's Sustainability Strategy

The FCRN will develop research and knowledge transfer projects in collaboration with key industry and research partners to address UN Sustainable Development Goals and we will make our research and impact outputs freely available through the FCRN website to the international sustainability research and innovation community.

Research performance over the past 6 years suggests that the Future Cities Research Strategy and Future Cities Research Network has provided both a clear research focus and operational infrastructure to support the work of UoA13 researchers. The strategic opportunities identified for the next 5 years provide confidence that research activity will continue to grow and make a significant contribution to the generation of new knowledge and understanding of the challenges and solutions/tools needed by built environment professionals to deliver inclusive, safe, resilient and sustainable cities.

**2. People****Staffing Strategy and Staff Development**

The **Future Cities Research Strategy**, as well as providing a clear research focus for UoA13 staff, from 2015 also provided the focus for research criteria included in all new academic job descriptions. As a consequence, all UoA13 appointments in the REF period strengthened the Future Cities research base. Appointments include: two professors (*Jones* and *Vogiatzaki*); seven lecturer/senior lecturers (*Ashagre*, *Imani*, *Morga*, *Oshodi*, *Pascale*, *Sherratt* (now an associate professor) and *Zuddas*); a Senior Research Fellow in Future Cities (*Rajendran – Miraglia* as maternity cover); and a Research Fellow (*Mulder*) working on the TURNkey project. All of these staff (except *Mulder*) were appointed to permanent positions within the University upon satisfactory completion of their probation period. In addition, REF2014 staff (*Du*, *Henjewe*, and *Foulds* – representing 37.5% of our REF2014 submission) are still in post and form part of our REF2021 submission (*Foulds* as part of UoA14). *Coday* and *Odeleye*, who were in post on REF2014 census date but who were not research active during the previous REF period, have been supported to grow their research activity through sabbatical leave and targeted research management opportunities (*Coday* is Director of the Professional Doctorate

course; *Odeleye* is Director of PhD students for the Faculty of Science & Engineering) to the point that they both now carry SRR and are included in this submission.

Along with the growth in staff numbers (138%) over the REF period, there has also been a change in the demographic profile of the UoA. The UoA13 submission comprises 60% female members (compared to 48.5% - all eligible staff); 31.5% BME (compared to 20% all eligible staff); 58% aged 35-44 (compared to 40% all eligible staff), 16% aged 45-54 (compared to 28.5% all eligible staff) and 29% aged 55-64 (compared to 25.9% all eligible staff).

All staff have an Academic Work Balance Model (AWBM) agreed through a formal annual Staff Appraisal process with their line manager (except for Professors who have tri-annual performance reviews) to review both their performance to date and their future career plans. As part of this process, all staff update their personal research plans and identify with their appraiser the support that they need to achieve these plans. Staff carrying SRR have a stepped allocation (13%, 31% or 55% of their workload) in their AWBM to reflect their research commitments for the forthcoming year which are further increased for any staff member who secures external research funding by an amount equivalent to the proportion of their time paid for by the research funding (e.g. a researcher who has 0.2 FTE of their time paid by an external grant would receive an additional 20% allocation on their AWBM).

Additionally, for Early Career Researchers (ECRs) (*Ashagre, Morga, Mulder, Oshodi and Rajendran*), the UoA aligns to the ARU ECR Charter. Staff development support takes the form of clear allocation of time for research activities on AWBMs, a minimum of one day per week free of scheduled teaching/administrative activities within all semesters, an individual research account of £2,000 over a five-year FTE period of ECR status, and the appointment of a research mentor drawn from senior researchers in the UoA.

A variety of support is offered to all academic staff, including financial support for conference attendance and travel to enhance researcher networks. UoA13 researchers have taken advantage of the central Sabbatical Scheme, and within the assessment period four colleagues (*Coday, Odeleye, Pooley (twice), Sherratt*) have been supported to take sabbaticals. These have resulted in activities as diverse as the completion of a PhD (*Pooley*), travel for international networking and the development of collaborative research project bids (*Coday*), and to undertake collaborative research with an overseas university (*Sherratt*). Application to the sabbatical scheme is open to all staff at all stages of their careers.

A key contributing factor in the development of staff and the enhancement of the research culture within the School is the Writing Group established by *Sherratt* in 2016 and supported by *Jones* (a REF2014 UoA16 Panel member). Initially this group, which is open to all staff, aimed to provide time and space for researchers to be actively supported and encouraged to write and develop quality publications. Since 2016 its aims have expanded (although its name has not changed) to support a wider range of research activities, including developing and writing research bids, and identifying routes to impact. General sessions have included writing good abstracts and responding to reviewers' comments and concerns, peer reviewing colleagues' papers, as well as writing convincing research proposals and designing pathways to impact. Informal sessions have involved senior researchers (*Jones* and *Sherratt*) working on a one-to-one basis with research colleagues on specific publications and research proposals, as well as providing guidance on their individual research careers. The success of the group can be seen through the number of journal papers published (146) and external research bids won (11) by less experienced researchers. In addition to the writing group, UoA13 researchers have also taken advantage of the Writing Retreats offered in Faculty. Two 1 week-long residential writing retreats have been held annually since 2014 and to date 3 UoA13 staff (*Imani (three times), Rajendran, Odeleye*) have attended within the REF2021 period.

In addition to UoA13 and Faculty support for research, ARU's Research and Innovation Development Office (RIDO) provides a comprehensive range of face-to-face and virtual staff training for research activities. RIDO activities include over 60 researcher development



workshops and online courses delivered by both external experts and senior research colleagues at ARU (*Coday, Jones and Sherratt* all regularly deliver training) available annually. The courses are organised around the 10 themes identified in the Vitae Researcher Development Framework and are available for any researcher to attend. UoA13 researchers attended 77 courses/workshops during the REF2021 period. As well as regular staff development activities, RIDO also supports bid development and project management of externally funded projects. This support includes one-to-one meetings with research colleagues to identify potential research opportunities; coordination and facilitation of research sandpits that bring together researchers across ARU with external stakeholders to identify and develop research bids (2 UoA13 researchers have received funding as a result of attending RIDO sandpits – *Rajendran, Pascale* (twice)); and post-project and project management support for large successful bids (*LIQUEFACT, TURNKey*).

### Research Students

UoA13 continues to grow its PGR student activity, although not as quickly as envisaged in our REF2014 submission; due in part to the relatively high proportion of ECR staff (26%) and shift of research focus as a result of the Future Cities Research Strategy, which has taken time to mature. This said, UoA13 currently has 57 PGR (32 PhD and 25 Prof Doc) students registered (an increase of 113% from 2014) with 17 (10 PhD and 7 Prof Doc) successful completions during the REF2021 period.

Table 3: PhD and Prof Doc completions 2013-20

Year	PhDs awarded	Prof Docs awarded
2013-14	0	0
2014-15	1	1
2015-16	1	0
2016-17	4	2
2017-18	2	3
2018-19	0	0
2019-20	2	1
<b>Total</b>	<b>10</b>	<b>7</b>

The UoA employs a number of strategists to recruit PGR students.

The FCRN website provides details of our research aims and objectives (<https://aru.ac.uk/science-and-engineering/research/institutes-and-groups/future-cities>) and provides links to the Engineering and the Built Environment PhD page (which provides generic details about studying for a PhD at ARU) and to the research project opportunities page that provides topic specific details for prospective PhD students; including ‘oven ready’ research projects that the UoA are actively looking to support. These PhD opportunities are also listed on [www.findaphd.com](http://www.findaphd.com).

ARU run an annual VC’s PhD Studentship competition, and in 2020 a UoA13 researcher (*Sherratt* in conjunction with Ivory (returned to UoA17)) was awarded a full-time VC PhD Scholarship to recruit a student to research the impacts of Industry 4.0 and complexity on construction project management practices for Future Cities.

**All PhD students** are supported by the ARU Doctoral School where they undertake a range of formal research training (*Epigeum research skills* and *personal development courses*) as part of their PhD journey and have the opportunity to attend University/Faculty wide research lectures and seminars and engage in social activities. The ARU Doctoral School, in collaboration with the Faculty, also provides the research administrative infrastructure to support our PhD students including: management of the formal documentation (via the ProgressPlatform system) and project management of key milestones (e.g. formal registration, annual progression, transfer from MPhil to PhD, and final viva exam arrangements) required for a student to progress through their studies. Finally, in addition to supporting students through their research journey, the ARU

Doctoral School provides training and support to PhD supervisors, who are also required to complete a number of Epigeum courses.

The UoA supplements the support provided by the ARU Doctoral School/Faculty through:

- a weekly research seminar series (organised by *Rajendran*) at which PhD students and researchers working on major FCRN projects present their work
- encouragement to support PhD students to present their work (either as posters or presentations) at the annual Faculty Research Conference and at international PGR seminar series (e.g. *ARCOM*, *New Scientist Conference*)
- commitment to fully support each PGR student to attend one international conference (in addition to PGR seminar sessions) during their programme (e.g. at CIB conferences). All PhD students can access a £500 grant for conference attendance
- engage socially with the wider Faculty PGR student community, led by the Faculty Director of Research Students (*Odeleye*), who sits within UoA13.

Taken together, the central and UoA13 activities seek to enhance a sense of collegiality within the PhD cohort.

The UoA provides each student with a supervisory team of three, able to deliver specialist subject support to the student (the first supervisor must have at least one successful completion) and enabling less experienced research staff to gain supervisory experience. Contact time for PGR students includes a minimum of once-monthly meetings for full-time, and every two months for part-time PGR students (which, conducted online, have been increased in frequency during the Covid-19 pandemic, to support both academic progress and well-being). These are supplemented by additional supervisory meetings as required. To help students prepare for their viva, each student experiences a personal mock viva led by an experienced researcher who is external to their project.

Each PhD student's progress is formally assessed through an annual monitoring process. PhD students are supported by their supervisory teams to prepare the documentation needed for their Annual Monitoring Report and for the viva-voce-style Annual Monitoring meeting. Each PhD student presents their progress to a panel comprising three experienced researchers, two drawn from the UoA in which the student is based and one from another UoA in the University. Wherever possible, the same panel members are retained throughout the student's journey to ensure continuity. Where this is not possible, new panel members have access to previous annual monitoring reports. Approximately midway through the research journey, PhD students undertake a formal transfer from MPhil/PhD to PhD (only in very exceptional circumstances are students enrolled directly onto a PhD programme) which involves the submission of a transfer report and a viva-voce examination. Again, supervisory teams support the students in the preparation of their documentation and for the viva-voce examination.

The UoA prepares our PhD students for their future careers through their inclusion in staff research training events and activities, and through the provision of appropriate associate lecturing opportunities. During the current REF period, 4 of our PhD students have taken up postdoctoral or lecturing appointments after leaving ARU (in the UK and China); taken research roles in other universities (in the UK) or in industry (for an SME). Students employed as Associate Lecturers receive formal teaching training through a dedicated 'Learning and Teaching in Practice' course or, if the lecturing commitment is substantial enough (e.g. it spans more than one trimester) are enrolled on ARU's PG Cert course. Students who intend to go into industry have access to University training including 'working with business', 'management and leadership' and 'commercialising research outputs'.

The Director for the Professional Doctorate (DProf) programme is a member of UoA13 (*Coday*). The DProf provides the opportunity for practitioners to undertake doctoral study with the intention of innovating practice and enabling real-world change. The DProf course is split into 2 stages. At Stage I, DProf students study four 30 credit modules (Advanced Professional Practice, Theoretical Perspectives of Advanced Professional Practice, Advanced Research

Design, and Advanced Data Collection and Analysis) that allow them to define their research context, formalise their research objectives and develop their research proposal. Each module is led by a UoA13 researcher (*Coday, Odeleye, Henjewele*). At Stage II, DProf students gather and analyse the primary data needed to address their research questions and complete a DProf thesis which they defend through a viva-voce examination. Again, in addition to the central support provided by the Doctoral School/Faculty, UoA13 researchers support 6 annual two-day workshops where DProf students come together to share their experiences, receive formal presentations by experienced UoA researchers and former DProf students, make presentations of their work, and meet face-to-face with their supervisory teams (DProf students are all part-time, and many live a long way from Chelmsford so most routine supervisory meetings are virtual, and were even before the Covid-19 pandemic).

### ***Equality and diversity***

UoA13 embeds the University guidelines on equality and diversity in all its practices. All UoA13 research staff have completed the University's mandatory equality and diversity training programme. UoA13 researchers (*Imani, Odeleye*) actively engaged in the Athena Swann process which culminated in the Faculty of Science & Engineering achieving a Bronze award in 2019.

In further support of inclusivity in the work environment, UoA13 staff are encouraged to utilise the University's flexible working policy which has options for condensed hours and frequent homeworking. This has been specifically relevant over the Covid-19 pandemic period. In support of homeworking, the UoA facilitated access to remote working through the provision of additional IT support (including financial support for staff to upgrade home broadband facilities where necessary) and virtual data collection facilities.

The UoA also supports the re-integration of staff returning from long-term sick leave or parental leave. One UoA13 researcher was supported through an extended period of homeworking and additional management support on his return from major surgery. Another received financial support (£4,000) through the parental return to work scheme to allow them to accelerate re-engagement with their research activities. Staff on maternity leave also make use of the Keep in Touch days to remain engaged with their research activities (3 researchers have made use of KIT days) during the REF2021 period.

We actively support staff with young children by, for example, allowing staff to undertake fieldwork accompanied by their children, providing suitable childcare arrangements are in place (e.g. one researcher did fieldwork in Italy using family members to provide childcare).

Finally, our commitment to equality and diversity can be seen through the gender and ethnicity profile of UoA13 researchers, of whom 60% are female (2 holding senior research grades); and 31.5% are from a BME ethnicity group.

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

#### ***Income***

External research income has increased significantly during the REF2021 period, growing from approximately £61k in 2013/14 to £707k in 2019/20, with a total income over the REF2021 period of approximately £4.79m. Whilst this increase has been due primarily to the award of two very large H2020 projects (LIQUEFACT £1.8m and TURNkey £400,000), both led by *Jones* (and including *Morga, Pascale, Sherratt* and *Wanigarathna* as Co-Investigators), it has also included income from other smaller projects from prestigious bodies such as NERC (*Imani*), and Innovate UK (*Sherratt*), the Royal Academy of Engineering (*Imani*) and the Royal Institution of Chartered Surveyors (*Wanigarathna, Pooley*). Table 2 gives more details of externally funded projects won during the REF2021 period.

In addition to external research income, UoA13 researchers have also benefited from internal QR funding. Each year, the University distributes its QR funds to the UoAs that secured them as

a consequence of REF2014. UoA13 has received approximately £600k which has been distributed (in part) to UoA13 researchers to support their work. Since 2017, UoA13 researchers have been required to write competitive bids to access this funding, which have been reviewed using a similar approach to that used by RCUK/InnovateUK/EU funding bodies (senior researchers have been excluded from this bidding process as they have acted as peer reviewers). Five UoA13 researchers have received QR funding (*Imani, Odeleye, Pooley, Pascale, Rajendran, Wanigarathna*), three of whom have subsequently attracted external funding (*Imani, Pooley, Wanigarathna*) in this way. QR funds have also been used to support staff engagement with international research networks (e.g. CIB – *Jones, Sherratt*; ARCOM – *Sherratt, Wanigarathna*;) to support conference attendance (for staff and doctoral students); and professional body briefings (*ICE, RICS, RIBA East*).

Internal funding has also been used to pump-prime research ideas and collaborations within the UoA, across Faculties, and with external partners in industry and academia. For example, sand-pit seed-funding was used (£27k) used to initiate our Almshouse and older living research (*Pooley and Pascale*) and £10k (Research England) was used to support work in the area of Infrastructure Resilience, specifically enhancing the ongoing dissemination and impact (*Imani*) of this work through the delivery of international workshops and events in Brazil and India (although the India event was postponed due to Covid-19 restrictions).

### **Infrastructure and Facilities**

The majority of UoA13 researchers (HEMS-based colleague *Achour* is the exception) occupy a large Open Plan office space (366m<sup>2</sup>) and smaller (40m<sup>2</sup>) dedicated work area located on the third floor of the Marconi Building on ARU's Chelmsford campus. Each researcher has a dedicated workspace provided with IT systems and secure storage. In addition, researchers have access to a dedicated breakout space; team working space; and social facilities on this floor and access to pooled meeting and seminar rooms across the Chelmsford campus. UoA13 researchers also have access to communal office and meeting space on the Cambridge campus to support their multidisciplinary work with researchers based there). Researchers have access to a substantial library and catering facilities on both campuses.

Although much of the research done by UoA13 researchers is desk-based, a small number of researchers needs access to specialist laboratories (*Du, Jones, Imani, Morga*) or real-world buildings (*Coday, Sherratt, Vogiatzaki*). UoA13 researchers have access to a range of civil engineering laboratories (*structures, geotechnical, hydraulics*) that are equipped with the facilities required to support their personal research and that of their PhD students. Access to external built assets is arranged on an ad hoc basis to support, for example, built asset monitoring (*Coday*) and construction health and safety (*Sherratt*). Access to a broader range of facilities is enabled as and when required through collaborations.

The UoA's PhD students have dedicated research space (66m<sup>2</sup>) located on the first and second floor of the Marconi building, Chelmsford campus. Each PhD student has a dedicated workspace with access to IT systems and secure storage. PhD students also have access to specialist IT, either at their dedicated workspace or in specialist laboratories.

In addition to the generally available IT facilities (e.g. Microsoft Office Suite, AutoCAD, Microsoft Visio, SPSS, NVivo) UoA13 researchers also have access to specialist research software (e.g. Matlab, Energy Plus, ANSYS, Design Builder) and high-specification PCs able to run such simulations and other packages. Specialist equipment is also purchased when needed as part of externally funded projects (e.g. building monitoring equipment).

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

### **Collaboration with the research base**

UoA13 researchers play an active role in collaborating and supporting the research base.



## Unit-level environment template (REF5b)

The vast majority of UoA13 research is multidisciplinary, involving collaboration with researchers and industry/government practitioners across the region, the UK and the world (Table 2). Major collaborative projects during the REF2021 period include:

- LIQUEFACT (7 research partners; 4 industry/government partners across 5 countries);
- TURNkey (10 research partners; 11 industry/government partners across 8 countries); and
- RESoURce@Brandia (3 research partners; 3 industry/government partners across 3 countries).

Further details of wider UoA13 project collaborations can be found in Table 2 above.

UoA13 researchers have close collaborative links to a number of external national and international research groups and networks. The UoA has a strong relationship with the Association of Researchers in Construction Management (ARCOM), led by representation on the ARCOM Committee (*Sherratt* was recently Secretary) and through regular attendance at the ARCOM annual conference from both researchers (*Sherratt, Henjeweale, Wanigarathna*) and our PGR (PhD and DProf) students. UoA13 also has a strong relationship with CIB (International Council for Research and Innovation in the Built Environment) commissions:

- W55 (Construction Industry Economics) – *Oshodi* and *Wanigarathna* are members
- W70 (Facilities Management) - *Jones* was a past Co-coordinator of (2014-2017) and with *Wanigarathna* is a current member
- W86 (Building Pathology) - *Jones* is a current member
- W92 (Procurement Systems) - *Henjeweale* is a member
- W99 (Safety and Health in Construction) – *Sherratt* is currently joint co-co-ordinator
- W111 (Public Private Partnerships) – *Henjeweale* is a member
- W116 (Smart and Sustainable Built Environments) - *Pascale* and *Rajendran* are members
- W123 (People in Construction) - *Oshodi* and *Sherratt* are members.

Through these collaborations, UoA13 has facilitated a number of researcher and PhD student exchanges during the REF2021 period (e.g. *Istanbul Sahir University, Turkey; DTU, Denmark; University of Naples Federico II, Italy, University of Colorado Boulder, USA*).

### **Contribution to the research base**

UoA13 researchers have made an active contribution to developing the architecture, built environment and planning research base during the REF2021 period through:

- Membership of the EPSRC Peer Review College (*Jones*)
- Membership of INNOVATE UK (Future Leaders) College (*Jones*)
- UK (EPSRC) project peer review (*Jones*)
- EU (H2020) project peer review (*Morga, Miraglia*)
- International Peer Review Colleges (*Jones - Swedish Research Council*)
- RICS project peer review (*Jones*)
- British Council – Newton Fund (*Morga*)
- External PhD and Engineering Doctorate examinations in the UK (e.g. UCL, UWE, University of Birmingham, University of Reading)
- External PhD examinations around the world (e.g. TU Delft, Chalmers University, DTU, University of Cape Town, University of Queensland, ETH Zürich)
- Membership of Journal editorial boards
  - ICE Proceedings of Management and Law (*Sherratt*)
  - Facilities and Journal of Building Pathology and Adaptation (*Jones*)
  - International Disaster Resilience in the Built Environment (*Achour*)
  - Disaster Medicine and Public Health Preparedness (*Achour*)
  - Founder and editor-in-chief of *archi-DOCT: The e-journal of doctoral research in architecture* (*Vogiatzaki*)
  - Journal of Sustainability (*Imani*)
  - Journal of Construction Business and Management (*Oshodi*)

- International Journal of Disaster Risk Reduction (Morga)
- Peer reviewing of journal papers (*Achour, Du, Henjewele, Jones, Odeleye, Oshodi, Miraglia, Morga, Pascale, Rajendran, Sherratt, Vogiatzaki, Wanigarathna, Zuddas*)

UoA13 researchers have also delivered invited Keynote Lectures to international research conferences and professional bodies during the REF2021 period, including at the:

- Cyber Security and Resilience Conference in London in 2019 (*Imani*)
- CIB W099/TG59 conference in Cape Town in 2017 (*Sherratt*)
- Industry-focused Envirosafe Health, Safety and Environmental Conference in Accra in 2018 (*Sherratt*)
- UK's Canal and River Trust Annual Health, Safety and Wellbeing Conference for all staff and volunteers in 2019 (*Sherratt*)
- 7ICEGE International Conference in Rome, 2020 (*Jones*)
- QuakeCoRE Annual Conference in New Zealand, 2020 (*Jones*)

In addition to the above, UoA13 supports all its researchers to attend as many conferences as they can. If conference funding is not secured through specific research projects, this is provided by the UoA through QR or general staff development (not research-specific) funding. In the REF2021 period the UoA has supported the following conference presentations: *Imani* (7 International), *Sherratt* (10 International, 5 UK), *Pooley* (2 International, 1 UK), *Morga* (3 International), *Wanigarathna* (1 UK), *Jones* (1 International).

Finally, UoA13 researchers have also been successful in terms of paper prizes, with *Pascale* being awarded the Emerald Award for her paper in *Facilities* in 2015, and *Imani, Jones* and *Sherratt* having papers selected for special issues following conference presentations.

#### **Collaboration and Contribution to economy and society**

The work of UoA13 researchers makes a direct contribution to economy and society. Their research focusses on the challenges professionals face in delivering the changes needed in the built environment to achieve UNSDG11 (making cities and human settlements inclusive, safe, resilient and sustainable). UoA13 researchers have explored resilience and sustainability in real-world contexts, developing greater understandings of necessary transitions, and the tools to help enable such transitions to be made. The multidisciplinary nature of our research, along with the use of participatory research methodologies (e.g. LIQUEFACT, TURNkey, HERALD, Almshouse) involves societal representatives as fundamental actors within our work, and not research subjects to be studied or acted upon. This creates a space in which we co-create our findings, maintaining a two-way dialogue that leads to robust and impactful research, notably a better understanding of the potential non-technical barriers that may impact uptake of the outputs of our research. In adopting this approach, our research makes a positive contribution to economy and society, making our Future Cities resilient and sustainable for all.