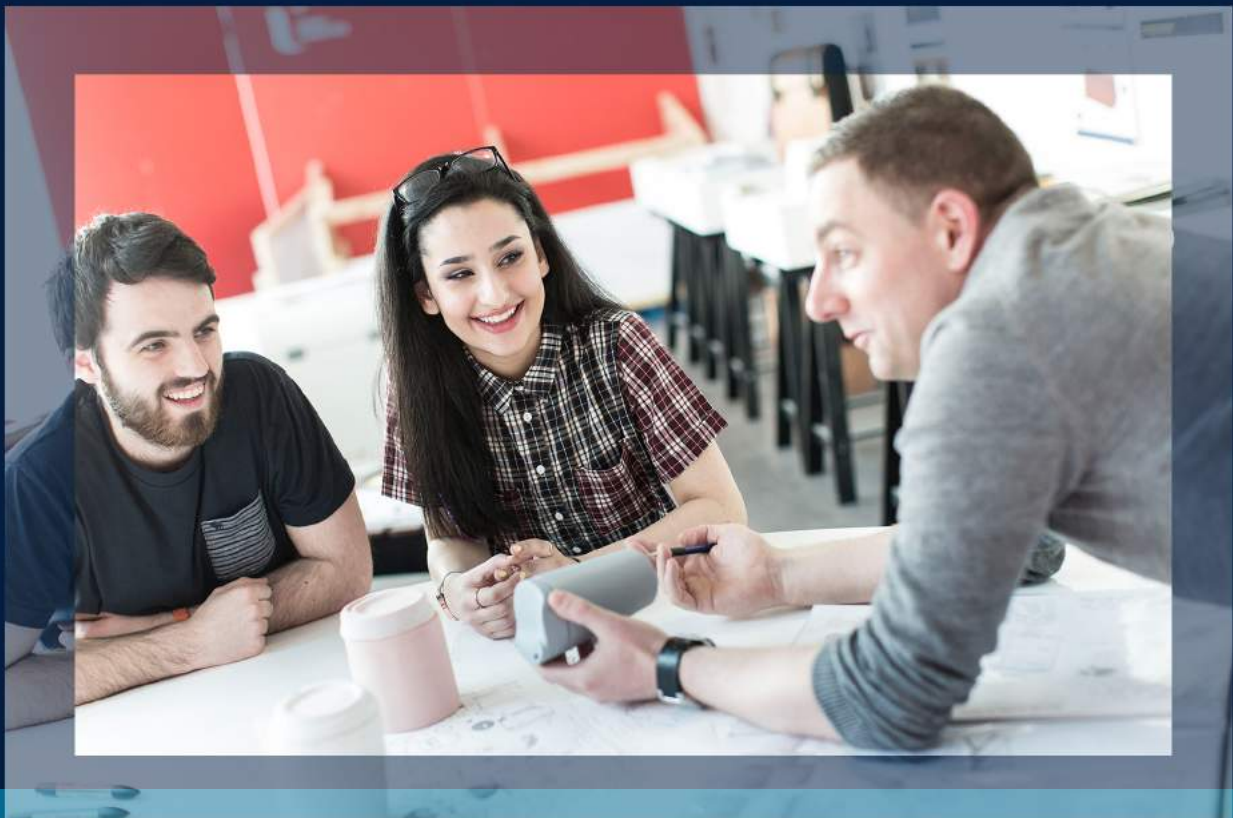


Belfast School of Architecture and the Built Environment

Annual Report
1st August 2019 -31st July 2020



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1. Foreword:
Research Director
Dr Jayanta Mondol

In presenting the Annual Report for the Architecture, Built Environment and Planning for the academic year 2019-2020, I am happy to report a very successful year in terms of our grant income, research outputs, contribution to collaborative projects, development of research networks both locally and internationally, engagement with wider communities and outreach activities.

In this foreword, we briefly review the activities of the five research centres within our school: Centre for Sustainable Technologies (CST), Fire Safety Engineering Research and Technology Centre (FireSERT), Hydrogen Safety Engineering and Research Centre (HySAFER), Centre for Research on Property and Planning (RPP) and Studies Allied to the Built Environment Research (SABER). The main sections of the report provide details of the PhD projects and graduating PhDs, publications and new research grants and few ongoing important research projects.

In this reporting period, we have secured over £2.7M of research awards through funders including EPSRC (~£800K), H2020 (~1M), Invest-NI CASE (£172K) and other funding sources such as the Royal Society of Chemistry, The Nuffield Foundation and Korean National Fire Agency.

Examples of note are the EPSRC funded project 'Comfort and Climate Box' (£202K) where CST researchers are developing an energy package combining Heat Pump, Energy Storage and Control technologies. Following on from the success of the SolaFin2Go project, CST has secured Energy Catalyst Round 7 EPSRC/Innovate UK funding to deliver the SwanaSmartStore project in collaboration with Kingston University and three industrial partners. In this project, the team is developing intelligent solar photovoltaic and thermal systems integrated with energy storage to provide reliable and affordable household energy access for socioeconomically diverse rural communities in sub-Saharan Africa. CST is also collaborating with 13 partners across Europe in H2020 'Novel building Integration Designs for increased Efficiencies in Advanced climatically tunable renewable energy Systems (IDEAS)' project to design a cost effective and efficient innovative integrated renewable energy system which will provide electricity, heating and cooling for residential and commercial buildings in different climatic conditions. In the H2020 Stage 2 'Advanced Indirectly Heated Carbonate Looping Process – ANICA' project, CST researchers are developing a novel efficient indirectly heated carbonate looping process for CO₂ capture from the lime and cement plants. Funded through Invest NI CASE Award the CST Foyle River Gardens project is developing a 'near zero carbon' community by maximising the use of on-site renewable and sustainable energy sources.

In collaboration with 15 partners across Europe, HySAFER is leading the €1M HyResponder project funded by Horizon 2020 to deliver a train the trainers programme on hydrogen and fuel cell safety technology. HySAFER is also collaborating with the EPSRC funded Ulster-QUB Kelvin-2 project that enables our researchers to utilise £5M high performance computer facility and high-speed network for simulation-based research work. HySAFER is also engaged in training a new generation of scientists and

engineers in Hydrogen safety under the EPSRC CDT SusHy (the Sustainable Hydrogen) programme in collaboration with Universities of Nottingham, Loughborough University and University of Birmingham.

Within this reporting period, a series of notable achievements and acclaimed research outputs were achieved by RPP including insightful and innovative contributions to key societal and environmental challenges at local, national, and international levels. At the local level, RPP continues to make a significant contribution to housing and planning policy development. Commissioned research undertaken for the Department of Finance highlighted the implications of empty property rates on local authority revenue streams while members from the RPP also completed the viability assessment of the Belfast Local Development Plan. These two commission projects afforded robust, transparent evidence to inform policy and guide investment priorities to support economic growth and societal development across the province. The report entitled 'Delivering a More Sustainable Housing Model for Northern Ireland' reflected the views and opinions of stakeholders from across the housing, planning and constructions sectors and led to extensive ongoing dialogue with policy makers to foster change, enhance collaboration and address inefficiencies in future housing provision. The ongoing EU funded project entitled Carbon Risk Real Estate Monitor (CRREM) provides science-based decarbonisation pathways for real estate assets. The CRREM project received the Best Paper Award at the American Real Estate Society Conference (2020) while the project team worked with the European Commission on the development of the Sustainable Investment Taxonomy. Expansion of RPP's research on Marine Spatial Planning (MSP) has led to a strategic partnership with Aalborg University, University of Oldenburg, University of Liverpool, University of Nantes, Leibniz Institute for Baltic Sea Research, Breda University of Applied Sciences, and the Finnish Environment Institute. Through this partnership, the team is contributing to the development of new innovative approaches to higher education and training on MSP.

FireSERT has secured two research awards funded by the Korean Government (£463K) for the designing of fire resistance protective clothing and for the development of the emergency response training facilities.

During this reporting period we have been actively involved in various outreach activities. CST co-hosted a 3-day workshops and training programmes (11-13 September 2019) on Wastewater Innovation and Climate Change as part of the Alice project. HySAFER organised a Digital Stakeholder's workshop in May 2020 as part of HyTunnel-CS project in which more than 220 people attended from Europe, United States, Canada and Australia. HySAFER was also involved in the delivery of a Joint European Summer School on Fuel Cell, Electrolyser and Batteries Technologies held in Athens, Greece (23-27 September 2019).

The merging of Belfast School of Architecture and the School of the Built Environment has created an opportunity for developing interdisciplinary research by combining Architecture discipline with sustainable technologies, construction and planning. We have established a new Architecture Research Group (ARG) in 2020 with the vision of developing an interdisciplinary, innovative research portfolio to design appropriate concepts and strategies for net zero emission buildings and communities, with strong interests in the health and well-being of the people. ARG is consisted of four main research clusters: (i) Zero Emission Buildings and Communities; (ii) Hidden Barriers and Divisive Architecture; (iii) Drawing: Methodology, making and media; and (iv) Practise Based Research. The research within this group aims to advance knowledge of climate resiliency, empowering people to thrive in an era of climate emergency; examine how the processes of political, economic, military and ideological conflict shape urban space and community development; explore the multiple practices, and mediums of drawing, across a wide range of physical and digital works to examine the relationship of drawing to current architectural education; and develop practice based

research in collaboration with the academia and professionals by creating PhD positions in partnership with industry.

A total of 80 PhD researchers are enrolled in the academic year 2019-20 and 12 PhD degrees have been awarded which comprise 4 VCRS, 1 DfE, 3 self-funded and 1 externally funded studentship.

This brief overview summaries our main engagements and contributions in the research in Architecture, Built Environment and Planning over the last year. I would encourage you to read through this Annual Report and follow up any queries with either myself or colleagues.

Further details of our research, facilities, staff profiles and research expertise can be found at <http://www.ulster.ac.uk/research/topic/built-environment> or by contacting Mrs Irene Moreland (Admin Support) at (Email: i.moreland@ulster.ac.uk; Ph: +44 28 9036 6101).



Dr Jayanta Deb Mondol
Research Director- Architecture, Built Environment & Planning.

2. Research Students

The following research students were registered on research degree programmes during 2019-20.

Name	Project title
Abid, Muhammad	Variable speed heat pump compressor for demand side management and network stability
Ademulegun, Oluwasola	Locational net benefit analysis for mass energy storage
Agbonaye, Osaru	Development of Business Models of Community Energy Schemes
Akagwu, Paul	Experimental & numerical study on performance of steel joints during fire
Alam, Naveed	Response of Slim Floor Systems in Fire
Alkadi, Sanaa	An Investigation of the Adaptation of the Southern Syrian Vernacular Dwelling
Allen, David	Location, Location, Location: A Northern Irish, I.T. driven perspective
Alnaseem, Nijood	Factors that impact on the achievement of value of money in public sector projects in the state of Kuwait
Ansong, Joseph	Coastal Governance on the Island of Ireland: challenges and opportunities in a new erast
Baby, Alosly	Synergistic Effect of Phosphorus and Nitrogen Containing Groups in Fire Retardancy of Polystyrene
Bani Mustafa, Motasem	Distributed energy storage models for DNO/DSO operations
Benson, Jordan	Resilient relationships: an investigation into the nexus between spatial planning and community planning
Bhutta, Rumeel	Personal protective equipment for accidentally high risk circumstances under extreme conditions
Bradley, Philip	The development of a conceptual framework to help achieve low carbon commercial office buildings in London by 2050
Byrne, Raymond	A heuristic evaluation of the energy performance of a Vestas V52 wind turbine in a peri-urban wind environment
Casey, Thomas	Friction after polishingL a probabilistic framework for improved roads management on national roads in Ireland
Cassidy, Peter	Design and evaluation of community fire safety educational programmes
Chakraborti, Shauli	Design development and experimental characterisation of an innovative solar building wall with thermal storage and heat transfer characteristics
Chang, Roma	Multifunctional Building Integrated Solar Technologies
Charlier, Marion	Characterization of travelling fires in large compartments
Chartouni, Joseph	The erasure of modernity from beirut's cultural/architecture heritage
Clarke, Gary	Multi-function Building Integrated Solar Technologies using Optical Components
Clarke, Sorcha	Shaping resilient places and communities: exploring expressions of planning theory and practice
Collen, Peter	Further investigation of surface dressing failures through 2D and 3D modelling
Comiskey, David	The Quality Dimension (qD) – Improving quality assurance in relation to fire barriers in ventilated façade systems

Coon, David	The interrelationship between noise and the physical wellbeing of inhabitants adjacent to major infrastructure such as transport routes
Coyles, David	Spatial legacy of the Troubles: A historical assessment of security led ideology in the redevelopment of inner-city Belfast 1969-1994
Cunningham, Gervase	Business development and innovation in construction companies
Czerwinska, Anna	Fuel Poverty - Retrofitting as a policy solution
De Priall, Oisín	Performance Study and Validation of the Downdraft Biomass Gasification
Dery, Wulme	High-pressure hydrogen storage tank rupture in confined space
Diamond, Declan	Sustainable City Regeneration through Infrastructure Investment
Donaghy, Leona	Optimum integration of a range of energy efficiency and renewable energy technologies under real conditions in occupied test houses
Donkoh, Emmanuel	Improving project performance: Application of system dynamics modelling in managing construction stakeholders influences and challenges
Dou, Mengmeng	Real estate valuation practice in China - An emerging market perspective
El Samra, Kristine	Downtown Beirut: A quest for urban regeneration frameworks of a city living in parallel to the living city
Fadeyi, Olawumi	Capital flow and real estate office markets in Global financial cities
Ferguson, Jason	The detrimental effect of water on asphalt pavement durability
Frey, Joe	The Growth of the Private Rented Sector in Northern Ireland: The implications for Housing Market Analysis and Planning for Housing Supply
Fumey, Benjamin	Absorption based heat storage with NaOH, heat and mass exchanger development and system of integration
Ghoraishi, Mohammad	Advanced Multifunctional Energy Efficient Building Facades
Greaney, Deirdre	Calibrating government planning policies for Irish urban centres from culturally durable and environmentally sustainable urban design principles and strategies
Hamill, Mark	Development of innovative management strategies to address proliferation of littering in the built environment
Hawe, Owen	Planning for Active Living: Aligning Policy, Product, Practice and Processes
Hussein, Harem	Pressure peaking phenomenon for hydrogen jet fires
Huynh, An	The characteristics of Fly ash based Geopolymer Concrete in Road Pavement
Isirima, Michael	Fire protection risk assessment: A study of offshore installations
Islam, A K M Khabirul	Water-Energy Nexus: Developing Technology to Produce Hydrogen from Wastewater
Jankowiak, Corentin	Optimal Integrated Solutions for Energy Storage, Electrification of Heat and Transport at a Domestic level
Kearney, Matthew	Regeneration and Resilience: Practical Solutions to Real World Problems
Kennedy, Robert	Legibility in Urban Design and Conservation Area Practice
Kinnear, Adam	Public Health: Environmental Protection
Larmour, Jane	A study of the architecture of baths and bathing establishments in Ireland to include spas, lidos and swimming pools as an aspect of our architectural social and cultural heritage
Lawson, Aaron	An Investigation of the Hand Hygiene Behaviours of the General Population when using Public Restrooms
Le, Khoa	Cascade Air-to-water Heat Pump With and Without Thermal Energy Storage: A Study for UK Domestic Retrofit

Liang, Hongyuan	The Development of a Strategic Performance Measurement Framework for Assessing Xiongan New Area in China
Lim, Ohk Kun	Structural performance of shear stud in fire
MacDonald, Colin	Law enforcement perspectives in lone act terrorism
MacIntyre, Sean	Solar PV in NI. An examination of the user profile and experience together with an assessment of its future potential for household generation and use via behavioural and technological changes
Mahon, Clare	To develop an economic operator prequalification model to assist in the award of public contracts
Mahone, Nedra	Economic base and the impact on real estate returns
McAleenan, Aoife	Using Irish road infrastructure as a means of connecting essential pollinator habitat corridors
McAllister, Anthony	Human behaviour in fire and emergencies
McGough, Anthony	Analysis and modelling commercial real estate investment markets
McKinstry, Colin	Development and validation testing of an advanced domestic air source heat pump
McMenamin, Deirdre	Developing cultural-spatial representation of the interrelationship between landscape and human agency in rural Ireland/NI: Revealing the agency of landscape strategy in Irish Vernacular Architecture
Muhumuza, Ronald	Clean power production with concentrating solar power technology: Development of a solar thermal energy device for latent heat storage from cost-effective, abundant and safe materials
Murray, Martin	Passive House Strategies, using Ireland as an exemplar
Nair, Ajay	Phase Change and Alternative Materials for Domestic Thermal Energy Storage
Nakkasunchi, Shalini	Water and energy nexus in water utilities
O'Brien, Vincent	PhD Research Project
Oakes, Luke	Development and evaluation of innovative, fibre-reinforced geopolymer composite solutions as permanent formwork for geopolymer cement concrete structures
Obasi, Gerard	Advanced Heat Pumps and Power Cycles
Oriaifo, Wilfred	Investigating the role of public buildings in the acculturation process
Patton, Marcus	Building Northern Ireland 1945 to 1980
Pishchukhina, Olga	Prevention and Mitigation of Accidents with Hydrogen-powered Vehicles in Confined Space
Quigley, Mura	Enabling a resilient future: exploring the leadership and governance of urban design
Rainey Keers, Karina	The air quality and health impacts of residential coal burning within Northern Ireland
Ramirez, Miguel	Design & development of a High Temperature Heat Pump (HTHP) for district heating and industrial applications
Ratajczak, Leonia	Smart Cities: Innovation, Technology, Partnership and Governance
Sakr, Mohamed	Modelling and large eddy simulation of large scale deflagration-to-detonation transition
Sheldon, Lisa	Community resilience, health and wellbeing - exploring community resilience in flood prone areas considering the increase in flooding prevalence
Shen, Yunfei	Residential property taxation reform in China

Sulaiman, Adam Yussef	Advanced Heat Pump Systems Accommodating High Temperature Evaporation
Tavanarezaei, Hossein	An investigation of the impact of older persons on the flow dynamics of a crowd
Tierney, Christopher	Dynamic road/ tyre interaction
Velanparambil Ravindran, Rahul	Reversible Heat Pump/Organic Rankine Cycle
Wang, Shurui	i.SEM, DS3 and GB/Fr Interconnection Electricity Marketing Modelling
Wilson, Tara	The role of assistive technology within architecture to improve quality of life of NI's ageing population
Yue, Wenhe	The Impact of Demographic Structure and Changing Government Policies on Urban Housing Demand in China

Graduated December 2019

Student Name	Thesis Title
Alam, Naveed	Response of slim floor systems in fire
Hussein, Harem	Pressure peaking phenomenon for hydrogen jet fires and safety considerations of indoor releases
Clarke, Sorcha	Protecting crowded places from terrorism: The potentiality of the urban planning system in counter terrorism practice
Lawson, Aaron	An investigation of the hand hygiene behaviours of the general population when using public restrooms

Graduated July 2020

Student Name	Thesis Title
Hawe, Owen	Planning for Active Living: Aligning Policy, Product, Practice and Processes
Lim, Ohk Kun	Fire performance of shear studs in transverse deck slabs
Le, Khoa Xuan	Cascade air-to-water heat pump with and without thermal energy storage: A study for UK domestic retrofit
Dou, Mengmeng	An investigation of urban land valuation methods and accuracy in China
Frey, Joe	The growth of the private rented sector: The implications for housing market analysis and planning for housing supply
Muhumuza, Ronald	Solar cogeneration for access to energy in off-grid rural households in developing countries (DCs)
Fumey, Benjamin	Heat and mass exchanger design for inter-seasonal liquid absorption heat storage
McGough, Anthony James	Advancements made in commercial real estate analysis and pricing

3. Publications

Details of all Publications by the School of Architecture, Built Environment and Planning are on the Ulster University's Institutional Repository- PURE <https://pure.ulster.ac.uk/>. This section reports those outputs published over the period of this report and classified as either journal articles, books/chapters in books, research reports and published conference papers.

3.1 Journal Articles

Ademulegun, O., Keatley, P., Bani Mustafa, M., Hewitt, N., 2020, Energy Storage on a Distribution Network for Self-Consumption of Wind Energy and Market Value, *Energies*, vol. 13, 11.

Ali, F., Nadjai, A., Akagwu, P., 2020, Behaviour of bolted steel splice connections under fire, *Journal of Constructional Steel Research*, vol. 170.

Aqlibous, A., Tretsiakova-McNally, S., Fateh, T., 2020, Waterborne Intumescent Coatings Containing Industrial and Bio-Fillers for Fire Protection of Timber Materials, *Polymers*, vol. 12, 4.

Asimakopoulou, E. K., Chotzoglou, K. E., Kolaitis, D., Zhang, J., Delichatsios, M. A., 2019, Numerical investigation of externally venting flame characteristics in a corridor-facade configuration, *Fire Safety Journal*, vol. 110.

Asimakopoulou, E., Zhang, J., McKee, M., Wieczorek, K., Krawczyk, A., Andolfo, M., Scatto, M., Sisani, M., Bastianini, M., Karakasidis, A., Papakonstantinou, P., 2020, Fire Retardant Action of Layered Double Hydroxides and Zirconium Phosphate Nanocomposites Fillers in Polyisocyanurate Foams, *Fire Technology*, vol. 56, 4, pp.1755-1776.

Balisampang, T., Abbassi, R., Garaniya, V., Khan, F., Dadashzadeh, M., 2019, Modelling an integrated impact of fire, explosion and combustion products during transitional events caused by an accidental release of LNG, *Process Safety and Environmental Protection*, vol. 128, pp.259-272.

Balisampang, T., Abbassi, R., Khan, F., Garaniya, V., Dadashzadeh, M., 2019, Accidental release of Liquefied Natural Gas in a processing facility: Effect of equipment congestion level on dispersion behaviour of the flammable vapour, *Journal of Loss Prevention in the Process Industries*, vol. 61, , pp.237-248.

Bondar, D., Basheer, M., Nanukuttan, S., 2019, Suitability of alkali activated slag/fly ash (AA-GGBS/FA) concretes for chloride environments: Characterisation based on mix design and compliance testing, *Construction and Building Materials*, vol. 216, , pp.612-621.

Boyce, K. E., Geoerg, P., Gwynne, S., Berchtold, F., Hoffman, A., Holl, S., 2019, Engineering Egress Data Considering Pedestrians with Reduced Mobility, *Fire and Materials*, vol. 43, 7, pp.759-781.

Byrne, R., Hewitt, N., Griffiths, P., MacArtain, P., 2019, An assessment of the mesoscale to microscale influences on wind turbine energy performance at a peri-urban coastal location from the Irish wind atlas and onsite LiDAR measurements, *Sustainable Energy Technologies and Assessments*, vol. 36.

Choi, S., 2019, Experimental Studies on the Behaviour of Headed Shear Studs for Composite Beams in Fire, *Steel and Composite Structures*, vol. 32, 6, pp.743-752.

Choi, S., 2019, Thermal Boundaries in Cone Calorimetry Testing, *Coatings*, vol. 9, 10.

- Chotzoglou, K., Asimakopoulou, E., Zhang, J., Delichatsios, M. A., 2019, An experimental investigation of burning behaviour of liquid pool fire in corridor-like enclosures, *Fire Safety Journal*, vol. 108.
- Comiskey, D., 2020, Changing attitudes towards the mental wellbeing of early career Architectural Technology professionals, *Architectural Technology Journal*, 134, pp.16-17.
- Das, B., Mondol, J., Debnath, S., Pugsley, A., Smyth, M., Zacharopoulos, A., 2020, Effect of the absorber surface roughness on the performance of a solar air collector: An experimental investigation, *Renewable Energy*, vol. 152, pp.567-578.
- de Fajtima Castro, M., Colclough, S., Machado, B., Andrade, J., Braganca, L., 2019, European legislation and incentives programmes for demand Side management, *Solar Energy*.
- Delichatsios, M., Zhang, J., 2019, Ground Wind Generated Near the Base by the massive convective column of Very Large-Scale Mass Fires, *Fire Safety Journal*, vol. 111.
- Fadeyi, O., McCord, M., Berry, J., Mc Greal, S., 2020, Capital Flows and Office Markets in Major Global Cities., *Journal of Property Investment and Finance*.
- Franco, P., Johnston, R., McCormick, E., 2020, Demand responsive transport, *Transportation Research Part A: Policy and Practice*, vol. 131, pp.244-266.
- Gluth, G. J. G., Arbi, K., Bernal, S. A., Bondar, D., Castel, A., Chithiraputhiran, S., Dehghan, A., Dombrowski-Daube, K., Dubey, A., Ducman, V., Peterson, K., Pipilikaki, P., Valcke, S. L. A., Ye, G., Zuo, Y., Provis, J. L., 2020, RILEM TC 247-DTA round robin test, *Materials and Structures/Materiaux et Constructions*, vol. 53, 21.
- Houlihan Wiberg, A. A. M., Lovhaug, S., Mathisen, M., Tschoerner, B., Resch, E., Erdt, M. H., Prasolova-Forland, E., 2019, Visualisation of KPIs in zero emission neighbourhoods for improved stakeholder participation using Virtual Reality, *IOP Conference Series: Earth and Environmental Science (EES)*, vol. 323.
- Houlihan Wiberg, A. A. M., Wiik, M. R. K., Lokland Slake, M., Manni, M., Ceci, G., Hofmeister, T. B., Auklend, H., Tuncer, Z. M., 2019, Life cycle assessment for Zero Emission Buildings - A chronology of the development of a visual, dynamic and integrated approach, *IOP Conference Series: Earth and Environmental Science (EES)*, vol. 352, 1.
- Jankowiak, C., Zacharopoulos, A., Brandoni, C., Keatley, P., MacArtain, P., Hewitt, N., 2019, The Role of Domestic Integrated Battery Energy Storage Systems for Electricity Network Performance Enhancement, *Energies*, vol. 12, 20.
- Kashkarov, S., Li, Z., Molkov, V., 2020, Blast wave from a hydrogen tank rupture in a fire in the open: Hazard distance nomograms, *International Journal of Hydrogen Energy*, vol. 45, 3, pp.2429-2446.
- Le, K., Huang, M., Shah, N., Wilson, C., MacArtain, P., Byrne, R., Hewitt, N., 2019, Techno-economic assessment of cascade air-to-water heat pump retrofitted into residential buildings using experimentally validated simulations, *Applied Energy*, vol. 250, pp.633-652.
- MacIntyre, J., 2019, The Utility of Solar Photovoltaic Panels at 55 Degrees North, *Agenda NI*.

- McCord, M., Davis, P., Bidanset, P., Sunderman, M., 2019, An exploratory approach for enhancing vertical and horizontal equity tests for ad valorem property tax valuations using Geographically Weighted Regression., *Journal of Financial Management of Property and Construction*, vol. 24, 2, pp.231-250.
- McCord, M., Davis, P., McCord, J., Haran, M., Davison, K., 2020, An exploratory investigation into the relationship between Energy Performance Certificates and Sales Price: A Polytomous Universal Model approach, *Journal of Financial Management of Property and Construction*, vol. 25, 2, pp.247-271.
- McCord, M., Lo, D., McCord, J., Davis, P., Haran, M., 2019, Measuring the Cointegration of housing types in Northern Ireland., *Journal of Property Research*, vol. 36, 4, pp.343-366.
- McCord, M., Lo, D., McCord, J., Hemphill, L., Davis, P., Haran, M., 2019, A spatial analysis of EPCs in The Belfast Metropolitan Area housing market, *Journal of Property Research*, vol. 37, pp.25.
- McDermott, R., Knox, R., 2019, Tap Water versus Bottled Water: A Pilot Study, *The Journal of Water Resource and Protection*, 11, pp.1398-1407.
- McDermott, R., Orr, S., Sproule, S., 2019, The Disinfection of Drinking Water in Trunk Water Mains, *Journal of Environmental Protection*, vol. 10, 9, pp.1085.
- McDermott, R., Solan, B., McCord, S., Littlewood, K., 2019, Irish Water and Scottish Water: A Comparison, *The Journal of Water Resource and Protection*, vol. 11, pp.1064.
- McGough, A., Berry, J., 2019, Pricing risk and its use in modelling real estate market yields, *Journal of Property Investment and Finance*, vol. 38, 5, pp.419-433.
- McIlhatton, D., Monaghan, R., Berry, J., Cuddihy, J., Chapman, D., Christensen, P., 2019, Protecting Commercial Real Estate and Crowded Places from Terrorism, *Journal of Real Estate Literature*, vol. 27, 1, pp.103-116.
- Moncaster, A. M., Rasmussen, F. N., Malmqvist, T., Houlihan Wiberg, A. A. M., Birgisdottir, H., 2019, Widening understanding of low embodied impact buildings: Results and recommendations from 80 multi-national quantitative and qualitative case studies, *Journal of Cleaner Production*, vol. 235, pp.378-393.
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- Muhumuza, R., Zacharopoulos, A., Mondol, J., Smyth, M., Pugsley, A., Francesco Giuzio, G., Kurmis, D., 2019, Experimental investigation of horizontally operating thermal diode solar water heaters with differing absorber materials under simulated conditions, *Renewable Energy*, vol. 138, pp.1051-1064.
- Muhumuza, R., Zacharopoulos, A., Mondol, J., Smyth, M., Pugsley, A., McGee, J., 2020, Simulation and experimental validation of solar radiation distribution on the absorber of a line-axis asymmetric compound parabolic concentrator, *Solar Energy*, vol. 198, pp.36-52.
- Nadjai, A., Allam, A., Nassif, A., 2019, Behaviour of restrained steel beam at elevated temperature - parametric studies, *Journal of structural Fire Engineering*, vol. 10, 3, pp.324-339.

- Pugsley, A., Zacharopoulos, A., Mondol, J., Smyth, M., 2019, Theoretical and experimental analysis of a horizontal planar Liquid-Vapour Thermal Diode (PLVTD), *International Journal of Heat and Mass Transfer*, vol. 144.
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- Solan, B., Ettema, R., Ryan, D., Hamill, G., 2020, Scour concerns for short span masonry arch bridges, *Journal of Hydraulic Engineering*, vol. 146, 2.
- Solorzano, J. A. P., Moinuddin, K. A. M., Tretsiakova-McNally, S., Joseph, P., 2019, A Study of the Thermal Degradation and Combustion Characteristics of Some Materials Commonly Used in the Construction Sector, *Polymers*, vol. 11, 11.
- Sreekumar, S., Joseph, A., Kumar, C. S. S., Thomas, S., 2019, Investigation on influence of antimony tin oxide/silver nanofluid on direct absorption parabolic solar collector, *Journal of Cleaner Production*, vol. 249.
- Sreekumar, S., Joseph, A., Kumar, C. S. S., Thomas, S., 2019, Optimisation of thermo-optical properties of SiO₂/Ag-CuO nanofluid for direct absorption solar collectors, *Journal of Molecular Liquids*, vol. 296.
- Sreekumar, S., Joseph, A., Thomas, S., 2020, Development of a low cost nanofluid based direct absorption solar collector, *Materials Today: Proceedings*, vol. 22, , pp.2424-2430.
- Takeo, K., Yamamoto, S., Sakatsume, R., Hirakawa, S., Takeda, H., Shentsov, V., Makarov, D., Molkov, V., 2020, Effect of shock structure on stabilization and blow-off of hydrogen jet flames, *International Journal of Hydrogen Energy*, vol. 45, 16, pp.10145-10154.
- Thomas, A., Joseph, P., Moinuddin, K. A. M., Zhu, H., Tretsiakova-McNally, S., 2020, Thermal and Calorimetric Evaluations of Some Chemically Modified Carbohydrate-Based Substrates With Phosphorus-Containing Groups., *Polymers*, vol. 12, 3.
- Vaganay, M., Lawson, A., 2019, The Effectiveness of a Poster Intervention on Hand Hygiene Practice and Compliance When Using Public Restrooms in a University Setting, *International Journal of Environmental Research and Public Health*.
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Whait, R. H., Lowies, B., Rossini, P., McGreal, W. S., Dimovski, B., 2019, The reverse mortgage conundrum: Perspectives of older households in Australia, Habitat International, vol. 94.

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3.2 Books/Chapters in Books

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3.3 Research Reports

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3. 4 Published Conference Papers

Ademulegun, O., Keatley, P., Bani Mustafa, M., Hewitt, N., 2020, Energy Storage for Increasing Self-Consumption of Wind Energy And Market Value On A Distribution Network, pp. 372 -383, Conference proceedings of the 14th International Postgraduate Research Conference 2019: contemporary and future directions in the Built Environment.

Agbonaye, O., Keatley, P., Huang, Y., Bani Mustafa, M., Ademulegun, O., Hewitt, N., 2019, VALUE OF DEMAND FLEXIBILITY FOR PROVIDING ANCILLARY SERVICES: A STUDY OF THE IRISH DS3 MARKET, 4th Annual APEEN Conference 2019.

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Bani Mustafa, M., Khasawneh, H., Al-Salaymeh, A., Saidan, M., 2019, Techno-Economic Evaluation of On-Grid Battery Energy Storage System in Jordan using Homer Pro, AEIT2019.

Cirrone, D., Makarov, D., Molkov, V., 2019, Cryogenic hydrogen jets: flammable envelope size and hazard distances for jet fire, International Conference on Hydrogen Safety.

Comiskey, D., Hyde, T., Millar, P., O'Kane, E., 2019, The Quality Dimension (qD), 160.

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Satola, D., Houlihan Wiberg, A. A. M., Gustavsen, A., 2019, Towards zero emission residential buildings in a humid subtropical climate. Analysis greenhouse gases emissions in referential locations according to obligatory energy codes and using generic LCA material data base, International Symposium on Heating, Ventilation and Air Conditioning.

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Shah, N., Cotter, D., Huang, M., Hewitt, N., 2019, Lubricant Investigation for High Temperature Heat Pump Application, pp. 249.

Solan, B., NOWROOZPOUR, A., Clopper, P., Watters, C., Ettema, R., 2019, SCOUR-INDUCED FAILURE OF MASONRY ARCH BRIDGES: CAUSES AND COUNTERMEASURES.

Tretsiakova-McNally, S., Solan, B., Currie, R., Akinsanmi, O., Arnscheidt, J., McDermott, R., Coleman, H. M., 2020, A LIGNO-CELLULOSIC BIO-ADSORBENT DERIVED FROM SAWDUST WASTE FOR THE REMOVAL OF MEROPENEM ANTIBIOTIC DISSOLVED IN WATER, European Waste Water Management Conference.

4. Research Funding

Ongoing and Active Research Projects, notably:

Unit of Assessment Member	Title of Award	Funding Body	Value	Project Dates
Prof G Leavey Dr M Loane Dr M McCord Dr M Rosato Prof AJ Moore Prof M Tully Prof D O'Reilly, QUB	ADRC 2018	ESRC	£905,432	2018-2021
Prof V Molkov Dr DV Makarov	SusHy - Centre for Doctoral Training in Sustainable Hydrogen	EPSRC	£552,308	2019-2027
Prof G Leavey Dr M Loane Dr M McCord Prof AJ Moore Prof M Tully Prof D O'Reilly, Queen's Uni Belfast	R&D Office contribution to Link - The NI Administrative Data Research Centre 2019	HSC R&D Public Health Agency	£205,766	2019-2021
Dr SK Choi	Development of Emergency Response Training Facilities	Korean National Fire Agency	£330,000	2019-2024
Prof N Hewitt Dr M Huang Angeles Rivero Pacho, Warwick University Bob Critoph, Warwick University David Ealmes, Warwick University Graham Maidmont, London South Bank Uni Eames, Loughborough University Sarah Davies, London South Bank Uni Stan Shire, Warwick University	Low temperature Heat Recovery and Distribution Network Technologies (Lo-NET)	EPSRC	£1,321,470	2018-2023

Steven Metcalf, Warwick University Vicky Haines, Loughborough University				
Dr M McCord Dr J McCord Dr M Hinch Dr PT Davis Mr SC MacIntyre Prof ME Haran	House Prices, Rents and Affordability	NIHE	£287,747	2019-2022
Prof V Molkov Dr DV Makarov	HyTunnel-CS	CEC-H2020-FCH	£338,910	2019-2022
Prof N Hewitt Prof PW Griffiths Dr A Zacharopoulos Dr C Brandoni Dr M Huang Dr P Keatley Mr D McLarnon Mr S Devlin Prof Y Huang Dr P Macartain, DKIT Mr JD McCorley, Arbarr Prof D Morrow, QUB Prof M Stack, Strathclyde Uni	SPIRE 2	INTERREG VA	£23,078,838	2017-2022
Dr J Mondol Dr A Zacharopoulos Dr MA Smyth	SolaNetwork	EPSRC	£211,716	2019-2022
Prof N Hewitt Dr M Huang Dr N Shah	CHESTER - Compressed Heat Energy Storage for Energy from Renewable Sources	CEC-H2020-LCE-2016-2017	£203,599	2018-2021
Prof V Molkov Dr DV Makarov Dr A Venetsanos, Nat Center for Sci Res Dr J Jallais, L'air Liquide Mr F Markert, Intl Assoc Hydrogen Safety Mr G Stern, Pro-Science	PRESLHY: Pre-normative Research for Safe Use of Liquid Hydrogen	CEC-H2020-JTI-FCH	£204,181	2018-2021

Mr O Jedicke, Karlsruher Inst fur Tech Mr R Fletcher, Health & Safety Executive Mrs V Mahieux, Inst National de L'enviro Prof J Wen, University of Warwick				
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Portfolio of new Research Grants awarded during period 1 August 2019 - 31 July 2020

Unit of Assessment Member	Title of Award	Funding Body	Value	
Dr M Huang Prof N Hewitt Dr Y Bi A Joyce, Laboratorio Nacional de Energia B Fox, LF Fasthouse C Walsh, Energy Co- Operatives Ireland E Strazzer, Uni Degli Studi Di Cagliari E Torralba Callega, Acondicion Tarrasens K Moosdorf, Assoc Portuguesa Das Empresa M Bottarelli, Uni Degli Studi Di Ferrara P Duff, Power Capital Renewable Energy P Lavin, APK Architects & Engineering P McHale, Mayo County Council Prof S Vranes, Institut Mihajlo Pupin S McCormack, Trinity College Dublin Z Ure, Phase Change Material Products	IDEAS	CEC-H2020-LC- SC3-RES-4-2018	£510,330.00	2019- 2022
Dr H Ritchie Carl Von Ossietzky, Universitaet	Knowledge Flows in Marine Spatial Planning - Sharing Innovation in Higher Education	C.E.C. Erasmus+	£47,036.00	2019-2022

Dr Igor Mayer, Stichting Breda Dr K Schiele, Leibniz-Institut für Ostsee Mr B Trouillet, Université de Nantes Mr S Jay, University of Liverpool Prof L Schroeder, AALBORG UNI Suomen Ympäristökeskus, Helsinki				
Prof Y Huang Dr C Brandoni Prof N Hewitt	ANICA - Advanced Indirectly Heated Carbonate Looping Process (Stage 2)	CEC-H2020-ACT-CCS.EU/Calls	£169,711.00	2019-2022
Dr SL Brennan Dr DV Makarov Prof V Molkov	HyResponder - European Hydrogen Train the Trainer Programme for Responders	CEC-H2020-FCH	£250,360.00	20-20-2022
Dr SK Choi	Development of Emergency Response Training Facilities	Korean National Fire Agency	£330,000.00	2019-2024
Dr S Tretsiakova-McNally	Improving fire resistance of styrene-based polymers through P-N synergism of reactive fire retardants	The Royal Society of Chemistry	£2,700.00	2020
Prof D Coyle Prof AJ Bjourson Prof V Molkov Prof JAD McLaughlin Mr S Orr, Catalyst Inc Mr S Trotter, Dell Corporation Ltd Prof R Woods, QUB	Northern Ireland HPC - Kelvin-2	EPSRC	£494,698.00	2020-2023
Prof N Hewitt Prof LP Maguire	Foyle River Gardens	Invest NI via Case	£172,135.00	2020-2021
Dr MA Smyth Dr A Pugsley	SwanaSmartStore	EPSRC IUK Energy Catalyst	£66,241.00	2020-2021

Dr A Zacharopoulos Dr J Mondol				
Prof N Hewitt Dr I Vorushylo Dr M Huang Dr N Shah	Comfort Climate Box	BEIS via EPSRC	£202,577.00	2020-2022
Dr SK Choi	Development of Optimum Firefighting Strategy for Battery Electric Cars	Korean National Fire Agency	£133,053.00	2020-2023
Dr H Ritchie	ESPON - Transnational Outreach Programme 2020 International Conference: Resilience in Marine Spatial Planning	ESPON	£3,437.00	2020
Prof G McKeever Dr J McCord Mr M Potkewitz	Removing the barriers to legal participation	The Nuffield Foundation	£354,578	2019-2021