Institution: University of Cambridge

Unit of Assessment: 13 Architecture, Built Environment and Planning

1. Unit context and structure, research and impact strategy

The Unit of Assessment consists of the Department of Architecture in the Faculty of Architecture and History of Art, within the School of Arts and Humanities, and the Department of Land Economy within the School of Humanities and Social Sciences. Both departments study **problems relating to the natural and built environment from a wide range of cross- and inter-disciplinary perspectives**. Actively **networked into the real world of practice and policy-making**, both departments aim to provide agile responses to pressing global challenges, particularly **sustainability transitions, nature conservation, urbanisation, settlements and the future of cities, and the infrastructure of healthcare and well-being**. We are at the epicentre of Cambridge research on the policy dimensions of grand global challenges, with our staff taking the lead on cross-University initiatives such as Cambridge Zero, the Cambridge Conservation Research Institute (**CCRI**), and the Interdisciplinary Research Centre for Infectious Diseases (**CID**) (Section 4.1).

1.1 Structure of the research environment

Research in **Architecture** is pursued in two modes, reflecting its straddling of the humanities and technology: (1) formalised cross-disciplinary research groups pursuing large funded projects; (2) less formal explorative collaborations between staff with similar interests from within and outside the department.

Examples of the first mode include: the Centre for Natural Material Innovation (led by Ramage), pioneering research in innovative structures and construction in low carbon materials; the Cambridge University Centre for Risk in the Built Environment (**CURBE**) (led by So) developing techniques to predict and mitigate risk from flooding, earthquakes and volcanic eruptions; the Centre for Urban Conflicts Research (**UCR**) (led by Pullan), which analyses intensely divided urban communities from Jerusalem to Cyprus to Belfast; and the joint Architecture-Land Economy Cities and Transport modelling group which emerged from Architecture's Martin Centre and spans both departments (Echenique, Jin, Lizieri, Mansley, Steemers, Tyler, Wan), conducting influential quantitative research on spatial economies at the urban, national and international scales (Impact Case-Study (ICS) 'Interdisciplinary modelling of city-regions').

The second mode is illustrated by the Sustainability and Health research group (led by Short), which explores the emerging built environment implications for health and wellbeing; the Cultures of Architecture and Cities group (led by Campbell) focussing on the history of construction and environmental control, post-colonial legacy and contemporary responses; and the Cities South of Cancer (**CSC**) (led by Hernandez and Sunikka-Blank), which studies the labyrinthine socio-economic contexts of Brazilian favelas and Mumbai slums.

Land Economy organises its research activity around two clusters: Environmental Economics and Policy (**EEP**) and Real Estate and Urban Analysis (**REUA**). EEP covers a broad range of environmental and natural resource management issues, whereas REUA studies resource allocation in land and real estate markets, urban and regional economy, urban planning and public policy.

Since 2014, new interdisciplinary research centres have been established in both clusters. Within EEP, the Department established the Cambridge Centre for Environment, Energy and Natural Resources Governance (**C-EENRG**) (founded by Vinuales), which incorporated the previous Cambridge Centre for Climate Mitigation Research (**4CMR**) and nested policy research within the wider CCRI, a university-wide Institute located in the newly refurbished David Attenborough Building (Section 4.1). Within REUA, the Department established the Cambridge Real Estate Research Centre (**CRERC**) (founded by Lizieri), and the Cambridge Centre for Property Law (**CCPL**) (founded by Dixon and Lees). Together with the pre-existing Cambridge Centre for Housing and Planning Research (**CCHPR**) (led by Burgess), the Rural Business Unit (**RBU**) (led by Lang), and the Laboratory of Interdisciplinary Spatial Analysis (**LISA**) (led by Silva), these centres provide the main research hubs in Land Economy.

1.2 Objectives and Goals

Both departments share a focus on cross- and inter-disciplinary research as a core constitutive feature. This is reflected in past and future objectives.

Objectives (2014-2020)

In its 2014 REF submission, **Architecture** identified three main objectives for 2014-2020:

(i) *Continuing to promote rigorous and internationally-acclaimed research on sustainability in the built environment and on the changing problems and development of cities;*

(ii) *Building upon and extending new strengths, especially in cross-disciplinary areas related to architecture and urbanism;*

(iii) Making structural changes in staffing and support to balance rapid responses to emerging Built Environment problems with the nurturing of longer established areas of strength and significance.

All three objectives have been achieved, sometimes synchronously. The span of research in sustainable building design has been broadened considerably from exploiting sophisticated environmental sensing to building greater understanding of users' behaviours, all within the constraints and opportunities offered by regulatory policy aimed at improving public health and wellbeing (with funded projects led by Bardhan, Short, Steane, Steemers, Sunikka-Blank).

Short's project on the adaptation of the existing UK hospital estate to boost its startlingly low resilience in a changing climate (**DeDeRHECC**) (Section 3.3) tackles both sustainability (objective (i)) and collaborates at the national scale with the NHS and the Department of Health (objective (ii)). The related ICS: 'Adaptation of existing buildings' explains that DeDeRHECC was instrumental in establishing the 2014-15 NHS Energy Efficiency Fund and the subsequent redrafting of the NHS-wide guidance on sustainability (HTM 07-02, 2015). DeDeRHECC methodology was subsequently expanded to investigate existing high- and middle-rise buildings in dense Chinese city neighbourhoods, in what became the LoHCool project (Section 3.3) in partnership with Zhejiang and Chongqing Universities and Reading (objective (iii)).

Similarly, the Leverhulme-funded Centre for Natural Materials Innovation created by Ramage (Section 3.3) brings together an extensive interdisciplinary network of industrial partners, architects and academics in Engineering, Biology, Chemistry and Material Science, fulfilling objective (ii). The continued development of Jin and Echenique's urban, regional and infrastructure planning group has produced a new generation of theoretical models, impacting policy in the UK and China (ICS: 'Interdisciplinary modelling of city-regions'), fulfilling objectives (i) and (ii).

Architecture's REF 2014 submission also proposed to build on the success of the ESRC-funded 'Conflict in Cities' project to create the Urban Conflicts Research Centre and develop this research at a global scale. Six years on, the UCR has expanded its research with funded projects such as Sternberg's 'Models of Transnationalism', focused on Polish-German border towns, and the extensive cross-disciplinary research on conflicts analysis of Baghdad, Belfast, Berlin, Brussels, Beirut, Jerusalem, Kirkuk, Nicosia and Tunis as well as on 'Terrorism in European Cities', under the umbrella of the 'Conflict in Cities and the Contested State' group. This work epitomises the approach to achieve goal (iii), combining emerging issues (terrorism) with established strengths (urban organisation).

Land Economy's 2014 REF submission identified three main objectives for 2014-2020:

(i) *Increasing tangible support for research activity and centres within the Department;*

(ii) *Launching and growing new research centres of excellence in Property Law and Real Estate;*

(iii) *Enhancing the quality, visibility and impact of our research output.*

The three objectives have been achieved. On (i), Land Economy scaled up significantly the administrative infrastructure supporting research and centres. In 2014, a Research Committee was established, which addresses research strategy, specific proposals and funding bids, prospective calls and opportunities, and administers the Department's seed, travel and research infrastructure budgets. The Department also invested (using its own funds) in a new senior full-time Research Administrator (Carr) and a senior Financial Administrator (Cave).

Concerning (ii), since 2014 the Department has established three new centres. In addition to the two centres envisioned in the REF 2014 submission, CRERC and CCPL, the Department established C-EENRG, highlighting the growing importance of sustainability policy in staff recruitment, research output, student interest, and real-life impact.

Regarding (iii), interdisciplinary research conducted in these centres has generated a substantial number of research outputs published not only in the leading field journals but also, as projected in 2014, in high-impact interdisciplinary journals, including *Nature*, *Nature Energy*, *Nature Climate Change*, *Nature Sustainability*, *Nature Communications*, *PNAS* and *Global Environmental Change* (see Outputs). The strategy has also paid off in terms of impact (ICS: 'Stranded Assets') and funding (Section 3).

Objectives (2021-2028)

During the 2014-2020 REF period both departments underwent the intense comprehensive University Strategic Research Review (**SSR**) process conducted by a panel of independent Cambridge and external experts (Section 3.2 shows membership), organised by the central Research Office to a set review cycle (Architecture in 2018 and Land Economy in 2019). Strategic Research Reviews are demanding exercises to objectively evaluate each department's research strengths and weaknesses and provide recommendations. For both departments, the outcomes were extremely positive, serving to inform and crystallise the development of the departments' strategic goals for the next REF cycle (2021-2028):

Architecture's strategic goals are to:

(i) *Further develop and consolidate cross-disciplinary connections across the Humanities and Social Sciences, particularly in the field of sustainable community building;*

(ii) *Expand a decade's work on health, healthcare and well-being in the built environment;*

(iii) Expand longer established work on global, regional and local urban challenges.

To boost these goals, Architecture has successfully secured University support for the appointment of four outstanding lecturers from large fields of very strong applicants worldwide: Simcik-Arese on Urban Ethnography and Community Design (2018-) and Schröder on Design Research (2019-) to support the first goal; Bardhan on Health and Well-being in the Built Environment (2019-) to expand work on the second; and Katz on Urban Studies with a focus on global challenges (2020-) to focus on the first and third goals.

Land Economy's strategic priorities are to:

(i) Further expand research in sustainability and public policy, as a key strategic area for staff and PhD recruitment, institutional development, funding and impact;

(ii) Enhance the integration of research activity within and across research groups within the Department without diminishing the scope for individual scholarship;

(iii) Better and more clearly communicate the research profile of the Department to the external scientific and policy worlds.

The Department has taken substantial steps in this direction: the appointment of the endowed Professorship of Climate Change Policy (Diaz Anadon), who is a lead author on innovation for the IPCC's 6th assessment report; the structure and location of C-EENRG, which consists of three constituencies (permanent staff, research-contract staff, and policy fellows) and is nested in the David Attenborough Building alongside nine leading conservation agencies; the key positioning of the Department's sustainability work as the connector between natural and social sciences at the University-level on low carbon transition research (Cambridge Zero); the ongoing project to create a specialised PhD in Sustainability and Public Policy, including a 'cities and the built environment' stream (led by Allmendinger). Moreover, C-EENRG leads the engagement strategy of a UK government-funded £3M+USD1M project on the Economics of Energy Innovation and Systems Transition (**EEIST**) (Section 3.3).

1.3 Enabling and sustaining impact

Impact is woven into both department's research management structures, staffing strategies, research proposals, and outreach strategies.

Regarding **research management structure**, Architecture's Research Committee has collectively taken the decision to share across the Department the financial and non-financial rewards gained from the research projects, e.g. spreading impact know how, sharing stakeholder network contacts, and pooling research overheads to fund the Faculty Research Office and the Research Support Discretionary Fund. This has enabled younger researchers

to grow their networks and to benefit from seed funding for travel and post-doctoral assistance. Similarly, Land Economy supports impact through its departmental Research Development Fund (a dozen £2k grants per year), the ESRC Impact Acceleration Account and the UKRI Global Challenges Research Fund (with awards to Diaz Anadon, Kontoleon, Larcom, Burgess, Salas, Vinuales), and the Head of Department Overhead Recovery Fund (used for early career support or strategic investments, e.g. seed money to launch C-EENRG).

Impact is also an integral part of **staff recruitment and development strategy**. Research impact is a strong indicator of academic quality and plays a vital role in all hiring decisions, with a high weight attached in the scoring system used during shortlisting and interviewing candidates. Impact is also explicitly discussed throughout the mentoring and appraisal process and plays a key role in departmental recommendations for promotion. The success rate of both departments' promotion applications since 2014 reflects, together with our staff development efforts, also the degree to which our impact is acknowledged and rewarded within the University (with promotions granted at the University-level to no less than 20 staff members between 2014-2020 (Section 2.1)).

Much of both departments' **research projects** directly engage non-academic stakeholders from the private and public sectors. Examples from Architecture include: Short's research on healthcare low-carbon newbuild and adaptation with NHS Estates and Facilities, NHSi, NHS Sustainable Development Unit, Public Health England, Cabinet Office and global practices BDP, HOK or Arup; Ramage's research on natural materials innovation with PLP Architects, Zurich Insurance, Royal Society, Royal Academy of Engineering; Campbell's research on construction history with the Brick Development Association, Historic England; Bardhan's research on slum resettlement in India with the Mumbai authorities. In Land Economy, some examples (one per centre) include: DEFRA's longstanding support for the RBU-led Farm Business Survey; funding from the Ministry of Housing, Communities and Local Government (**MHCLG**) for CCHPR's research on leasehold and freehold charges; financial support and partnership with BEIS and FCO for C-EENRG's EEIST project; CRERC's Future Cities programme in partnership with Capital & Counties Properties Plc; LISA's machine learning mapping of Beijing's built environment supported by UCF China and YH International Design; and CCPL's McHugh work on aboriginal title in relation with the Canadian and New Zealand governments (ICS: 'Legal and political recognition of Aboriginal Land').

These projects also showcase our proactive approach to **outreach**. Both departments cultivate an extraordinary diversity of public and private stakeholders, many as serial formal project partners over many years and projects (Section 3.3). Land Economy also maintains the Land Economy Advisory Board (**CLEAB**) which comprises high-level executives within

commercial real estate, finance, law, development and associated sectors, providing a central focus for our interactions with built environment professionals. CLEAB supports the achievement of impact both financially and by partnering with the Department in networking events with stakeholders, a mentoring scheme for graduate students, career advice, and student placements. Research impact is also promoted and disseminated through the alumni-based Cambridge University Land Society (**CULS**), which is the oldest, largest and most active departmental alumni society in the University with over 1,000 members, including some of the most influential players in the property industry today: senior executives/partners in the NHS England, Government Property Agency, City of London, Land Securities Plc, the Grosvenor Group, Goldman Sachs, British Land, etc. Land Economy is also the initiator and co-organiser of two other influential annual conferences, the 'Real Estate Finance and Investment Symposium' and the International Conference on the Economics of Biodiversity (**BIOECON**). Both of these large events significantly engage public and private stakeholders.

1.4 Support for Interdisciplinary Research

Through the establishment of new centres, groups, programmes and the recruitment of staff with strong interdisciplinary credentials, both departments have invested heavily in supporting interdisciplinary research on four fundamental challenges of enduring relevance: sustainability transitions; conservation; urbanisation, settlements and the future of cities; the infrastructure of healthcare and well-being.

In the last decade, there has been a surge in interest in **sustainability transitions**, understood as social and technological processes driven by environmental constraints that lead to fundamental changes in social organisation. In 2014, Land Economy established C-EENRG to focus specifically on sustainability transitions (led by Diaz Anadon). C-EENRG has attracted substantial funding in these areas (Section 3.3), including the EU-funded H2020 project INNOPATHS on low-carbon transitions (Diaz Anadon), a Sloan Foundation grant for work on clean technology spill-overs (Diaz Anadon), the UKRI-funded project on 'Co-location of manufacturing and innovation' (Diaz Anadon), the ESRC-funded BRIDGE project on the food-energy-water nexus in Brazil (Vinuales), and the BEIS/CIFF-funded EEIST project on energy transition policy modelling techniques (Diaz Anadon, Mercure, Salas, Vinuales). These examples evidence the return on Land Economy's substantial investment in the 2012 endowed Harold Samuel Chair (Vinuales) and the 2015 endowed Professorship of Climate Change Policy (Diaz Anadon). Work on sustainability has also fuelled applications to our MPhil in Environmental Policy, which more than doubled between 2014-2020. Many outputs in high-impact interdisciplinary journals are derived from this work (see Outputs), some forming the basis of ICS: 'Stranded Assets'. A new interdisciplinary Doctoral Programme on Sustainability

and Public Policy is being developed in this area. In Architecture, work on sustainability is illustrated by Ramage's research for the Centre for Natural Materials Innovation, showcased in its timber skyscrapers, and Short's LoHCool project on building resilience to climate-induced extreme temperature variability (Section 3.3).

Nature conservation has also been actively supported by Land Economy through C-EENRG's participation as the policy arm of the CCRI, located in the David Attenborough Building alongside leading conservation agencies such as IUCN, UNEP-WCMC, RSPB, Birdlife and TRAFFIC. Jones' move to Cambridge brought to C-EENRG her EU-funded FIDELIO project on the social impacts of protected areas in Europe (Section 3.3). Kontoleon's UKRI-funded work on the social benefits of avoided deforestation (**REDD+**) projects in Sierra Leone and Brazil, recently published in *PNAS*, has fundamentally changed how such projects are evaluated. Kontoleon is also the lead convenor of BIOECON, a global scientific network of over 2000 economic and legal experts working on biodiversity conservation. In 2020, the Department invested in the recruitment of a new lecturer focusing on conservation (Liu).

Both departments have continued to support and invest in research on **urbanisation, settlements and the future of cities**. In Architecture, the Martin Centre (led by Jin) hosts the city-scale data science and urban modelling applications of the EPSRC Centre for Smart Infrastructure and Construction (2011-2020), the EPSRC Managing Air for Green Inner Cities MAGIC project (2015-2020) (Jin, Short, Steemers), the Cambridge-Berkeley-Singapore Smart Urban Design project (2016-2018), the joint Architecture-Land Economy Cities and Transport modelling group, and the international symposia series on Applied Urban Modelling (since 2011). In Land Economy, urbanisation was the focus of CRERC's three-year Future Cities Programme (Lizieri, Mansley), funded by Capital & Counties Properties plc, to host an annual visiting senior fellowship programme, eight PhD research fellowships, and three annual international conferences (2016-18) on 'High-rise living and density', 'Growing our cities well', and 'Successful cities of the future'. CCHPR works on urbanisation through its participation in the Cambridge Centre for Digital Built Britain (**CDBB**) and the wider £30.7M ISCF Core Innovation Hub (Burgess). In 2017, Land Economy secured a £1M endowment from the Pecan Trust for the establishment of a new Lectureship in Chinese Urban Development (Wan). It has further strengthened work in this area with the recruitment since 2014 of five lecturers on planning, housing, real estate and spatial economics (Larsson, Lindenthal, Luca, Oner, Sielker). In Architecture, a Lecturer on Urban Ethnography was appointed in 2018 (Simcik-Arese) and another on Urban Studies in 2020 (Katz).

The **infrastructure of healthcare and well-being** is a growing area of interdisciplinary work. In Architecture, Short's DeDeRHECC project explores refurbishment strategies to improve the

energy efficiency and resilience to temperature variability and extremes in the UK and, through LoHCool, also in China (ICS: 'Adaptation of existing buildings'). Short's ExiSE project studies strategies to reduce the risk of infection from antibiotic-resistant pathogens in the surgical environment (Section 3.3). Bardhan was appointed in 2019 to boost this area's effectiveness. Her research explores slum housing rehabilitation in India (Mumbai and Kolkatta) and social housing in Indonesia. In Land Economy, Burgess has conducted projects on co-living models for vulnerable older people, digital nomads in the private rented sector (Section 3.3), and the use of 'smart' homes to meet the demands of an ageing population. Wellcome Trust-funded work by Kontoleon used social network analysis in hundreds of African villages to understand the infrastructure of mass drug administration tackling neglected tropical diseases (e.g. schistosomiasis).

1.5 Open Access, Ethics, Risk and Data Protection

Cambridge has University-wide open access/research policies and dedicated open access/open data repositories. Some staff members use other open access platforms (for papers: arXiv, SSRN, RePEc; for data: UK Data Archive, Zenodo) or open access journals (PLOS). Staff also use open access platforms (OSF registry) to preregister their empirical research designs which promotes transparency and replicability of scientific work. Both departments maintain a dedicated intranet section providing guidance to staff on open access/research and funds available to cover article processing charges and other related costs. They encourage and assist staff to include open access/data strategies in research proposals through their Research Committees and Administrators, a University-wide Research Data Management website with advice and examples, specific training (online and in-person) and 'Data Champions' (Silva, Schupp), i.e. volunteer advisors on data management.

The two Research Committees closely manage and enforce the University's comprehensive Ethics, Risk and Data Protection policies. Both departments provide their researchers detailed guidance and check-lists through dedicated websites and staff induction and mentoring processes. Researchers must submit application forms to their respective Research Committees for approval, describing ethical, data protection, and personal risk issues. More complex cases are sent to higher School- and University-level committees following Research England guidelines.

2. People

As of 2020, **Architecture** has 15 University Teaching Officers (**UTOs**), established permanent academic posts (UTOs) (3 Professors, excluding retirements; 4 Readers; 4 Senior Lecturers; and 4 Lecturers), 2 endowed visiting Professorships, 7 full-time Research Associates and 53 PhD students. **Land Economy** has 23 UTOs (10 Professors, excluding retirements, 4 of which hold endowed chairs, 4 Readers, 2 Senior Lecturers, 7 Lecturers), 2 Principal Research Associates, 1 Senior Research Associate, 11 post-doctoral Research Associates, 12 Research Assistants, and 72 PhD students.

2.1 Staffing and staff development

Staff development policies

Both departments implement University-level career development guidelines and processes, with respect to induction, mentoring, staff training and support, appraisal and equality and diversity, and they have dedicated full-time senior administrators overseeing these processes. Strong evidence of the effectiveness of this system, as implemented in both departments, is provided by our remarkable success in the University's rigorous **promotion procedures with 20 staff members** promoted during 2014-2020 across both departments (Fuerst, Howarth, Kontoleon, Pullan and Silva to Professor; Bao, Campbell, Fennell, Jin, Larcom, Lees, Ramage and So to reader; Abreu, Hernandez, Lindenthal, Sternberg and Sunikka-Blank to senior lecturer; Wang and Burgess to senior and principal research associate).

The **mentoring system** begins with the allocation of a senior mentor to every new member of academic/research staff. The mentor's role is to support and empower mentees by undertaking joint initiatives (joint publications, joint research projects, networking). For example, Kontoleon (then Reader) was encouraged to participate in the University's Emerging Leaders Programme; Silva (then Senior Lecturer) received institutional support to establish LISA; Jin (then Senior Lecturer) became director of the Martin Centre; Lees (then Lecturer) and later Salas (then post-doc) were C-EENRG's deputy-directors; Larcom, Lindenthal (then lecturers) and Silva (then Senior Lecturer) were entrusted with the direction of MPhils; Bao (then Lecturer) became International Director (Section 3.2).

Progress is appraised through a formal process: a University appraisal form is completed in advance and discussed in a dedicated meeting, which covers teaching, postgraduate supervision, research and general contribution, but also adequate access to research equipment, data, staff development opportunities, leave entitlements and promotion. Members

of staff in their probationary period receive an annual appraisal. Members of staff beyond probation are normally appraised every two years.

Support is also offered through pump-priming **research and impact funds**, travel and subsistence grants for attending conferences, establishing collaborative work and applications and participating in networks. In Architecture, financial resources, knowledge and experience from Department-wide research projects are pooled to help early career researchers with seed money and networking. Land Economy has a dedicated Research Development Fund and a senior full-time Research Administrator to facilitate applications for research grants. This support is available to all academic staff but widely used in practice by early career members. In addition, Land Economy's alumni engagement through CLEAB and CULS has resulted in generous funding for a range of projects (Section 1.3).

Further support is provided by the University-wide **sabbatical leave system**, which both departments have pro-actively supported. UTOs are entitled to (i) one term's fully-paid sabbatical leave for each six terms of service (2 years); (ii) parental leaves and flexibilities available to all staff (Section 2.3), (iii) one-year paid sabbatical leave after a three-year period of senior administrative responsibility, (iv) unpaid leave to pursue research and impact-related opportunities, and (v) a Returning Carers' Scheme (Section 2.3). In practice, leaves are widely used by staff at all levels, which has been key for career progression (e.g. Abreu, Fuerst, Jin, Lees and So).

Similar appraisal and progression processes apply to **administrative staff**, with regular meetings managed by both departments' heads of institution and senior administrator. Other initiatives to develop department-wide team spirit include 'Away Days' twice a year, transparent task allocation schedules, and joint participation in 'challenges' (e.g. Land Economy's 'Platinum Award' in Cambridge Green Challenge).

Recruitment strategy

Recruitment is run by **departments** but Appointment Panels include representation of the Schools and, for senior posts, a Vice-Chancellor's nomination. Both departments emphasise research excellence, real-life relevance and impact (Section 1.3), equality and diversity (Section 2.3) and, through the last decade, a focus on the four strategic interdisciplinary areas of enduring relevance (sustainability, conservation, urbanisation, health and wellbeing infrastructure) (Section 1.4). Both departments have attracted and retained very high calibre academics with excellent publication and impact records. The focus is on the skill-sets, versatility and real-life relevance of our appointed staff (Section 1.3) at all levels.

Architecture's four new lecturer appointees between 2018-2020 closely match its long-standing research strengths, now streamlined in our 2018 strategic goals. Bardhan's appointment strengthens the areas of sustainability, healthcare/well-being infrastructure, and urbanisation. The growing focus on the latter is manifested by the appointment of a Lecturer on Urban Ethnography (Simcik-Arese), a specialist in non-Western architecture (Schröder), and a Lecturer on Urban Studies with a focus on global challenges (Katz). These are all outstanding appointments, who the Department is proactively nurturing to take on leadership positions in the field. Katz was the recipient of a 2016 RIBA Research Award for Cities and Community for her cutting-edge work on temporary Israelo-Palestinian camps and her research on the role of spaces of every-day life in mediating social and cultural diversity is central to two of Architecture's strategic goals. Bardhan, Schröder and Simcik-Arese have all become directors of different Architecture MPhil programmes in the areas of urban studies, history and theory, and design. In addition, Schröder directs the Design Research Studio.

In 2013, **Land Economy** inaugurated a new endowed chair – the Harold Samuel Professorship (Vinuales) – in the area of sustainability. In 2015, it also secured competitive funding for the endowment of a new Chair of Climate Change Policy (Diaz Anadon). On conservation, the department attracted Jones as a principal research associate, and appointed a conservation specialist (Liu) to the Lectureship in Applied Economics. On urbanisation and the future of cities, it secured funds to establish two new full-time posts, the Pecan Trust-funded Lectureship in Chinese Urban Development (Wan) and the Lectureship in Real Estate Finance (Ling Li). Four more lecturers on real estate finance, urban economics and policy were appointed (Lindenthal, Larsson, Oner, and Luca). Moreover, Sielker was appointed to a Lectureship on Planning and Housing for her versatility to work at the intersection of these areas, and Burgess was promoted to Principal Research Associate and Acting Director of CCHPR in recognition for her influential work on housing policy. Burgess also conducts work on health and wellbeing infrastructure (Sections 1.4 and 3.3).

Early Career Researchers

Early career researchers benefit from a mentoring scheme, financial support for travel, conferences, article fees, seed-money, advice and support by senior colleagues and research administrators to develop substantial research proposals, and institutional empowerment to their own initiatives or through their integration into centres, groups, initiatives, and teaching programmes.

Both departments also closely integrate research students (Section 2.2), **post-doctoral research associates** (**PDRAs**) and affiliated researchers. In Land Economy, PDRAs have taken many initiatives. For example, C-EENRG PDRAs have launched a C-EENRG Thursday

Seminar series, regular C-EENRG Research Conversations, a public Database on Bilateral Energy Agreements and a Platform for International Energy Governance. They have also attracted, and sometimes led, research projects (e.g. Salas-led BRIDGE-TESC). In Architecture, seven research cluster home spaces accommodate early career researchers, providing meeting and desk space. The vitality of these cluster spaces, dominated by PDRAs and senior PhDs, has been startlingly productive in incubating the growth of new cognate research groups on social and cultural studies, building history and conservation, sustainable buildings, spatial economic modelling, data-driven analytics, digital modelling of the built environment, and natural material innovation. Architecture's environment is further enriched by 20 fractional Design Fellows, practising architects drawn from innovative practices, who regularly discuss their own work and invite their peers and emerging talents. PDRA career progression is generally outstanding, both at Cambridge (e.g. Burgess, Salas, Wang) and elsewhere (e.g. Duvic-Paoli, Mercure, Morgandi).

2.2 Research Students

Both departments run vibrant PhD and MPhil programmes. As of 2020, Architecture has 53 PhD students overall (83 PhDs were admitted during the 2014-2020 period overall) while Land Economy currently has 72 PhD students overall (125 over the 2014-2020 period overall). Admission is highly competitive. For taught postgraduate (MPhil) courses, Architecture receives some 200 applications a year for approximately 40 places, while Land Economy receives over 900 for some 90 places. MPhil programmes act as feeders into the PhD in both departments, although direct external applications are frequent.

In both departments, the **PhD community** has students from the UK, Africa, the Americas, China, Europe, the Indian sub-continent, Oceania and South-East Asia, with over 50 nationalities and around 45% women. Although funding is a recurrent issue, in most cases PhDs benefit from external grants (e.g. China Scholarship Council, CONICYT-Chile, Swiss-NSF, Heinrich Böll Stiftung, CCK Foundation-Taiwan) or funds secured and distributed by Cambridge (e.g. ESRC DTG, AHRC DTG, EPSRC block grants, EPSRC Future in the Built Environment programme, Cambridge Trust, Gates Foundation, departmental scholarships). Some major research grants have in-built doctoral components (e.g. ERC FIDELIO, an ERC grant funding 2 PhD students for 3 years each at £62K). There are also industry-funded PhDs (e.g. Investment Property Forum, CLEAB/CULS, Capital & Counties Properties). Land Economy has introduced 3 teaching assistant positions (20% FTE each) to give PhD students teaching experience as a key component of their career development.

All research students are invited to **join centres/groups** as 'researchers' or 'research associates', where they enjoy dedicated desk and meeting space, and they are encouraged

to undertake research initiatives (e.g. Architecture's student-run '**Scroope'** journal). This integration complements the formal training aspects: ESRC Doctoral Training Centre, modules in the cross-disciplinary Social Science Research Methods Centre, a wide range of methodology, transferable skills and career development programmes available through the University, and a dedicated seminar series in each department required in the first year of the PhD. Each department hosts and funds an annual Early Career Researchers' Conference. In Architecture, the endowed Kettle's Yard Fund and the Faculty Fieldwork Fund provide some £40k+ to Architecture and History of Art graduate students for project-related travel, adjudicated through a competitive process. Land Economy PhDs are each allocated up to £3k for collecting field data, purchasing specialised equipment, data-sets and software. LE PhDs also receive grant £300 to attend academic conferences, and they are given specific training on teaching, publishing and career options after their PhD.

We are proud of our research students' performance in **prizes and employability**. Land Economy's students regularly win prizes at international conferences and competitions (e.g. Scott at the ARES (Seattle) and ERES (Milan), Steiner and Garza at International AREUEA (Singapore), Ormond at ERES (Edinburgh)). Lees won the JEL's 2016 Richard Macrory Prize and Chami the Grand Prize in the Dow Sustainability Innovation Student Challenge Award. In Architecture, research students have won RIBA Research Prizes (Gage in 2014, Katz in 2016). Our graduates perform particularly well in the academic and professional market. Land Economy graduates have the highest employability rate amongst all graduates in the Cambridge School of Humanities and Social Sciences. Since 2014, PhD graduates from Land Economy and Architecture have secured tenure-track positions and prestigious fellowships: Cambridge (Ewhi, Lees, Steiner, later in Cornell, Wan), Oxford (Chami), Sheffield (Katz, now back in Cambridge), LSE (Szumilo), UCL (Baumann), Glasgow (Liu, now back in Cambridge), Cornell (DuFour, Steiner), Macau (Lam), HKU (van Gevelt), Singapore (Seo).

2.3 Gender, Equality & Diversity

Both departments implement **University-level policies on diversity and inclusion**, including Athena SWAN, the Race Equality Charter and Equal Opportunities Policy. All staff undergo regular E&D and implicit bias training, which is mandatory for staff with junior/senior management positions. Both departments have established specific Athena SWAN and E&D Committees; both have Equality Champions, Dignity at Work and Racial and Sexual Harassment Officers. Architecture was awarded an Athena SWAN Bronze Award (2019), and Land Economy is preparing an application for it.

Athena SWAN and E&D are areas where constant improvement is needed. Much work remains to be done but both departments have **improved their situation** as compared to pre-

2014. In Land Economy, 10/25 of current UTOs are female (40% compared to 30% in 2014). Amongst senior research staff (Professors/Readers/Principal Research Associates), 7/16 (44%) are female, as compared to none pre-2014. Female staff have been particularly successful in the internal promotion processes (Silva to Reader and then Professor, Lees from Lecturer to Reader, Bao and Fennell to Senior Lecturer and then to Reader, Abreu and Morrison to Senior Lecturer, Burgess to Principal Research Associate). Gender-balance has also improved through recruitment since 2014: Diaz Anadon was appointed to the new Chair of Climate Change Policy; Jones was recruited as Principal Research Associate; 4 (Lees, Ling Li, Oner, Sielker) out of the 9 Lecturers recruited since 2014 are female, and consistently at least 50% of applicants shortlisted for all vacancies were female. In Architecture, since 2014, Pullan was promoted to Professor, So to Reader and Sunikka-Blank to Senior Lecturer. Moreover, 3 out of 4 Lecturer appointments since 2014 went to female candidates (Bardhan, Schröder, Katz). Our firm commitment to equality and diversity is also reflected in our research students (Section 2.2) and PDRAs (13 female researchers of 10 different nationalities out of 21 funded PDRAs since 2014). Our Outputs submission reflects the efforts to improve gender balance, with an output distribution (female: 41.2%; male: 58.8%) which mirrors our staff demographics.

Both departments have sought to improve gender-balance in all committees and leadership roles (e.g. in Land Economy, Abreu and Lees served as PhD directors, Bao is International Director, Burgess directs CCHPR, Diaz Anadon chairs the Degree Committee and directs C-EENRG, Fennell is Athena SWAN lead, Silva directs LISA and the MPhil in Planning, and Lees is deputy-director of the MPhil in Environmental Policy; in Architecture, Pullan directed UCR, Schröder directs the Design Research Studio, Steane and Sunikka-Blank serve as Deputy Heads of Department). Female staff are also proactively supported in internal and external seed-funding and funding applications, and they are assisted – through administrative support – in taking on considerable PI responsibilities in large projects (Burgess, Diaz Anadon, Jones, Silva).

Family leave has been taken up by 3 colleagues in Architecture and 3 in Land Economy during the 2014-2020 period, while flexible working arrangements are in place for 2 staff in Land Economy. We have been successful in applying to the University's Returning Carers' Scheme, which provides funding of up to £10k p.a. to support the career and professional development of individuals affected by periods of leave for caring responsibilities.

Both departments actively promote the university's Breaking the Silence campaign for prevention, reporting and support of victims (staff and students) of harassment, abuse and sexual misconduct.

3. Income, infrastructure and facilities

In the 2014-2020 REF period, the UoA secured some **£14.8M in research income** (leading 21 projects in Architecture for £6.3M and 70 projects in Land Economy for just over £8.5M), which represents a **7.5% increase** in the UoA's research income as a whole, as compared to REF 2014. Income for the period came from **increasingly diverse and international sources** and **for a wider range of project-scales**, in line with both departments' 2014 funding diversification strategies. Notably, research funding from **industry sources almost quadrupled** between the two REF periods, while an additional £1M of ERC funding compared to REF 2014 was secured (£2.5M instead of £1.5M). Income from the Royal Society and British Academy for smaller, often seed projects, more than doubled. The organisational and physical infrastructure put in place by both departments has been key to secure funding. For some examples illustrative of the nature, scale and funding-source of projects undertaken between 2014-2020 (Section 3.3).

3.1 Funding Strategies

In addition to our growing focus on four interdisciplinary challenges of enduring relevance (Section 1.4), both departments sought to diversify funding sources and project-scales.

Since 2014, **Architecture** has significantly increased industrial, international and charitable funding whilst continuing to pursue research council funding with vigour. UKRI funding (mostly from EPSRC and Innovate UK) comprised 55.5% of total direct funding, followed by charity funding (28.8%), ERC funding (7.9%) and industry funding (6.2%). Architecture's major research projects derive from direct interdisciplinary collaboration in large consortia within and outside Cambridge (e.g. with MIT and Berkeley, TU Delft, TU Munich, NUS-Singapore, Tsinghua, Tongji, Nanjing, Zhejiang and Chongqing), some of which we lead as PI (e.g. the Leverhulme-funded Centre for Natural Materials Innovation (Ramage)), whose total secured funding over the current REF period amounts to £46.7M with wider cash and in-kind contributions totalling some £1.1M.

Land Economy increased significantly the level of industry and international funding, while continuing to pursue grants from research councils, the ERC and charitable foundations. It secured £440k from private sources (British Land, Credit Suisse, Deloitte, Land Securities) to establish CRERC and further private funds to establish a Lectureship in Chinese Urban Development (Wan) (£1M from the Pecan Trust) and a Director of Research in Real Estate (Mansley) (£350k from Aubrey Adams). CRERC also established an MSt in Real Estate Finance for practitioners to secure an additional funding stream (sustaining Lindenthal).

International partnerships, particularly in Asia, were supported by the establishment of the post of International Director (Bao). In addition to 'blue-chip' funding (UKRI and ERC), funding sources include various UK Government Departments (e.g. MHCLG, BEIS, DEFRA, TSB), NIHR, local authorities, charitable foundations (CIFF, Philomathia, Sloan, Leverhulme), professional bodies (RICS, IPF, EPRA, ULI, INREV), foreign governments and industrial funding. Overall, the two main sources remain UKRI (45%) and EU (24%) funding, with industry and government funding together amounting to approximately 17% and Charity funding third (12%), much of which is highly and impact practice-orientated.

The University itself provides substantial support for research through key strategic initiatives (Cambridge Humanities Research Grant scheme, Isaac Newton Trust, CCI, ESRC Impact Acceleration Account, Global Challenges, Cambridge Paris Science et Lettres, CamPo (Cambridge-Science Po, Paris)) and other seed funding schemes. These are smaller grants but both early career (Bardhan, former PDRA Bocquillon, Duvic-Paoli, Larcom, Lees, Salas, Simcik-Arese) and senior staff (Diaz Anadon, Campbell, Kontoleon, Vinuales) have secured a good share.

3.2 Organisational and Physical Infrastructure supporting Research

Throughout 2014-2020, both departments streamlined and expanded the organisational and physical infrastructure supporting research (Section 1).

Architecture shares both the financial (pooling research overheads) and non-financial rewards gained from the research projects across the Department (e.g. experience of achieving impactful research, stakeholder network contacts) to resource the Faculty Research Office and the Research Support Discretionary Fund. Architecture's organisational infrastructure for research is largely based on formalised research centres (the Martin Centre, CURBE, Centre for Natural Material Innovation, UCR, Design Studio) and groups (Section 1.1). At the level of physical infrastructure, substantial improvements were made in the pre-2014 period, with a £3.7M University investment in a new studio building and a major refurbishment of the main Scroope Terrace, which Architecture has continued to enjoy, together with its Library, served by three Librarians, which houses one of the finest collections of rare books on architecture in the world.

The 2018 Strategic Research Review and its recommendations were critical in the development of its 2021-2028 Strategy (Section 1.2). **Panel members** were: Martin Jones, *George Pitt-Rivers Professor of Archaeological Science*, University of Cambridge; Marilyne Andersen, *Professor of Sustainable Construction Technologies and Dean of the School of Architecture, Civil and Environmental Engineering*, École Polytechnique Fédérale de

Lausanne; Richard Coyne, *Professor of Architectural Computing*, University of Edinburgh; Diane E. Davis, *Charles Dyer Norton Professor of Regional Planning and Urbanism and Chair of the Department of Urban Planning and Design*, Harvard University; and Flora Samuel, *Professor of Architecture in the Built Environment*, University of Reading.

Land Economy scaled up its research management infrastructure significantly, with the establishment of a Research Committee, the appointment of a senior full-time Research Administrator (Carr), the creation of three interdisciplinary centres (C-EENRG, CRERC, CCPL) alongside existing ones (CCHPR, RBU, LISA), the development of a mentoring scheme for early career researchers, and the establishment of specific research funds to kick-start applications, among other steps. It also appointed an International Director (Bao) to expand the Department's research and fundraising network.

In 2019, Land Economy also underwent a Strategic Research Review. **Panel members** were: Susan Lee Robertson, *Professor of Education*, University of Cambridge; Liz Fisher, *Professor of Environmental Law*, University of Oxford; Andrés Rodríguez-Pose, *Professor of Economic Geography*, London School of Economics; Jim Watson, *Professor of Energy Policy*, University College London; Catherine Hughes, *Associate Professor in Real Estate & Planning*, Henley Business School, University of Reading. This demanding exercise led to a Departmental stock-taking exercise (through several meetings) of practices, strengths/weaknesses, and strategic goals. The outcome was extremely positive and, as a result, the University has prioritised its fund-raising effort with the aim to relocate the Department to a new building. C-EENRG, which leads the Department's work on sustainability transitions and nature conservation, has secured significant space in the newly refurbished RIBA-award winning David Attenborough Building. Refurbishment was possible thanks to a £10M endowment from property developer Arcadia. The building houses the CCI, bringing together C-EENRG (as the policy arm of CCRI) and 9 leading conservation agencies.

3.3 Representative research projects

The following list illustrates the nature, scale and funding-source of the research projects undertaken by both departments in the 2014-2020 period:

(i) Anadon's work on low-carbon innovation policy has been funded by multiple sources amounting to close to £1M, including as PI in US-NSF/UK-ESRC-funded 'Co-location of manufacturing and innovation: drivers and impacts of technological innovation along the wind energy global value chain' (2018-2020), £120k, and as Co-I in EU H2020-funded 'Innovation Pathways, Strategies and Policies for the Low-Carbon Transition in Europe (INNOPATHS)' (2016-2020), EUR6.3M (work package 1 lead: EUR 360k), the Sloan

Foundation-funded 'The role of technology and knowledge spillovers in the development of novel clean energy technologies' (2018-2021), USD 559k (share: USD 215k), and BEIS/CIFF-funded 'Economics on Energy Innovation and Systems Transition (EEIST)' (2020-2023), £3M+USD1M (work package 3 lead: £110k).

(ii) Bao's led ESRC-funded 'Nudging Towards a Better Financial Future: Applying Behavioural Insights in the Development of Financial Systems in Rural China' (2017-2020), £320k, with China NSFC match funding of approximately £230k on the uptake of financial instruments in rural China.

(iii) Burgess' work funded by the CDBB, a multimillion partnership between BEIS and Cambridge exploring how the construction and infrastructure sectors could use a digital approach to better design, build, operate, and integrate the built environment. Burgess-led work includes 'Socio-economic inhibitors to the uptake of digital tools in the UK construction industry' (2019-2022), £458k, 'Digital Nomads' (2018-2019), £56k, and CCHPR's participation in the INNOVATE UK-funded Transforming Construction Alliance's £30.7M 'ISCF Construction Innovation Hub' (2018-2022) along with CO-Is Ramage, Burgess and Allmendinger among others (share: £303K)

(iv) Jones' ERC Starting Grant on 'Forecasting Social Impacts of Biodiversity Conservation Policies in Europe (FIDELIO)' (2019-2024), EUR1.5M, exploring the socio-economic impacts of EU protected areas to predict how perception of such impacts change over time.

(v) Penz-led AHRC-funded 'A Cinematic Musée Imaginaire of Spatial Cultural Differences' (2017-2020), £449k, followed by the GCRF-funded CINEGENUS (2019-2020), £75k, exploring domestic energy use in low-income housing in Mumbai though cinema.

(vi) Ramage's Leverhulme Trust-funded Centre for Natural Materials Innovation (2014-2019) £1.75M, exploring alternative structural materials, natural in origin, to replace carbon intensive concrete structures, showcased in its timber skyscrapers research with PLP architects and engineers Smith and Wallwork. The Centre builds on findings from the Ramage-led Eco-House Project (Sep 2012-Sep 2017), which attracted a rapid succession of grants. Ramage has won a further £1.2M, which includes his successful bids to EC Interreg, FLOWERFAX (2018-2022), MTC FB Innovate UK (2018-2022), MTC FB Innovate UK (2019-2022) and Percheron-funded Asia-Pacific Modular Engineered project (2019-2021).

(vii) Short's EPSRC-funded 'Low carbon climate-responsive Heating and Cooling of Cities' (LoHCool) (2015-2019), £987k, plus equivalent match funding from China NSF, explored

the retention and adaptation of the existing building stock in the Hot Summer-Cold Winter zone cities in China with Co-Is in Chongqing, Zhejiang and elsewhere. MAGIC, a spin-off collaboration with Imperial College, has been funded by an EPSRC Grand Challenges fund (with Short and Jin as Co-Is). Cinetecture used LoHCool's findings for the film 'A Low Carbon Future for China's Furnace Cities', which won the 2019 Global Sustainability Film of the_Year award. LoHCool is an extension of Short's led EPSRC-ARCC funded 'Design and Delivery of Robust Hospital Environments in a Changing Climate' (DeDeRHECC), £1M. Other work by Short includes the AHRC-funded 'Excising Infection in Surgical Environments' (ExISE) (2017-2020), £248k, which also illustrates Architecture's contribution to the University-wide Interdisciplinary Research Centre in Infectious Diseases.

(viii) So's EPSRC-funded 'Learning from Earthquakes' (2017-2022), £178k continued CURBE's long-established work on disaster risk prevention and management.

(ix) Sunnika-Blank's British Academy-funded 'Gender and household energy: female participation in designing domestic energy in India's slum rehabilitation housing' (2018-2019), £49k, unveils life-threatening inadequacies in Mumbai's slum rehabilitation schemes, and is expanded in her AHRC-funded 'Building a film database to support decision making for energy infrastructure in low-income housing in India and South Africa' (2020-2021), £54k.

(x) Vinuales' ESRC-funded 'Building Resilience In a Dynamic Global Economy: Complexity across scales in the Food-Water-Energy Nexus (BRIDGE)' (2016-2020), £579k, and partial match funding from Brazilian institutions, explores feedbacks within the food-energy-water nexus in globally significant Brazil. This project was prepared by Vinuales-led Philomathia-funded 'The Law of Energy Transitions' (2014-2016), £115k, and Mercure-led (Vinuales Co-I) EPSRC-funded 'Linkages between energy, food and water consumption for Brazil in the context of climate change mitigation strategies (LINKS2015)' (2015-2016), £46k. It has been extended in a NERC-funded 'Financial Risk and the Impact of Climate Change (FRANTIC)' (2019-2020), £226k (Vinuales Co-I, share £63k), and in BEIS/CIFF-funded 'Economics on Energy Innovation and Systems Transition (EEIST)' (2020-2023), £3M+USD1M, focussing on the modelling of energy transitions in the UK, the EU, Brazil, China and India. C-EENRG leads two out of five work-packages (WP1: Vinuales/Salas, WP3: Diaz Anadon, for a total of £426k).

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

4.1 Research collaborations

Research in both Architecture and Land Economy is highly collaborative, relying on the extraordinary array of disciplines within Cambridge and beyond globally, benefitting greatly from the substantial efforts by the University to build cross- and trans-disciplinary collaborative structures. This section highlights some noteworthy illustrations out of a large pool of possible examples.

At the **local and national levels**, both departments are founding members of several trans-disciplinary structures. One is the CCI, based in the David Attenborough Building, which brings together the University and nine leading conservation agencies. Within CCI, the CCRI operates as the 'engine room', with C-EENRG as the policy research arm (Diaz Anadon, Kontoleon, Jones, Larcom, Lees, Salas, Vinuales) working together with Cambridge colleagues from Ecology, Geography, Plant Sciences, Veterinary Medicine, Zoology, etc. The leading global network of biodiversity economics, BIOECON, is also run from C-EENRG (Kontoleon). Other illustrations include the Natural Material Innovation for Sustainable Living initiative (Ramage), which brings together Architecture, Biochemistry, Applied Maths/Theoretical Physics, Chemistry and Plant Sciences, and the AHRC-funded antimicrobial resistance project ExISE (2017-2020) (Short) undertaken in collaboration with the BP Institute, Infectious Diseases and History of Art (Cambridge), History (KCL), Engineering (Leeds), and the Royal College of Surgeons, under the aegis of the Interdisciplinary Centre for Infectious Diseases. In 2019, Cambridge launched another University-wide ambitious initiative, Cambridge Zero, which brings together Land Economy (C-EENRG), Architecture (Centre for Natural_Material Innovation) and many other faculties and departments across the social and natural sciences to develop, synthesise and communicate knowledge to support the low-carbon transition.

Both departments are also involved in a wide network of **international collaborations**. Some major examples include the Cambridge-Nanjing University Research Centre on Architecture and Urbanism inaugurated in 2012, which has since provided the hub for several research projects (Steemers, Penz), the LoHCool project (Short), the MAGIC project (Jin, Short, Steemers) (Section 3.3). Another is a collaborative project between the UK ESRC and China's NSFC on Behavioural insights on financial decision-making in rural China (Bao) (Section 3.3). Several other projects have developed research partnerships with major emerging economies,

such as the ESRC-funded BRIDGE project in Brazil (Mercure, Salas, Vinuales) or the BEIS/CIFF-funded EEIST project (Diaz Anadon, Mercure, Salas, Vinuales) in partnership with Anglia Ruskin, Exeter, Oxford and UCL, and with leading institutions in Brazil (UFRJ, Campinas, FGV), China (Tsinghua, ERI) and India (TERI, WRI) (Section 3.3). Strong ongoing research collaborations with European and North American partners, include the EU H2020-funded INNOPATHS project (Diaz Anadon), in collaboration with UCL, the Potsdam Institute for Climate Impact Research, Sciences Po Paris, the European University Institute and ETH Zurich, or the Sloan Foundation-funded project on technology spillovers (Diaz Anadon), in collaboration with Harvard (Kennedy School) and Minnesota. In Africa, Kontoleon's work on the social benefits of REDD projects in Sierra Leone, funded by a Global Challenges Research Fund grant, is undertaken in collaboration with Gola Rainforest National Park and Njala University.

4.2 Engagement with recipients and research impact

Both departments engage widely the public and private recipients of research, and the wider community. The forms of engagement are diverse: providing an evidence-base for decision-making, advice to public bodies, participation in major science-policy interfaces and boards, provision of evidence or expert testimony in court proceedings or public inquiries, and wider dissemination of knowledge, through lectures to wider audiences, media interventions, curating exhibitions, etc. This section provides some illustrations out of a very large pool.

In **Architecture**: Pullan has made specific presentations before UNESCO ('Heritage and Conflict in Heavily Contested Cities', Paris, June 2015) and the UN General Assembly ('Jerusalem...in context', Jakarta, December 2015); So is a member of the UK Scientific Advisory Group for Emergencies (SAGE) providing scientific and technical advice supporting the UK government's Cabinet Office Briefing Room (COBR), she serves on the Science Board of the Global Earthquake Model (GEM), and she has also made specific presentations before international meetings, such as the Third UN World Conference on Disaster Risk Reduction ('Role of Architects in Disaster Risk Reduction', Sendai, Japan, March 2015); Short has prepared influential reports for the UK Government (e.g. NHS Energy Efficiency Fund, February 2015; NHS Health Technical Memorandum (HTM) 07-02, March 2015); Jin is the Lead Advisor on big data analytics and advanced urban modelling applications for City Planning Institute and Beijing Institute of Architectural Design, a Major Research Project Assessor and Rapporteur for the EU DG CONNECT, and a Member of the International Standardization Organization ISO/TC 268/SC01 Committee for best practice guidelines.

In **Land Economy**: RBU (Lang, Reader), together with partners, has for several decades conducted the influential Farm Business Survey (£3.8M between 2014-2020), which provides

the main evidence-base for DEFRA to conduct agricultural policy on this issue. DEFRA's Senior Economist acknowledges the importance of this work: 'It's impossible to overstate the importance of FBS data in policy-making'; CCHPR (Burgess) regularly conducts research commissioned by the MHCLG to provide an evidence-base for policy-making on housing and planning; in the context of the reform of the Land Registration Act 2002, the Law Commission retained Dixon and Lees as academic consultants and their research effectively catalysed the need for reform, led to a reversal of the previous case law (in EW Court of Appeal: *Swift 1st v Chief Land Registrar*) and shaped the Law Commission's Consultation, Report and Bill; Lizieri provided expert evidence in a landmark leasehold enfranchisement case, *Sloane Stanley vs Mundy and others* ((Upper Chamber (Lands Tribunal), [2016] UKUT 0223 (LC), 2015-2016), and served as Chair of the WEF's Industry Agenda Council on the Future of Real Estate and Urbanization (2014-2016); McHugh regularly provides expert evidence before the Waitangi Tribunal and Select Committee, New Zealand, influencing several major decisions (ICS: 'Legal and political recognition of Aboriginal Land') at the intergovernmental level, Vinuales' chairmanship of the UN/WHO Protocol on Water and Health's Compliance Committee, an international agreement governing the water and sanitation policies of 27 countries of the pan-European region, has led to a change in the understanding of the relations between the Protocol's obligations and EU law (Interpretive Note, ECE/MP.WH/2019/5/Add.1); Diaz Anadon is the Lead Author of the Chapter on Innovation and Technology Transfer for the IPCC's 6th Assessment Report, and a Member of the UK Innovation Caucus; Kontoleon is an advisor to the UN CBD, the IPBES, and the TEEB programme, and one of the lead authors of the UK's National Ecosystem Assessment.

Both departments also encourage their staff to engage with the wider public. Some examples include: Penz's curation of an exhibition of Rome amateur films 1960-1980, Sinfonietta Urbana, at the Vittoriano in Rome organised by the Polo Museale and the British School at Rome; Vinuales' art installation, co-created with an Argentine artist, Sounds of the Anthropocene, exhibited at the Edinburgh's International Science Festival or his several contributions to the UN Audiovisual Library on International Law; Diaz Anadon's contribution to BBC Radio's 'Climate Change: Tough Choices'; a film recording Short's LoHCool project, 'A Low Carbon Future for China's Furnace Cities', by Monika Koeck of Cinetecture won the Global Sustainability Film of the Year 2019. In addition, staff frequently intervene or are quoted in the media, including the BBC, CNN, *The Economist*, the *New York Times*, *The Guardian*, *The Times*, *The Financial Times*, *Le Monde*, the *Wall Street Journal*, Bloomberg, Huffington Post, The Conversation, among many others.

4.3 Wider influence of our researchers

This sub-section surveys the wider influence of the UoA staff, as evidenced by numerous marks of esteem. These are selected to demonstrate not only the leading position of both departments in their areas of research but also to provide further evidence of our sustained and lasting influence on such areas. A few illustrations are offered for each category.

Fellowships

In 2019, Short was elected President of Clare Hall College (2020-2027), one of the two research-based Colleges in Cambridge. In 2014, he was appointed George Collins Fellow of the Society of Architectural Historians (US) and Geddes Fellow (Edinburgh). Ramage is Vice-Master of Sidney Sussex College, Cambridge. In 2018, Howarth was elected as an Honorary Member of the Bench of the Middle Temple, one of the four Inns of Court which have the exclusive right to call law students to the Bar. Dixon was also elected as an Honorary Bencher of Lincoln's Inn in 2017. The regulations state that Honorary Members of the Bench are distinguished individuals who have excelled in their respective professions. In 2019, Vinuales was elected to the Institute of International Law, the most authoritative world academy in the field, recipient of the Nobel Peace Prize in 1904.

Awards

In 2014, Lizieri was awarded the *David Ricardo medal*, the American Real Estate Society's top research honour, in recognition of 'innovative and extensive publications on real estate office markets and the role of capital in urban development ... his thought leadership, his influence on new directions of research, teaching, public policy and practice'. In 2015, Steiner received the *Aareal Award of Excellence in Real Estate Research*, recognising her work on real estate investment trust capital structure choices. In 2016, Fingleton was awarded the *British and Irish Regional Science Association Lifetime Contribution Award* and the *EIB-ERSA Prize in Regional Science* at the 56th European Regional Science Association Congress in Vienna. In 2017, So, as part of the team having developed the 'anti-seismic house' Guangming, China, won the *World Building of the Year 2017 Prize*. In 2018, Diaz Anadon received the *Banco Sabadell XVIII Prize for Economics Research* for the best Spanish economist under 40, recognising her leadership in the field. In 2019, Öner became *Sweden's 2019 Young Researcher of the Year*, a prize awarded every year by the Entrepreneurship Forum for her 'significant contributions to our understanding of entrepreneurship'. Many other awards and honours have been received over the REF period (e.g. Steemers' 2017 honorary LLD from Bath; several best published paper awards for Allmendinger, Fuerst, Lees, Luca, etc.).

Journal and Series Editorships

Our research staff are at the forefront of scholarly engagement through contributions to editorial boards. We contribute to all leading disciplinary and interdisciplinary journals relevant to the areas covered by Land Economy and Architecture. Membership of editorial boards include: Diaz Anadon in *Nature Energy* and *Environmental Research Letters*; Campbell in the *Journal of Architectural Conservation* and *Construction History*; Fingleton as Editor-in-Chief of the *Journal of Spatial Economic Analysis*; Kontoleon in *Environmental Resource Economics* and *Sustainability*; Lizieri in the *Journal of Property Research* and as guest editor of *Land Use Planning* and *Cities*; Pullan in *Memory Studies*; Vinuales as General Editor of the *Cambridge Studies on Environment, Energy and Natural Resource Governance* and the *ICSID Reports*.

External Reviewing

Staff in both departments review extensively for all the major high-impact **journals** (e.g. *Nature*, *Science*, *PNAS*) and more focused publications, both generalist (e.g. *American Economic Review*, the *Economic Journal*, *Law Quarterly Review*, *Oxford Journal of Legal Studies*) and top-field (e.g. *Nature Energy, Joule, Journal Environmental Economics and Management, American Journal of Agricultural Economics, Environmental Resource Economics, Ecological Economics, Journal of Real Estate Research, Cities, Regional Studies, Environment & Planning*, etc.). In addition, our staff serve as **external reviewers for academic publishers** (e.g. Oxford University Press, Cambridge University Press, Routledge, Wiley, Springer, Sage); **Research Councils** (ESRC, EPSRC, AHRC, ERC), Raoul Wallenberg Foundation (Sweden), Austrian Research Council, Dutch Research Council, Swiss National Science Foundation, Leverhulme Fund); **graduate programmes/examinations** (e.g. Albort University, HKU, Edinburgh, KCL, Oxford, Heidelberg, American University of Beirut, Effat University, Sorbonne, Panthéon-Assas, European University Institute, ELTE University, Sao Paulo, Geneva); **appointment/promotion reviews** (e.g. Yale, ETH Zurich, LSE, NUS-Singapore, Tsinghua, KCL, Royal Academy of Ireland, Edinburgh, Sussex, Open University, Tilburg, Wageningen, Athens, NTNU-Norway, Malta, Bin Khalifa University, University of Eastern Finland, Ohio State).

External Professorships

Allmendinger, Visiting Professor (ETH Zurich, 2020); Diaz Anadon, Distinguished Visiting Professor (Tsinghua, 2020-2023); Lees, Visiting Professor (Newcastle, 2019); Mansley, Visiting Professor (Cass Business School, 2015); Pullan, Visiting Professor (Peking University, 2018-19); Short, Distinguished Professor Grant (Zhejiang, 2018-2021); Sunikka-Blank,

Visiting Associate Professor (Keio University, 2018); Vinuales, Visiting Professor (The Graduate Institute, 2013-2015-; Madrid, March-April 2016; Roma-Sapienza, May-2016; Pantheon-Assas, January-2018; Wuhan Institute of International Law, April-2019; LUISS, March-May 2021).

Conference Convener and Organiser Roles

Heo chaired the scientific executive committee of the 2018 IBPSA-England Building Simulation and Optimisation Conference (Cambridge); Wan co-chaired and organised the AESOP Session Track 12: Big data, open sources, generative tools, AESOP 2017 Congress in Lisbon; Mansley and Lizieri co-organised three international conferences on The Future of Cities (2016, 2017, 2018); Lizieri chaired the 6th International Real Estate Finance & Investment Conference, London, 2018; Lees and Vinuales co-organised an international conference on 'Energy and Climate Change after Paris', Cambridge (January 2016) and an international workshop on 'Comparative Environmental Law' (January 2017); Vinuales co-organised Biennial Congresses of the Latin-American Society of International Law (Santiago de Chile, 2016; Buenos Aires, 2018) and an International Conference on the Global Pact for the Environment (Paris, 2019); Silva co-organised the International Congress on Sustainable Development, Public Management and Territorial Governance, WSB University - Dąbrowa Górnicza, Poland (March 2019); Campbell served on the Scientific Committee of two International Congresses on Construction History (Chicago and Brussels) and organised and chaired five International Conferences in Cambridge.

Membership of Academic and Professional Bodies

Diaz Anadon: Member of the Breakthrough Ideas Steering Committee of the Carbon Trust, the UK Innovation Caucus, and Lead Author of the IPCC (Working Group III: Lead author of the chapter on innovation); Hernandez: Director of Centre for Latin American Studies University of Cambridge; Campbell: Founding member of International Federation of Construction History and Chair of Construction History Society; Jin: Member of ESRC Peer Review College, Academic Board Member of the Institute of Urban Spatial Culture and Science, Shanghai Jiao Tong University, Lead Advisor on big data analytics and advanced urban modelling applications for City Planning Institute and Beijing Institute of Architectural Design, and Member of ISO/TC 268/SC01 Committee for best practice guidelines; Kontoleon: advisor to the UN CBD, the IPBES, and the TEEB programme, and a lead author of the UK's National Ecosystem Assessment; Lizieri: Manager of the Cambridge Endowment for Research in Finance, Chairman of the European Public Real Estate Association's Research Committee (2013-2016), Chair of the WEF's Industry Agenda Council on the Future of Real Estate and Urbanisation (2014-2016), Member of the World Economic Forum's Advisory Committee on

Asset Price Dynamics (2014-2016) and Member of the Expert panel to the MHCLG/HM Treasury on Land Auctions and Land Value Capture; Mansley: Chair of the Cambridge Future Cities Group; Pullan: Member of the ESRC Peer Review College and Affiliate of the British Council for Research in the Levant; Short: International Co-Director of the Ministry of Education-sponsored 'Joint International Research Laboratory of Green Buildings and Built Environments' and the 'National Centre for International Research of Low-carbon and Green Buildings'; Steemers: jury member of the International Daylight Award (2x €100,000, Villum/Velux Foundation, Copenhagen); Vinuales: Chairperson of the UN/WHO Protocol on Water and Health's Compliance Committee, Member of the International Advisory Board of the Leverhulme Centre on Climate Change, Member of the List of Arbitrators of the Shanghai International Centre and Director-General of the Latin-American Society of International Law.

4.4 Contribution to the Sustainability of our Disciplines

Both departments have invested heavily in research on fundamental challenges of enduring relevance (sustainability transitions, nature conservation, urbanisation, settlements and the future of cities, and the infrastructure of healthcare and well-being) (Section 1.4), through the establishment of centres, groups, programmes and targeted recruitment.

The substantial resources invested in new appointments specifically in these areas at the Professorial and Lecturer levels, and the outstanding promotion rate of no less than 20 staff members (Section 2.1) are strong evidence of both departments' commitment to the sustainability of our disciplines. The policies and practices supporting progression of Early Career Researchers are discussed in Sections 2.1 and 2.2.

Both departments have seen a substantial increase in the number of applications to their programmes and have outstanding placement records. Land Economy is currently developing a new PhD in Sustainability and Public Policy programme, with three streams (Governance, Economic Policy, Cities and the Built Environment) specifically to contribute to the sustainability of research in these areas.

All in all, the very significant investments made throughout the 2014-2020 period and described in this statement have yielded a substantial return. The research, published work and outreach efforts have shown incredible vitality, reaffirming the world-leading position of both departments on some of the major global challenges the world faces today.