

Institution: De Montfort University

Unit of assessment: 13

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

1.1 OVERVIEW

Architecture and the Built Environment research at DMU is carried out within two groups: the Institute of Energy and Sustainable Development (IESD), which is part of the Faculty of Computing, Engineering and Media; and the Institute of Architecture (IoA), located within the Faculty of Arts, Design and Humanities. Taken together, they cover the entire gamut of architecture, planning and the built environment and successfully attract and deliver funded projects that ensure the use of multidisciplinary research perspectives. IESD's uniqueness lies in its local roots but global reach to deal with complex societal challenges such as energy access, low-carbon transition and sustainable built environment (with a focus on energy, water, waste and transport). Following a whole-systems approach that encourages a practical, multidisciplinary perspective to arrive at solutions, the group aims to achieve an effortless blend of hard engineering with softer social sciences. Similarly, the uniqueness of the IoA lies in its multidisciplinary staff and their collaborative research to understand how architecture and the built environment work effectively in the real world, with links to both the academic and public sectors.

The research undertaken by each Institute has close links in the areas of building energy, cities and the local environment where the Institutes closely collaborate in terms of research activities and research supervision. Securing circa £3,300,000 in external research-grant funding during the census period (compared to £3,600,000 in REF 2014), registering a 75% growth in output volume (393 outputs compared to 225 in previous period) and successfully supervising 44 PhD awards (compared to 28 PhD awards in REF 2014), the Unit has played a vital role in research in DMU. The marginal loss in grant income arose as a consequence of the retirement of senior researchers and a research capacity building strategy of attracting Early Career Researchers (ECRs). The Unit has more than doubled its members of staff since REF 2014, with 31.2 FTE being returned this time against 14.1 FTE returned in REF 2014. In addition, each Institute pursues its distinct research focus as highlighted in 1.2.

1.2 STRUCTURE

The organisational structure of research groups within the UOA has maintained close continuity with the structure in REF 2014 but as part of a series of initiatives undertaken by DMU to realise its ambitious research strategy (2018–2023), research activities are now organised in research institutes and centres. While IESD existed prior to this latest reorganisation, the IoA was set up in 2018, regrouping the researchers of the erstwhile Leicester School of Architecture. Each Institute is led by a director and a deputy director, who report to the Head of School and the Associate Dean (Research and Innovation) in the respective faculty on a regular basis. Each Institute has a set of core members, who are complemented by associate members, honorary fellows and visiting researchers to facilitate wider collaboration in research activities.

In REF 2014 the focus of the Unit was on building energy, behaviour-change and low-carbon technologies. In the current census period, this research has been broadened and deepened, as outlined below. Research activities in IESD are now organised around three broader themes, with several sub-themes capturing the research foci of the Institute (see Figure 1). One of the main features of the thematic clustering is to pay closer attention to the United Nations' Sustainable Development Goals (SDGs) through research. The research theme on Low-Carbon Energy Systems and Infrastructure builds on our research strength in building and industrial energy efficiency and smart grids with a new focus on low-carbon transport and renewable energy integration. This directly connects with SDGs related to affordable and clean energy (7), climate action (13), responsible consumption and production (12), and good health and well-being (3). The theme of Sustainable Communities and Sustainable Living has broadened its focus on resource-use behaviour and governance to embrace smart cities and smart villages as well as the resilience of communities for a sustainable future. This touches on SDGs related to water (6), cities and

communities (11), climate (13), institutions (16) and partnerships (17). The third theme, Solutions for the Base of the Pyramid Population, has been introduced since 2014 and emerged as a new thematic focus with an international development agenda. This new area of research strength is a result of strategic investment (**Bhattacharyya's** recruitment in 2012) and the internationalisation strategy of the Unit. The theme is aligned with SDGs related to health and well-being (3), energy access (7) and climate change (13), among others. Researchers have cross-affiliations to different themes but doctoral students and research project staff generally have specific thematic affiliation.

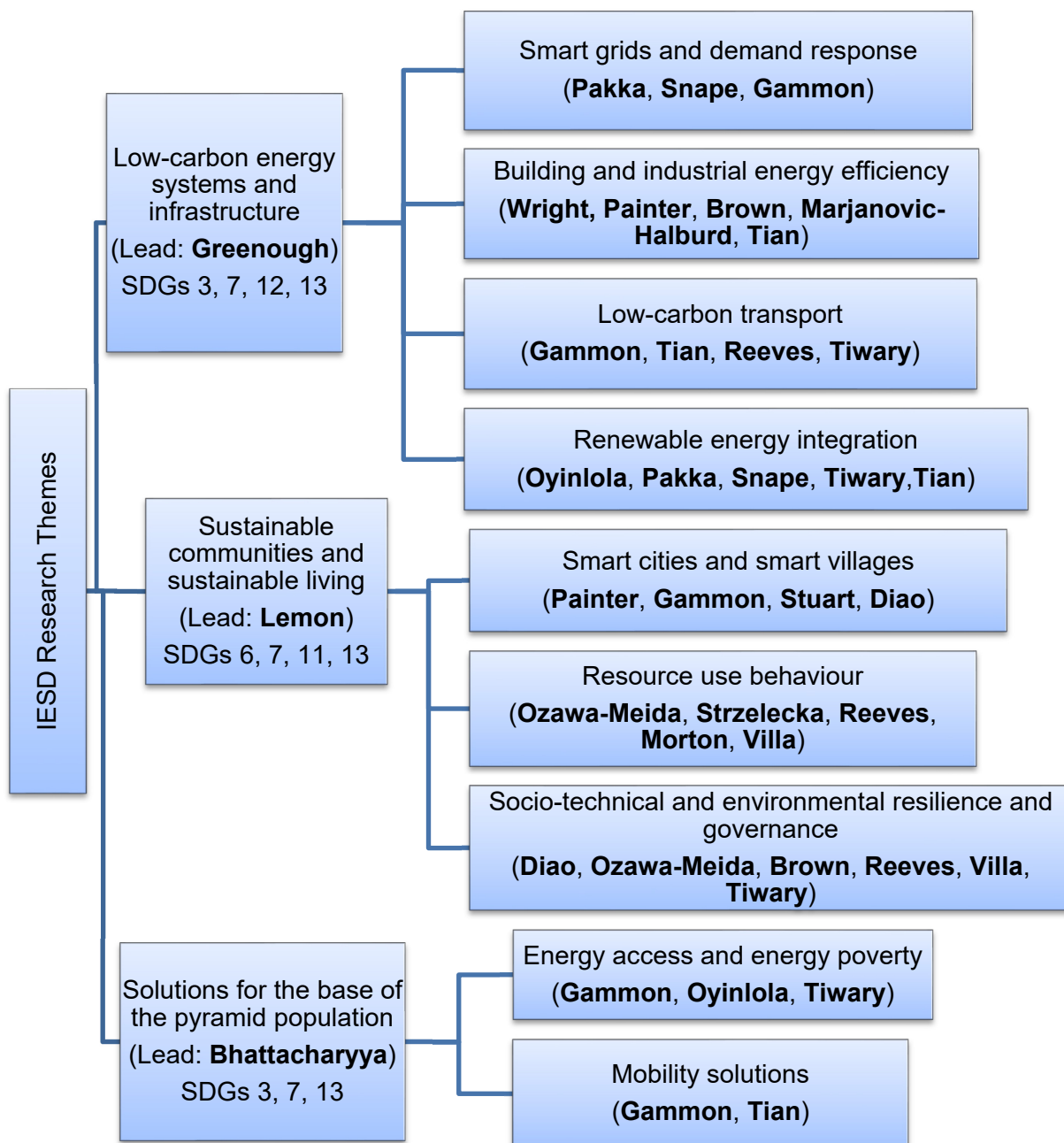


Figure 1: IESD research themes

Similarly, in REF 2014, the research in the School of Architecture was organised around three research themes: Architectural Design; Architectural History, Theory and Criticism; and Developing World Built Environment. Due to changes in the composition of research-active staff, the thematic focus of the IoA has been adjusted at the time of its formation in 2018. The Institute has worked hard to consolidate, build upon and further evolve the strategy established in REF 2014. The key features are to retain existing research excellence in the low-impact built environment and to enhance the research specialisation in new research themes focused on cities

and urbanism, housing and dwelling together with a new emerging theme in architectural geometry and fabrication (see Figure 2). The strength of the Institute lies in its multidisciplinary staff and their collaborative research. The research in the Institute ranges from technical and empirical research to practice-based outputs, focusing on ways to understand how architecture and the built environment work in the real world. The research here is mainly related to SDGs 11 (sustainable cities and communities) and 13 (climate action).

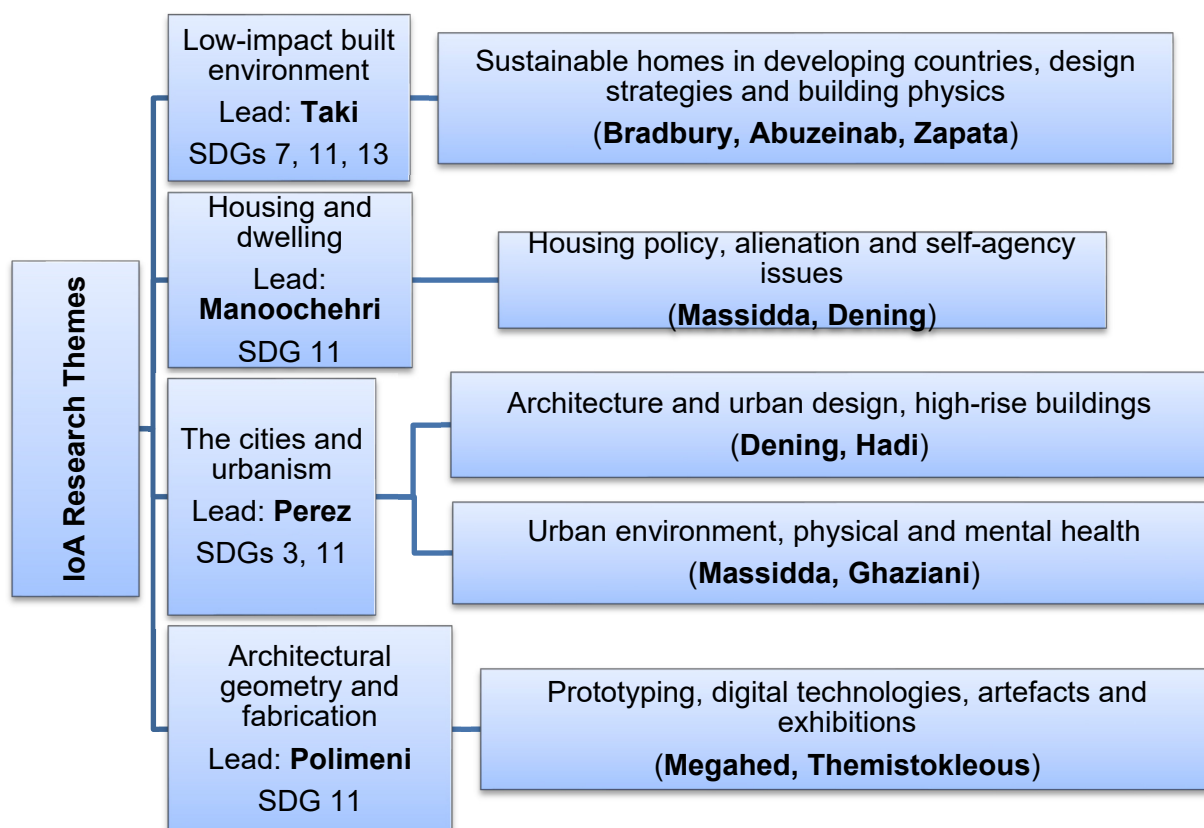


Figure 2: IoA research themes

1.3 RESEARCH STRATEGY

For REF 2021, the strategic aim of the Unit was to achieve research excellence and impact on society by addressing key societal challenges through a focus on an interdisciplinary portfolio, societal impact, people, and partnerships both nationally and internationally (discussed below in more detail). This strategy is well-aligned with DMU's overarching research and scholarship strategy (REF5a). The theme of sustainable development connects the various research activities of the Unit, and the search for a sustainable built environment remains a key societal challenge. Both Institutes are heavily engaged in research on the sustainable built environment, paying specific attention to low-carbon infrastructure, sustainable communities in urban and rural contexts nationally and internationally, and improving the well-being of the users through effective interventions. The emphasis on sustainability and the SDGs received DMU-wide recognition subsequent to DMU becoming a 'designated hub' for SDG 16 and the University's strategic decision to support the 17 SDGs through our pioneering research, community work and ambitious teaching (REF5a).

As a dynamic process, the Institutes have aligned their research agenda with the changing societal challenges. For example, in REF 2014, IESD had a strong focus on understanding building energy performance using modelling, behavioural analysis and considering smart monitoring and control systems. There was a particular emphasis on increasing the understanding of how technologies actually work in the real world in the area of buildings in the European context. However, since 2014, there has been a gradual shift in the research focus to low-carbon solutions to help develop sustainable communities, both locally and internationally. New recruitment, staff movement and retirement of researchers have contributed to this change in the research agenda, which, in turn, has brought new dynamism and allowed globalisation of research activities with new collaborations in Asia and Africa. By broadening the focus and introducing new themes such as Solutions for the Base of the Pyramid Population, the applied research in IESD has reached a wider section of the population and is contributing to the well-being of a diversified user base. Similarly, the IoA is consolidating its strong foundations in built environment research that was already recognised in REF2014 as impact-generating and making a real difference to people's lives. Since 2018, when the university was chosen as a Global Hub for SDG 16 by the United Nations, IoA strategically aligned its focus to SDGs 11 (sustainable cities and communities) and 13 (climate action), using this partnership to explore the UN's 17 SDGs. Through ECR recruitment and active participation in local and global impact-generating projects, IoA utilised its internationally recognised areas of expertise in Architecture and the Built Environment to meet these and other challenges.

The research strategy of the Institutes for REF 2021 is centred around four pillars:

- Portfolio: delivering excellent research of a multidisciplinary nature across selected themes;
- Proof of impact: ensuring impact that makes a difference to society;
- People: supporting researchers to realise their full potential; and
- Partnership: integration with researchers nationally and internationally.

These pillars and related achievements are elaborated below.

1.3.1 Multidisciplinary research portfolio

The Institutes have undertaken a diversified portfolio of funded and self-funded research, with projects addressing societal challenges such as sustainable housing, low-energy buildings, energy poverty, climate change, and sustainable living through better water, waste, transport and infrastructure services. The research undertaken by the Unit is multidisciplinary in nature, involving engineering (e.g. **Greenough, Oyinlola, Pakka, Brown**), building physics (e.g. **Taki, Wright**), architecture and urban planning (e.g. **Manoochehri, Bradbury, Perez, Massidda**), economic (e.g. **Bhattacharyya**), social (**Lemon, Reeves, Morton**) and environmental (**Villa, Ozawa-Meida**) perspectives. In-house availability of diverse expertise naturally facilitates cross-disciplinary research within the Unit and interdisciplinary research remains one of the main pillars of research strategy for this Unit.

The research excellence is evidenced by a growing volume of publications, success with research-grant funding (see 3.1) and awards for research project outcomes (as indicated in 4.2.4). Table 1 indicates our output growth compared to REF 2014. This represents an increase of 75% in output volume and an increase of 67% in journal article publication over the previous REF period. The team ensures research integrity through adherence to DMU's research ethics and integrity codes, and appropriate staff training.

Table 1: Research output growth of the Unit

	Total volume	Journal papers
REF 2014	225	133
REF 2021	393	222
Growth over the period	75%	67%

1.3.2 Proof of impact

The applied research undertaken through the Institutes has directly influenced the conditions of residents in households, users of public buildings, businesses, local communities and the environment. Examples include:

- Through the OASYS South Asia project (EP/G063826/2), **Bhattacharyya** and his team demonstrated the role of mini-grids for electricity access both academically and practically, thereby directly affecting the lives of 5,000 users in rural India (see the impact case Transforming Rural Lives Through Mini-Grids in India). Similarly, **Gammon's** ESCoBox project (EP/L002566/1) has introduced the concept of sustainable operation and management of mini-grids in the developing world by integrating the concept of demand management, demand response and smart control systems. These projects have directly contributed to clean energy access (SDG 7), climate action (SDG 13) and helped improve living conditions of the rural population through better health, better education and poverty reduction (SDGs 3, 4 and 1, respectively).
- **Boait, Snape** and **Greenough's** work on demand response and renewable energy integration at the community level through the CEGADS project (EP/M507210/1) and BEIS supported Demand-Side Response projects translated research into a novel business model for community energy schemes in three Oxfordshire villages (see the second impact case around this work, Localisation of Electricity Generation and Use).
- Research carried out by **Fleming, Stuart** and **Ozawa-Meida** (among others) through EU-Horizon 2020-funded projects (such as SMARTSPACES, GOODDEEDS, SAVES, SAVES2, EDI-NET and POWER) has led to the uptake of modified energy management and sustainability communications behaviour in more than 40 organisations across Europe. Through the delivery of software and training developed by DMU, organisations have been able to more closely integrate utility metering data into their operational practices. This has led to improved information and communication resulting in significant carbon emissions reductions of a minimum of 3,600 tonnes of CO₂ (see the third impact case study titled Urban Analytics being submitted from this work).
- The IoA is engaged in the DMU Square Mile India project to help an informal settlement in Ahmedabad (India) that suffers from severe flooding every year. The initiative led by **Bradbury** delivered the Loving Community flood resilience and home upgrade project in partnership with Gandhi Ashram, Ahmedabad and SeaLab Architects drawing on research expertise in Architecture and the Built Environment. SeaLab architects led the design in partnership with the School of Architecture using community engagement methods to understand the needs and issues in the community. The project assessed the cause of flooding of the homes and potential site-wide responses that might alleviate flooding, and identified adaptations to several homes within the community to stop flooding prior to the onset of the monsoon season. This was carried out within a budget of approximately £3,500 per home, using a range of recycled and other materials to minimise cost. The project is ongoing and was started in February 2018.

Open access to research outputs and data has underpinned the impact strategy of the Unit. Research projects have adhered to DMU's Open Access and Research Data Management Policies (see REF5a). All research publications and related data are made available through DMU repositories, DORA and DMU Figshare.

1.3.3 People

Both Institutes recognise the importance of an excellent research environment for productive research activities. As indicated in section 2, the Unit has benefited from the recruitment of 17 ECRs and diversification of research capacity through 3 appointments at senior levels. The Institutes offer a collegial and supportive research environment where the members of each Institute use common facilities (e.g. laboratories, studios, office space, common areas and administrative support). The Unit supports interdisciplinary research through a shared vision of sustainable development that brings the teams together. A formal monthly meeting of the Institutes, informal conversations among colleagues on a regular basis and a monthly research

seminar series where researchers share their research ideas, ongoing activities and achievements also strengthen interdisciplinary collaboration.

Research within the Unit is conducted following high standards of research ethics and research integrity. All research projects involving humans and human data undergo a formal ethical review at the Faculty level and where appropriate at the University level. Researchers and research students receive appropriate training from the University to ensure adherence to relevant policies and procedures for the entire research lifecycle.

1.3.4 Partnerships

Finally, the Institutes have successfully developed research partnerships nationally and globally (see 4.1).

1.4 FUTURE STRATEGY

Beyond the census period, the research strategy seeks to build on the strengths of the four pillars of the current strategy and aim for the following:

- strengthen impactful, interdisciplinary research through ongoing projects (e.g. SIGMA and Modern Energy Cooking Services (MECS) in Table 3 in section 3) and successful conversion of project pipelines into externally funded research through strategic investments in people and facilities;
- explore and develop new niche areas of interdisciplinary research within Architecture and the Built Environment to address emerging societal challenges (such as post-Covid recovery through Renewable Energy (RE) interventions, RE hubs for international development, and smart cities) through strategic positioning, collaboration and partnerships;
- nurture and develop research talent at all levels, including Postgraduate Researchers (PGRs), through researcher training and support to ensure high research integrity and excellent quality; and
- engage widely with the academic and non-academic communities for Open Access dissemination of research outcomes. Ongoing projects in the areas of decarbonisation of the built environment will be leveraged to gain further momentum during this period and both Institutes are well placed to contribute to the societal challenge through impact-generating research.

1.5 IMPACT STRATEGY

The impact strategy of the Unit is to translate research that contributes towards addressing important societal challenges into practice. Recognising different types of impacts, namely academic, social, environmental and economic, a multipronged strategy has been adopted. For example, the OASYS South Asia project had a demonstration component as one of the work packages that required practical implementation of alternative business models for off-grid electrification on the ground. The project team decided to use the budget for this component innovatively to experiment with multiple delivery models that allowed the benefits to reach a wider user base. These activities directly addressed several SDGs, namely SDG 3 on well-being, SDG 7 on energy, SDG 13 on climate change and SDG 6 on water. Similarly, IoA has been delivering impact through community engagements and interactions with policymakers at the city and national levels: for example, the flood-resilient low-cost housing for dwellers of informal settlements in Gandhi Ashram (India) is of interest to the non-academic community, and is contributing towards SDGs 7, 11 and 13. Indirectly, the research in these Institutes addresses several other societal challenges as identified in SDG 1 (poverty), SDG 2 (hunger), SDG 4 (education), SDG 5 (gender equality), SDG 9 (industry and infrastructure) and SDG 12 (responsible consumption and production).

To realise research impact, the Unit has adopted a multipronged approach (Design, Develop, Demonstrate, Disseminate):

1.5.1 Design and development activities

DMU realised the importance of research impact and the Impact Tracker software from Vertigo Ventures has been used to manage evidence and support impact case development. As part of any research proposal activity, researchers are encouraged to consider the impact from the conceptualisation stage. Identification of who will be affected by the research, how they will benefit, the need for recording appropriate evidence of impact and adequate funding to support such activities are considered at this stage. DMU's Research Services Directorate (RSD) provides support at different stages of impact pathways.

1.5.2 Demonstration activities

Researchers have undertaken demonstration activities as part of their research projects. Pilot projects have formed an integral part of realising research impact in several funded projects, including OASYS South Asia, ESCoBox, SAVES, EDI-NET and MECS. Demonstration projects have also been implemented using DMU funds, contributions by locals and from other partner organisations – the DMUglobal project in India to design and demonstrate low-cost housing for the low-income population is a prime example. **Gammon's** demonstration of the concept of a Solar Taxi in Gambia used DMU funding and support from industry partner Nissan.

1.5.3 Dissemination and public engagement activities

Research projects are actively pursuing communication and dissemination strategies to reach different user groups, namely academic, institutional users, general public and community-based users.

- For academic beneficiaries, dissemination via journal papers, conference participation and contributions to books has been used. Researchers of the Unit have published in high-quality journals in the field, ensuring Green or Gold Open Access. Several authored and edited books were published too. For example, **Bhattacharyya** has published edited books (*Mini-Grids for Rural Electrification of Developing Countries* and the *Routledge Handbook of Energy in Asia*). **Manoochehri** has co-edited *Smart Futures, Challenges of Urbanisation, and Social Sustainability*. **Perez** has co-authored the book, *Repurposing the Green Belt in the 21st Century*. **Megahed** has published a book *Practiceopolis*.
- For institutional users, targeted reports, policy briefs, newsletters and engagements via focus groups, interviews and surveys have been relied on. For example, EDI-NET and POWER projects have worked with local councils in various European cities to influence user behaviour in public buildings.
- Web and social-media presence is widely relied on to share the knowledge with a wider population. News articles in *New Scientist* and on the *BBC Future* online platform have disseminated **Bhattacharyya's** and **Villa's** interviews globally.
- The Unit's research has also been disseminated through conference participation: 'Energising the SDGs Through Appropriate Technology and Governance' held in Leicester in July 2019 attracted around 100 participants from around the world. IESD's virtual conference in July 2020 on 'Aligning the Local Interventions with the UN SDGs' attracted around 50 participants to share their research on cities and rural areas from around the world. Furthermore, an international symposium hosted by DMU focusing on learning environment design was organised in October 2019 and additionally two international symposiums were held in 2020 at the University to set up an international network around (1) the issues of toxicity and phyto- and bio-remediation in relation to 'Landscapes of Hope: Contamination and Collective Design in Contexts of Urban Poverty'; and (2) 'Biophilic Design in Primary Schools: Impacts on Children's Well-Being'.

The impact strategy has helped deliver the desired impact of applied research of the Institutes both nationally and internationally, which in turn has improved the visibility and recognition of the Institute brands. Moreover, researchers from IESD have set up a spin-off company, EcoVisum Ltd (www.ecovisum.com) in April 2016 to commercialise the knowledge on urban analytics. Beyond

the census period, the Unit's impact strategy will follow the multipronged approach outlined above and support all potential impact cases through training, funding and impact tracking.

Section 2. People

The Unit is composed of researchers of different levels and backgrounds and follows a staffing strategy that allows continuity, investment in strategic areas and support to researchers to deliver high-quality work.

2.1 STAFFING STRATEGY AND DEVELOPMENT

As dynamic organisations, both Institutes of UOA 13 have experienced staff movement and staff retirement over the assessment period while the parent Schools and Faculties have also reviewed and realigned their growth strategy. These factors have influenced staffing. Both Institutes have benefited from staff recruitment at different levels:

- Strategic appointments: Senior appointments included Ljiljana **Marjanovic-Halburd** (as Head of School of Engineering and Sustainable Development with affiliation to IESD for research purposes), Raffaella **Villa** (Reader in Environmental Engineering, affiliated to IESD), Simon **Bradbury** (PVC Dean, Faculty of Arts, Design and Humanities).
- Attracting young researchers: IESD and IoA have also benefited from the Vice-Chancellor's flagship VC2020 Lectureship Scheme (REF5a) and Early Career Academic Fellows (ECAFs). In all, 17 researchers were recruited in VC2020 lecturer and ECAF positions in the two Institutes (see Table 2).

As a consequence, compared to REF 2014, the research capacity of the Unit has more than doubled: from 14.1 FTE in 2014 to 31.2 FTE in this submission.

All new staff in the UOA attend a staff induction event and as per DMU policy, all research-active staff apply for individual time allocations for undertaking research. All VC2020 positions and ECAFs have received a 50% research-time allowance in their first year, a personal research budget (of up to £5,000) and a mentor for advice and support. New researchers are paired with a senior researcher within the group, having expertise in related areas for mentoring purposes. Mentors provide advice regarding research training, funding options, grant applications, publications and doctoral supervision. Four VC2020s have also participated in DMU's Future Research Leaders programme, which provides mentorship through an external mentor and financial support (up to £1,500). **Abuzeinab**, **Polimeni**, **Perez** and **Oyinlola** have taken part in this programme during this census period, which has made a visible contribution to their research careers (for example, Abuzeinab became the ADH Faculty Head of Research Students and Polimeni an Institute Head of Research Students).

Researchers of the Unit are supported by the Research Services Directorate who provide a range of training and development opportunities to equip researchers for proposal development, ethical issues, intellectual property issues and project management aspects. Researchers are required to complete Equality and Diversity training and the Certificate in Research Supervision course.

All research-active staff are given research-time allocations to undertake research through DMU's Research and Innovation Allowance (RIA) scheme, which allows researchers to apply for one of the three allowance categories (320, 480 and 640 hours) in addition to a 10% scholarship allocation given to all (equating in total to 1.5–2.5 days per week). Further, budget allocation given to each Institute is used to support research and dissemination activities. These funds have been used to buy consumables for lab-based work, pay for Open Access publications, conference participation and procuring transcription services, among others. This budget is in addition to any support from funded research projects or funding support given to VC2020s and ECAFs.

DMU's clear career pathway has facilitated the Unit's researchers to progress organically in their careers: ECAFs get promoted to lecturer positions, VC2020 lecturers become senior lecturers and then associate professors. Finally, internal promotion to reader and full professorships has

also been achieved during the census period. For example, **Taki** received his chair in September 2019. A new position, Associate Professor, has been created to allow for a mid-career research position, with several researchers of both Institutes reaching this level through internal promotion (see Table 2 for details). The distribution of staff with significant responsibility for research returned in this submission and in 2014 is shown in Figure 3. The improvement in the gender balance is clearly evident from this figure.

Table 2: Staff recruitment, retirement and movement within UOA 13

Recruitment	Internal promotion	Retirement	Left DMU
Marjanovic-Halburd (Head of School, Engineering and Sustainable Development)	<u>Professor position</u> Taki	Fleming Rylatt Boait Cropper	Bull
Villa (Reader)	<u>Associate professors</u> Painter Manoochehri Oyinlola		
Bradbury (Dean, Faculty of Arts, Design and Humanities)			
<u>Senior Lecturer</u> Tiwary Perez			
<u>VC2020s in IESD</u> Beizaee Oyinlola Snape Pakka Tian	<u>Senior Lecturer</u> Snape Pakka Tian		Beizaee
<u>VC2020s in IoA</u> Hadi Abuzeinab Sharmin Villatoro Ghaziani Megahed Themistokleous	<u>Senior Lecturer</u> Abuzeinab Zapata Hadi Megahed		Sharmin Villatoro Ebohon Causar Ireland Periton
<u>ECAFs</u> Massidda Polimeni Zapata Morton Strzelecka	<u>Lecturer</u> Morton Massidda Polimeni		

All researchers submitted to UOA 13 are members of either IESD or IoA. The monthly research-group meetings, which are attended by researchers affiliated to the Institutes and the associated PGRs, provide a platform for discussing research-related issues, recent developments and initiatives to support research activities at the Institute and University levels. The Unit's researchers also participate in a research seminar series operated at the School level, and benefit from seminars organised by the East Midlands branch of the Energy Institute, which are held at DMU on a monthly basis. In addition, researchers have benefited from the internal funding schemes, e.g. Higher Education Innovation Funding (**Brown, Gammon, Bradbury**) and Funding for Enterprise Projects (**Villa**). The University's competitive annual Research Leave Scheme is also available to researchers.

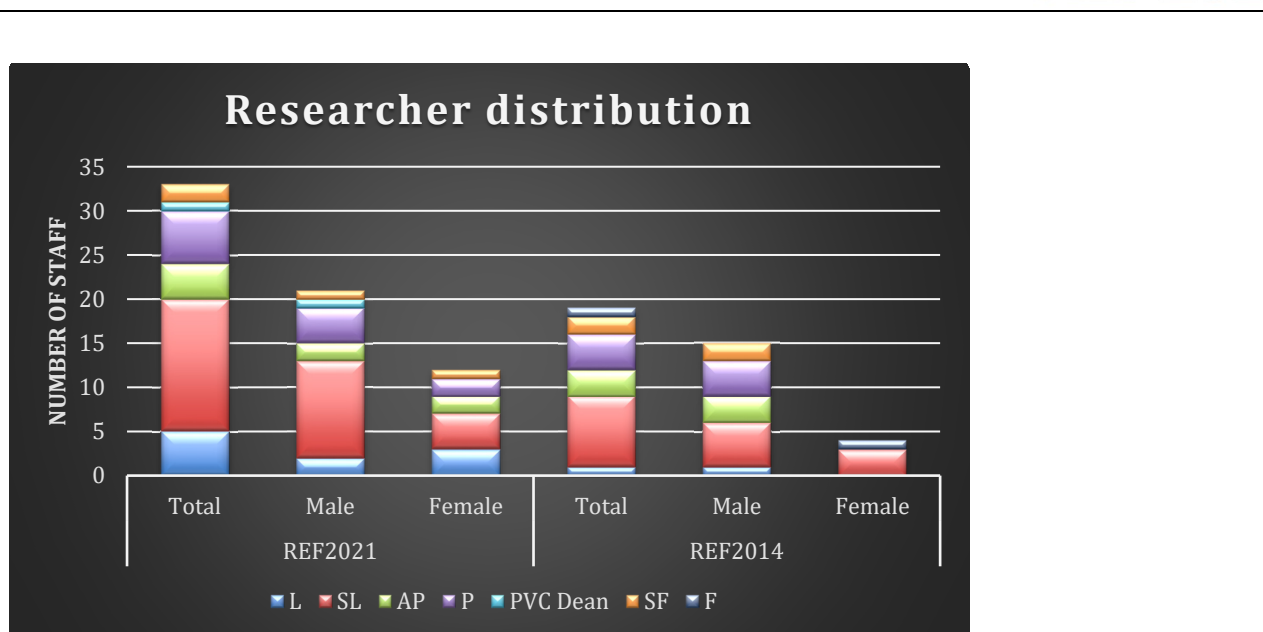


Figure 3: UOA 13 researcher distribution by rank and gender

Note: L – lecturer; SL – Senior Lecturer, SF – Senior Research Fellow; AP – Associate Professor, P – Professor, PVC Dean – Pro Vice-Chancellor, Dean of Faculty

2.2 PGR STUDENT SUPPORT

UOA 13 has a strong and successful Doctoral Training Programme, with 44 students gaining their degrees during the census period compared to 28 PhDs awarded during REF2014. As of July 2020, PGR recruitment is also strong: 49 students are currently enrolled under postgraduate research programmes (27 with IESD and 22 with IoA). This vibrant and diverse PhD community supports the scholarly activities of the Institutes. A majority of the current PGR students (more than 80%) are of international origin and are either sponsored by national agencies (e.g. Petroleum Technology Development Fund, Nigeria; Ministry of Agriculture and Rural Development, Vietnam; Governments of Libya and Jordan), supported through DMU scholarships or support from faculties (eight full award and one fee-waiver) or self-funded.

The Institutes have embedded doctoral research within their research culture. Doctoral students participate in the research group's monthly meetings, which has ensured better integration of doctoral researchers in the overall research activities of the Institutes. In addition, a doctoral seminar series was launched in July 2018, which is voluntarily managed by a doctoral student under the guidance of the Institute Head of Research Students. In this seminar series, a student presents his/her work for 20–30 minutes, followed by a discussion session for another half an hour. At the end of the event, written feedback is collected in a standard template from all attendees and is given to the presenter. Being a student-led activity, the series has become popular with doctoral students. In addition, a cross-Institute annual conference for PhD students promotes cross-disciplinary learning and student interactions.

PGR students are recruited and managed centrally by the Doctoral College in close cooperation with the Faculty Head of Research Students, who is assisted by the Institute Head of Research Students. The affiliation of doctoral students to the research institutes is determined by the research-group membership of the main supervisor, but the student can hold associate membership in other research institutes as well.

Every PGR student is supervised by a team of at least two supervisors having relevant skills and expertise in the student's area of research. All supervisors are required to obtain the University's Certificate in Research Supervision and are encouraged to attend refresher courses to keep up-to-date with changes in regulations and procedures. The supervision team interacts with the

student on a regular basis and students are required to complete regular records of discussion which are reviewed annually; their progress is monitored through our online PGR management system. International students and part-time students not based locally receive supervision via emails, MS Teams meetings and Skype calls. The procedural requirement is to have at least one recorded interaction per month for full-time students. PGRs are reviewed annually by a panel that includes an independent assessor.

DMU follows a standardised approach to PGR training at the Doctoral College level that focuses on the entire lifecycle of a research project and helps develop knowledge and intellectual abilities, personal effectiveness, research governance and organisation, and engagement, influence and impact. All students are offered a training programme that covers research methods, critical thinking, research project planning and management, research ethics and integrity, literature searching, writing and communication skills and good academic practice. They are also given training for career development so that they can transition to the independent researcher stage.

PGRs who are based on campus have a desk in the same area as other researchers. For example, PGRs in the IoA have benefited from the self-contained premises in DMU's historic cottages – see 3.2. This allows them to interact with the Institute members on a regular basis. In addition, if any specialised kit is required, the Institutes and the Schools support the procurement through the research supervisors. A number of PGRs are involved in teaching or supporting laboratory activities for undergraduate students and postgraduate students under the supervision of module leaders. This gives them the opportunity to develop their teaching and communication skills and prepares them for a future career in academia.

PGR students are encouraged to publish and disseminate their research within the University as well as nationally and internationally. Doctoral students have been supported financially by the Institutes and the Faculty to participate in key events (e.g. International Conference on Climate Change in Washington, DC, in 2019; UK Heat Transfer Conference in Nottingham in 2019; 3rd OIKONET Conference on Global Dwelling: Sustainability – Design – Participation, 2016, Manchester). All PGR students can apply for up to £500 for research activities, including conference attendance and travel. Students also participate in other events (such as the annual poster session and 3-Minute Thesis challenge) organised by the Doctoral College and on several occasions, they have received prizes and commendations (e.g. best poster in 2018). In addition, the Doctoral College has initiated a lecture series highlighting the contribution of doctoral students to the SDGs and PGRs from this Unit of Assessment have participated in these events.

2.3 PROMOTION OF EQUALITY AND DIVERSITY

DMU champions diversity and equality through its policies and practices (REF5a). All staff are required to undergo mandatory training on equality and diversity. The Unit has a well-diversified researcher base in terms of gender, race and ethnicity. For example, out of 33 staff returned from this Unit in this REF, 12 are from BAME background and 12 are female researchers. More importantly, since 2014, seven new female researchers have joined the Unit, including one as professor and head of school, and a second as reader. Gender diversity has improved as a result (see Figure 4). The ethnic diversity has also improved: in REF 2014, only 3 BAME researchers were returned – this has risen to 12 in REF 2021.

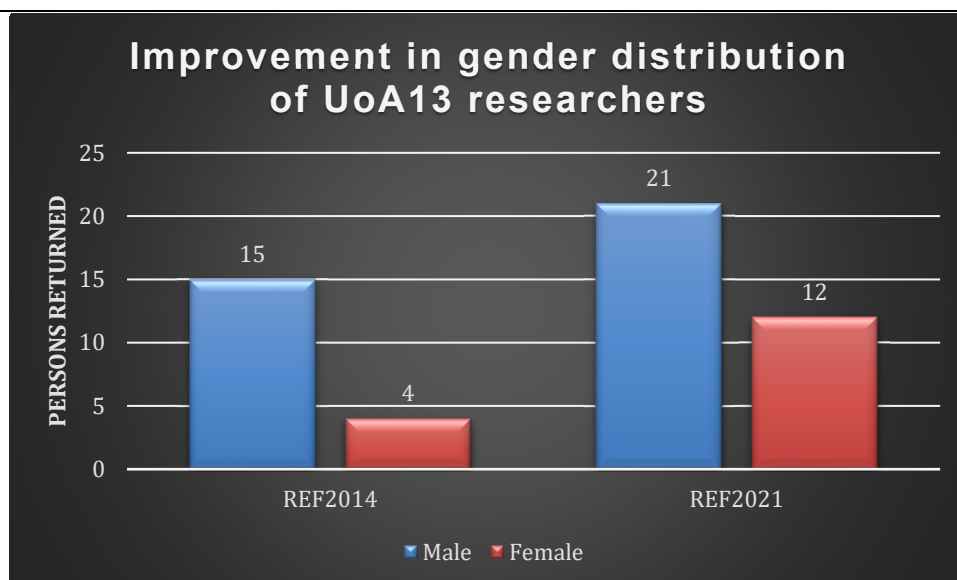


Figure 4: Improvement in researcher gender diversity in UOA 13

Schools within each faculty are responsible for staff recruitment following HR policies. The Institutes adhere to DMU policies in respect of equality and diversity and all decisions related to support and career development are fully aligned with the statutory and policy requirements in this respect. Staff members have benefited from the University's leave policy and are offered the opportunity to request a flexible working arrangement to ensure a better work–life balance. In addition, the faculties organise well-being sessions for researchers on a regular basis and offer support for health and safety through a variety of programmes and events.

The process for research-time allocation allows individual researchers to explain their individual circumstances. The University Research Leave Scheme is also friendly towards diversity and equality principles – any researcher with continuous work experience of one year is eligible to apply for leave to undertake a dedicated research activity. The Institutes operate a transparent and equitable policy for using their budgetary resources as well. For example, IESD researchers are notionally allocated a fund of £500 to spend on any research-related activity (conference participation, software purchase, data transcription service fee, Open Access fee, etc.). For any remaining unused funding, researchers are invited to submit requests for spending in appropriate areas.

Overall, the Unit has benefited from new recruitment that has improved the diversity, sustainability and vitality of the group. This people-centric focus has supported the Unit to deliver its research objectives successfully and will remain a key element of the Unit's future strategy.

Section 3. Income, infrastructure and facilities

This Unit is an important research-income generator within DMU and has benefited from investment in infrastructure and facilities in recent years. This section elaborates on these aspects.

3.1 EXTERNAL INCOME

During the assessment period, the Unit has received £3,300,000 in research-grant funding from different sources (UK Research Councils, EU sources, government agencies and charities), which is marginally less than £3,600,000 reported in REF 2014. The retirement of several senior researchers (e.g. **Fleming**, **Rylatt** and **Boait**) and a strong focus on capacity building through ECRs has contributed to this marginal loss in grant income. However, the Unit has generated additional income via commercial research (e.g. **Snape**, **Gammon**, **Wright**, **Bhattacharyya**) as well as doctoral fellowships from industries and other sources (**Painter**, **Lemon**) during this census period which are not reported in HESA returns. Table 3 shows that the Unit has been successful in attracting research grants of different sizes from various sources.

Table 3: Selected research projects

Title	PI at DMU	Duration	Funding agency	Project value
Agent-based Modelling of Electricity Networks (AMEN)	Rylatt	2013–2016	EPSRC	£561,836.00
Circular Plastic	Oyinlola	1 April 2020–31 March 2021	EPSRC	£127,544.00
Consortium for rapid smart grid impact	Bhattacharyya	2014–2017	US Department of State (Global Innovation Initiative)	£50,000.00
Digital Innovations for Transitioning to a Circular Plastic Economy (DITCh Plastic)	Oyinlola	May 2020–April 2021	EPSRC	£129,471.00
EDI-NET	Fleming/Marjanovic-Halburd	2016–2019	H2020	€1,558,800.00
ESCoBox	Gammon	2013–2017	EPSRC	£843,943.00
e-Teacher – End-user tools to empower and raise awareness of behavioural change toward energy	Bull/Reeves	2017–2020	H2020	€2,394,862.50
GEOTECH – Geothermal Technology for Economic cooling and heating	Greenough	2015–2019	H2020	€7,136,662.88
Integrating the SDGs into climate planning of British and Japanese cities	Bhattacharyya	2019–2020	ESRC	£50,000.00
Leicester City Council KTP	Fleming/Cropper	2013-14 to 2015-16	Innovate UK, KTP	£51,358.00
Modern Energy Cooking Services (MECS)	Gammon	2018–2023	DFID	£280,000.00
Networking Grant – healing nature	Ghaziani	2019-20 to 2020-21	GCRF	£24,960.00
OASYS – South Asia	Bhattacharyya	2012–2015	EPSRC/DFID	£829,548.00
POWER – Political and Social Awareness on Water and Environmental Challenges	Fleming/Marjanovic-Halburd	2015–2019	H2020	€3,747,937.50

REEMAIN – Resource and Energy Efficient Manufacturing	Greenough	2013–2017	FP7	€6,098,037.00
SMARTSPACES	Fleming	2012–2015	H2020	€6,977,199.00
STEEP – Support and Training for an Excellent Energy Efficiency Performance	Fleming	2014–2017	Intelligent Energy Europe	€2,700,000.00
UKRI GCRF Sustainability, Inclusiveness and Governance of Mini-Grids in Africa (SIGMA)	Bhattacharyya	2 March 2020–1 September 2023	ESRC	£1,243,899.00

The research funding has supported several key areas of research, including:

- energy for international development through projects such as OASYS South Asia project, ESCoBox project, Modern Energy Cooking Services, SIGMA, Circular Plastic and Digital Innovations for transitioning to a circular plastic economy;
- smart grid and renewable energy integration through AMEN, REEMAIN, Geotech and Consortium for rapid smart grid impact; and
- energy efficiency and behaviour change in industry and non-domestic public buildings in European countries through European projects such as SMARTSPACES, EDI-NET, Steep, POWER and e-teacher.

The Unit has successfully diversified the grant portfolio and, more importantly, young and mid-career researchers (**Gammon, Oyinlola, Tiwary, Ghaziani**) have become successful grant holders, which will form the building block for future growth and success of the Unit beyond the census period.

3.2 INFRASTRUCTURE AND RESEARCH FACILITIES

IESD and IoA have benefited from investment in facilities and infrastructure. The new Vijay Patel Building (£55,000,000) has offered modern facilities for the IoA whereas the Energy Lab within IESD has allowed experimental research activities. The Energy Lab was set up in 2016 with an investment of £200,000 by the Faculty to support energy-related research and education. In 2019/20, a further expansion of the facility has been completed to support e-mobility and demand response research with an investment of £150,000. An additional £100,000 investment has been planned in 2020/21 to integrate smart-grid research elements. In addition, investments in 3D printers, high-performance computing facilities, and software licences have also been made by the Faculty (£100,000).

The IoA has excellent self-contained premises for use by its PGRs in the historic 6 and 7 Castle View cottages (66m² floor area), helping to create a clear sense of identity, a common purpose and a vibrant community spirit. The Institute has installed a high-performance computing facility, approximately 140 Z4 computers at a cost of £2,000 per unit in the IT Lab, Vijay Patel Building. The workshop facilities in the IoA continue to be upgraded to provide excellent and up-to-date equipment from traditional woodworking to printed models. On average £200,000 is spent annually on new and replacement equipment. The workshops have been part of the campus for over 40 years and are equipped with advanced and precise laser cutters, 3D scanning / 3D printing, milling and rapid prototyping machines. The IoA also has extensive facilities for model-making, photography and small-scale video production, and a high-performance computing facility with current releases of a range of software and analysis tools that can be used for teaching and

research purposes. This includes AutoCAD, Revit, 3ds max, Adobe Creative Suite, SketchUp, Rhino/Grasshopper, V-Ray, DesignBuilder, and Elmhust Design SAP. The IoA has installed a range of architectural software together with Dynamic Thermal Simulation tools.

In IESD's labs and workshops, research activities include the development of electric vehicle systems (e.g. a hydrogen-powered range extender), smart grid and demand-side response systems, thermal and electrical energy storage systems (e.g. a hybrid battery-electrolyser device) and many more. They also provide space for students to undertake practical work on projects, such as the electric racing car for the Formula Student competition. Experienced technicians support the research activities in the Energy Lab. As part of DMU's system, the Institutes benefit from the services offered centrally by the Research Services Directorate (such as training, networking, support for grant proposals) and the administrative support of the Research and Innovation Office at the Faculty level (such as procurement, budget monitoring and reporting).

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

4.1 COLLABORATION AND PARTNERSHIPS

This Unit has established strong collaborations and partnerships with researchers from around the world. The research collaboration has relied on a number of approaches:

- 1 Funded research has allowed participation in research consortiums, which is a natural way of developing strong research collaboration.
 - Participation in several Horizon 2020 projects of the European Union (e.g. POWER, EDI-NET, REEMAIN, GEOTECH, SMARTSPACES) have allowed partnership with a range of European partners from academia, local authorities, regional organisations and businesses. These partnerships have allowed follow-up research projects and widened the reach of research activities. Collaboration developed through SMARTSPACES supported the subsequent successes in the form of EDI-NET and POWER.
 - UK Research and Innovation (UKRI)–funded research (e.g. OASYS South Asia, ESCoBox, AMEN, SIGMA, CAPACities, etc.) has supported collaboration with other UK universities (e.g. Edinburgh Napier, Sussex, Newcastle and Cranfield, among others). The collaboration developed through OASYS and ESCoBox projects has facilitated the consortium-building for the subsequent award SIGMA.
 - A Global Challenges Research Fund Networking grant on 'healing by nature' has enhanced collaboration with Universitas Indonesia.
 - Funding from UKRI international projects and the Department for International Development has supported research collaboration with international partners in Asia and Africa (particularly in India, Kenya, Nigeria, Tanzania, The Gambia), which in turn facilitates the wider reach of research impact and internationalisation of research influence of the Unit.
 - Through a Global Innovation Initiative project funded by the US Department of State, research collaboration was established with UNESP (Brazil) and Purdue University at Calumet. A list of partner organisations for different projects is given in Table 4. In many cases, DMU has formal collaboration agreements that go beyond the project life.

Continued grant success and development of a project pipeline directly follow from collaborations mentioned above.

- 2 International research students and alumni have been another source of international collaboration. A number of international students have facilitated the process of collaboration with their former organisations and acted as anchors. For example, an Argentinian alumnus received a British Council Higher Education Link grant for two weeks (in 2019) to participate in research work on sustainable energy solutions in social housing involving DMU and his current employer. Additionally, the Architecture courses have a strong employability focus and the school has an excellent track record in the delivery of Architecture education and has developed several niche areas of strength. This has led to

	growing our Transnational Education provision in the area of the built environment in Sri Lanka, for example. This has potential for further research collaboration to be exploited beyond the census period including, but not limited to, supervisory collaboration.
3	<p>The strategic collaboration arrangements or initiatives made by the University have also opened up new opportunities. These include:</p> <ul style="list-style-type: none"> • Square Mile India and Loving Community flood resilience and home upgrade project; • the 'Built Environment' DMU Local+ project through which consultancy services to Leicester City Council were provided in relation to emerging regeneration plans for areas of north-west Leicester; • an agreement for research capacity building with Srinakharinwirot University (Thailand) and Africa Centre of Excellence on Science, Engineering & Technology for Entrepreneurship in The Gambia; • Memoranda of Understanding between IoA and Pescara University, Italy; Federal University of Technology, Kaduna Polytechnic in Nigeria; and Institute for Rescue on Innovation and Services for Development (IRISS CNR), Napoli to strengthen collaborations; • research collaboration between IoA and Seville University, Spain and other international partnerships; and • research collaboration between IoA and Taif University (Saudi Arabia) whereby their Head of Civil Engineering spent the whole summer in Leicester working with us on research related to energy and indoor climate. This resulted in a joint article in the <i>Journal of Indoor and Built Environment</i>.
4	Partnership through other initiatives: the Institutes within this UOA have developed research collaboration through other interactions and initiatives as well. Book projects constitute a case in point. Bhattacharyya was commissioned by Routledge to edit the <i>Routledge Handbook of Energy in Asia</i> . This project over two years led to interactions and engagement with world leaders in Asian energy issues. Subsequently, a joint project proposal with one of the collaborators (IGES) got funded through ESRC, thereby further strengthening the research partnership. Similarly, the SDG Conferences organised in July 2019 and July 2020 further supported partnership efforts. In addition, ECRs through the Erasmus Staff Exchange programme were received by the Unit, which led to the submission of a Marie Curie Fellowship proposal for further innovative research.
5	Links with professional organisations and professions: CIAT, CABE and RIBA are regularly invited to the IoA as part of accreditation processes; Massidda was recently shortlisted for RIBA President's Awards for Research 2020, for her journal article 'Shantytowns, Housing and State Order: The Plan de Emergencia in 1950s Argentina'. Further dialogue has strengthened relationships with these bodies and led to discussions regarding how to achieve a greater integration with practice and the built environment that links to our undergraduate and postgraduate teachings. Similarly, IESD is actively involved with the Energy Institute and hosts the East Midlands EI talks and seminars on a monthly basis. In addition, IESD has close links with CIBSE.

Table 4: Selected list of project partners and collaborators

Title	Project partners
Integrating the SDGs into climate planning of British and Japanese cities	Institute for Global Environmental Strategies (Japan)
SIGMA: Sustainability, Inclusiveness and Governance of Mini-grids in Africa	University of Sussex (UK); Institute of Development Studies (UK); ECREEE (Cape Verde); Tatedo (Tanzania); CFIA (Kenya); ICEED (Nigeria)
Decentralised off-grid electricity generation in developing countries: Business models for off-grid electricity supply (OASYS – South Asia)	Edinburgh Napier University (UK); University of Manchester (UK); The Energy and Resources Institute (India); TERI School of Advanced Studies (India)
ESCoBox: Smart monitoring, billing and control for pro-poor access to energy services	Newcastle University (UK); University of Nairobi (Kenya); Practical Action (UK); SteamaCo; Bboxx
Agent-based Modelling of Electricity Networks (AMEN)	National Energy Foundation (UK); E.ON (UK); European Institute for Energy Research (Germany); CSIRO (Australia)
Consortium for rapid smart grid impact	UNESP (Brazil); University of Purdue (USA)
POWER – Political and Social Awareness on Water and Environmental Challenges	Consortium Ubiquitous Technologies SCARL (Italy); Fundació CTM Centre Tecnològic (Catalunya); KWR Water BV (Netherlands); European Institute for Participatory Media EV (Germany); Climate Alliance (Germany); Universiteit Utrecht (Netherlands); Leicester City Council (UK); Aggregate Formula LDA (Portugal); Hagihon Company Ltd (Israel); Milton Keynes Council (UK); Companyia d'Aigues de Sabadell SA (Catalunya)
EDI-NET: Energy Data Innovation Network	Climate Alliance (Germany); Leicester City Council (UK); Centre Internacional de Mètodes Numèrics en Enginyeria (Catalunya); Departament de Territori i Sostenibilitat – Generalitat de Catalunya (Spain); Empirica Gesellschaft für Kommunikations- und Technologie Forschung mbH (Germany); Stadt Nurnberg (Germany)
REEMAIN – Resource and Energy Efficient Manufacturing	Fundación CARTIF (Spain); Integrated Environmental Solutions Ltd (UK); Galletas Gullón SA (Spain); Bossa Ticaret Ve Sanayi Isletmeleritürk Anonim Sirketi (Turkey); Accademia Europea di Bolzano (Italy); R2M Solution SRL (Italy); Uli Jakob (Germany); Fraunhofer-Gesellschaft zur Förderung der Angewandten Forschung EV (Germany); Youris.com (Greece); Solera GmbH (Germany); Est Enerji Sistem Teknolojileri Sanayi Ic Ve Dis Ticaret Limited Sirket (Turkey); Ikerlan S. Coop (Spain); Centro di Ricerca e Innovazione Tecnologica SRL (Italy); SCM Group Spa (Italy); Asociación Española de Normalización (Spain); Dr Jakob Energy Research GmbH & Co. (Germany); SCM Fonderie SRL (Italy)

Both the Institutes have an open research environment where researchers are free to pursue their own interest individually and in collaboration with other researchers within the Institutes as well as with researchers in other faculties in the University and beyond. This cross-faculty collaboration also enriches the research of the Institutes and opens new funding opportunities. For example, the work on smart cities being carried out within the Unit has involved collaboration with the Business School. Similarly, collaboration exists with the Faculty of Health and Life Sciences in the areas of water and sanitation issues for international development.

4.2 WIDER CONTRIBUTION TO THE RESEARCH BASE, ECONOMY AND SOCIETY

Being units of applied research, researchers at IESD and IoA are fully engaged in enterprise activities. The teams have maintained a close working relationship with Leicester City Council, who participated in several EU-funded projects as a partner (e.g. SMARTSPACES, EDI-NET, POWER, SAVES, etc.). This has allowed researchers to engage with local schools, users of public buildings, and the local policymakers. The team has been actively involved in shaping Leicester's smart-city strategy (**Painter, Greenough, Marjenovic-Halburd**), its climate response (**Reeves**) and the local police force's effort to control serious and organised crime (**Lemon**). The team has also provided consultancy services via DMU Local+ projects. The engagement, however, is not limited to local areas. The Unit has given advice to the Department for Business, Energy and Industrial Strategy (**Snape**), social housing associations (**Lemon**), the Department for International Development (**Bhattacharyya**) and the World Health Organization, among others. These engagements allow the researchers opportunities to share their expertise and work under different environments, thereby enriching their experience as well. This also acts as an inspiration for junior researchers and opens opportunities for further research.

Researchers submitted to this Unit contribute to the research base in a number of ways:

4.2.1 Participation in research council panel meetings

Bhattacharyya has served as a member of the Research Councils Norway in 2020. He is also a reviewer of IPCC AR6 WGII. **Fleming** has also served at several EPSRC panels during this REF period.

4.2.2 Peer Review College membership

- **Bhattacharyya** is a member of Energy Institute College.
- **Bhattacharyya, Fleming, Taki** and **Tian** are members of the EPSRC Peer Review College and review grant applications for UK.
- **Tiway** is a member of the EPSRC Associate Peer Review College since 2018.

4.2.3 Committee memberships

- **Bhattacharyya** has been appointed as a member of the Scientific Advisory Board of FEEM – Fondazione Eni Enrico Mattei, Milan (for 2021–2023).
- **Greenough** is a member of Experts Reference Group for Leicester City Council and was chair (2015–2018), then Events Secretary (2018–present) for East Midlands Branch of Energy Institute.
- **Lemon** is an external advisor to Open University and is an assessor of the PhD Supervisor Development Programme in Northampton University.
- **Lemon** and **Marjanovic-Halburd** are co-chairs of the Expert Reference Group set up to give advice to Leicester City Council on their climate policy.
- **Marjanovic-Halburd** was an organising committee member for the 2nd IBPSA-England Conference, BSO14 Building Simulation and Optimisation (2014). She is also a member of the CIBSE Knowledge Partnership Sub Committee (KPSC).

- **Painter** is a member of Smart Leicester Land, Buildings and Infrastructure Board (Leicester City Council).
- **Reeves** is a member of the Experts Reference Group and Environmental Experts Commission, both of which support initiatives by Leicester City Council and partner organisations.
- **Taki** was an invited committee member and chaired an international conference track on 'Sustainable Streets – Meeting Future Needs', the 2nd International Conference on City Street, Notre Dame University Lebanon, 2016.
- **Tiway** was a member of the Hong Kong Chemical, Biological and Environmental Engineering Society Conference Technical Committee member, 2020.
- **Villa** is an assessor for the British Federation of Women Graduates Scholarship from 2011, ongoing.
- **Wright** is a member of Special Interest Group on School Design; chair April 2017–April 2019. This included working with the Department for Education on a project to assess future adaptation of school buildings to climate change.

4.2.4 Awards and recognition

- H2020 POWER Project received the Water Governance Award at Water Innovation Europe Award 2020.
- OASYS South Asia Project (EP/G063826/2) received two Green Gown awards for Community Innovation in 2015.
- SAVES2 energy dashboard has won the 'Best in Class' digital innovation award in 2019.
- A team consisting of **Snape**, **Boait** and others won the Dynamic Demand Challenge competition in 2014 set up by Ofgem and National Grid.
- **Villa's** EU/ERDF Bio-Thermal RED project was highly commended by the Anaerobic Digestion and Biogas Association (ABDA) in 2016.

4.2.5 Examination of research work

Researchers in this Unit regularly act as internal and external examiners for PhD research. The invitations for such tasks are routinely received by the staff from UK Universities and abroad. For example:

- **Bhattacharyya** has examined doctoral research of students from the UK, Australia, India, Singapore and Thailand during this assessment period.
- **Taki**, **Yuri** and **Perez** have examined doctorates at Nottingham University, Salford University and Sheffield University.
- **Wright** has externally examined 9 doctoral studies during this REF period.

4.2.6 Editorship of journals and edited books

- **Bhattacharyya** is an associate editor of *Energy for Sustainable Development* and is a member of the editorial board of *Environmental Research Letters* and *AIMS Energy* as well as being series editor of Sustainable Development Goals Series: Affordable and Clean Energy (Springer Nature).
- **Lemon** has edited a special issue on 'Mixed Methods and Energy Research' for *Energies* in 2015.
- **Lemon**, **Painter**, **Morton** and **Mitchell** have guest edited a special issue of *Energies*, 'Communities Living Sustainably: Multiple Perspectives on Low Carbon Energy' in 2020.

- **Manoochehri** has co-edited *Smart Futures, Challenges of Urbanisation, and Social Sustainability*.
- **Perez** has co-authored the book, *Repurposing the Green Belt in the 21st Century*.
- **Snape** is a guest editor of a special Issue of *Energies on Low Carbon Energy Systems*.
- **Taki** is an invited chief guest editor of a special issue on the subject of 'Advances on Building Performance & Sustainability' for the journal of *Sustainability* in 2021.
- **Tiway** has published an edited volume *Air Pollution: Measurement, Modelling and Mitigation* (3rd and 4th editions) and is a section board member of *Sustainability* (MDPI journal).
- **Villa** is the editor of *Environmental Technology Review* (Taylor & Francis) and member of the Editorial Board of ICE-Proceedings of the Institution of Civil Engineers – Water Management.

4.2.7 Review of research proposals and journal articles

Researchers of UOA 13 review grant proposals for research funding agencies.

- **Bhattacharyya** has reviewed proposals for EPSRC, ESRC, British Council, Leverhulme Trust and international funding agencies (Norway, Netherlands, Switzerland).
- **Greenough** has reviewed proposals for RAE Ingenious programme (2), ESRC (1), EPSRC (1), and Leverhulme Trust (1).
- **Snape** is an European Commission Expert and has reviewed several H2020 project proposals under Marie Skłodowska-Curie Actions.
- **Taki** has been reviewing grant proposals for EPSRC since 2000.
- **Tiway** has reviewed grant applications for British Council Newton Fund Grant. He has also reviewed grant applications for a UKRI-EPSRC thematic call on research and innovation ideas to address Covid-19 issues (2020). He is also acting as a reviewer for the Hong Kong Government Research Grant Council's Environmental Theme-based Research Scheme (2014–) and for the Jordan Government Scientific Research Support Fund (2017–).
- **Villa** has reviewed grant applications for BBSRC, EPSRC, NERC and EB Network, EU-Horizon 2020, Science Foundation Ireland, SÉRCYMRUII, the Water Research Institute of the University of North Carolina, and the Agricultural Research Council (ARC-ZA).
- **Wright** has reviewed proposals for EPSRC and GCRF projects.

Researchers also review papers for journals and book proposals for publishers.

- **Greenough** has reviewed journal articles for *Energies, Sustainability, Inventions, Journal of Cleaner Production, Geothermics, Sustainable Production and Consumption* and *Energy and Buildings*.
- **Lemon** reviews for *Energies, Open Learning, International Journal of Sustainable Development in Higher Education, Environment International, Environmental Science and Policy, Journal of Cleaner Production*, among others.
- **Marjanovic-Halburd** has reviewed for *Energy and Buildings, ASHRAE Transactions, Indoor and Built Environment* and *Building Services Engineering Research and Technology*.
- **Massidda** is external peer reviewer for *Journal of Latin American Studies* (2021), *Urban Studies* (2020), the *Bulletin of Latin American Research* (2019), *Estudios del Hábitat* (University of La Plata, 2019), *REVISTARQUIS* (University of Costa Rica, 2019), *Journal of Latin American Cultural Studies* (2018).
- **Morton** and **Reeves** have reviewed papers for *Energy Research & Social Science*.
- **Painter** has reviewed papers for *Building and Environment, Energy & Buildings, Building Research and Information, Energy Research & Social Science* and *Energy Efficiency*.

- **Snape** has reviewed papers for *Climate Policy*, *Energy Policy* and *Energies*.
- **Tiwarly** has reviewed papers for *Environmental Technology & Innovation*, *Ecological Engineering* and *Renewable and Sustainable Energy Reviews*.
- **Villa** has reviewed papers for *Bioresource Technology*, *Journal of Cleaner Production*, *Journal of Environmental Management*, *Journal of Molecular Catalysis B: Enzymatic*, *Waste Management* and *Water Research*, among others.
- **Wright** has reviewed papers for *Applied Energy*, *Sustainability*, *Energies*, *Building Services Engineering Research & Technology*, *Energy*, *Politics and Governance*, *Frontiers Built Environment* and *Energy Reports*.

4.2.8 Contribution to the wider economy and society

Most of the research undertaken by this Unit, being applied in nature, directly influences society. Some examples have already been provided (see 1.2 and 1.3) and additional examples are given below.

Currently, the IoA is engaged in a DMUlocal project (REF5a) with Leicester City Council contributing to the Council's aspirations regarding the built environment. During 2019/20, the IoA contributed architecture/urban design expertise to the Council and chaired interdisciplinary meetings to support the redevelopment work at Stocking Farm, Beaumont Leys and the intentions to establish an Urban Room. The IoA continues to support the Council in its 'Leicester Better Built Environment Project' in Beaumont Leys, presenting proposals to inform their implementation of a 'gateway' from Beaumont Leys Lane to Beaumont Lane Green Open Space.

Ghaziani's research with Earlsdon Primary School, Coventry was part of a successful Partnership Grant application to the Royal Society. The project has received funding and will continue beyond the census period. It will involve installing (interior and exterior) green (living) walls in Earlsdon Primary School. The project is designed to provide a connection to nature in an urban school. The project, about the relationship between urban schools and nature contributes to Ghaziani's ongoing research into biophilic design.

Gammon undertook a field trial in The Gambia, which resulted in the piloting of Africa's first solar-powered taxi service whereby an electric taxi is recharged entirely from a solar-powered mini-grid. This project benefited the local community addressing SDGs 1 (poverty), 3 (health), 7 (energy), 8 (economic growth), 11 (cities and communities), 12 (responsible consumption and production) and 13 (climate action).

IESD research on building energy via the SMARTSPACES project has influenced the consumption behaviour of users in public buildings in Leicester and other European cities. The SAVES project has directly influenced DMU students' awareness and behaviour towards energy use in their halls of residence and helped reduce energy use in the halls. Through a knowledge exchange project and through H2020 POWER project, IESD has also worked closely with Leicester schools in improving their building energy awareness and energy performance.

Researchers of the Unit have actively participated in dissemination activities to share scientific knowledge with the general public as well. For example, **Villa** has shared her research on urban waste management with the general public through:

- New Scientist Live – The complex science of fatbergs, October 2019;
- Channel 4, *Food Unwrapped: The Saponification Process*, 2018;
- Channel 4, *Fatberg Autopsy: The Secrets of the Sewers*, May 2018;
- Museum of London, 2018 introduction;
- SoapBox Science – Biogas from Waste; and
- BBC Radio 4, 'Costing the Earth' interview on Fat, Oil and Greases Management from Waste, 2014.

The research unit has made a significant contribution to society both nationally and internationally through research in diverse areas of the built environment and is well-positioned to continue on this trajectory beyond the census period.