

Belfast School of Architecture and the Built Environment



August 2020 – July 2021

Annual Report
For Research & Impact



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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 2020-21, I am happy to report a very successful year in terms of our research grant income, publications, research impact, external collaborations both locally and internationally and engagement with wider communities and outreach activities.

In this foreword, we briefly review the activities of the six 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), Studies Allied to the Built Environment Research (SABER) and newly formed Architecture Research Group (ARG). The report includes titles of the PhD projects, our unit's publication details, successful research grants received during this reporting period, and a few ongoing large scale research projects.

The ongoing Covid-19 pandemic had a profound impact on the research landscape over the period, with a series of national and international conferences and keynote speaker events around the world cancelled or postponed indefinitely. The pandemic also adversely impacted research income secured as many funding bodies delayed commissions or retracted funding opportunities due to the more constrained financial landscape. However, we still have managed to secure over £2.9M research income through UKRI, EU H2020, INTERREG IVA, Invest-NI CASE and other funding sources such as the Royal Society, Belfast City Council, Department for the Economy, National Road Authority and Invest NI.

With approximately £10M of live projects within the CST, the centre has secured three more large scale research projects amounting to a total circa £1.98M. The CST is involved in the FASTER project funded through EU INTERREG VA programme to develop charging facilities and infrastructures for the Electric Vehicles in the UK. This large scale (€6,41 M) Project is a joint initiative undertaken by 6 partners (Ulster University, Southwest College, Louth County Council, Dundalk IT, HITRANS and University of Strathclyde) from Scotland, Ireland and Northern Ireland to support the low carbon transport systems in these regions. The project aims to implement the physical roll-out and installation of 73 rapid (50KW capacity) electric vehicle charging stations in the UK and Ireland.

The CST is collaborating with Warwick University and Loughborough University in HP-FITS project funded by EPSRC to deliver an integrated packaged solution combining novel storage, heat pump and control systems for providing space heating and electricity for domestic buildings. This proposed technology would be more economical and efficient compared to existing technologies. The developed technology will be demonstrated at 'Terrace House', a living lab based at Jordanstown Campus, Ulster University. CST's 'Decarbonisation of Data Centres with Geothermal Energy (DDCGE)' project funded through Invest NI/CASE will consider all new renewable energy sources like wind and solar while exploring opportunities and barriers to harnessing Northern Ireland's geothermal energy resources in the form of natural heat emanating from the earth's core. Such geothermal heat is used around the world to generate electricity and provide heat to agricultural and industrial processes, but is as yet untapped in Northern Ireland. The project will also assess the distribution and harvesting of geothermal resources in Northern Ireland's subsurface, the utilisation of geothermal energy at the surface, including conversion to electricity, and the required policy and legislative framework in Northern Ireland to enable accelerated and sustainable geothermal development.

HySAFER is leading the hydrogen safety research within UK and Europe and currently delivering over £2M research projects funded through H2020 and EPSRC. In collaboration with industries (Optimum CPV - Plastic Omnium, Belgium and Misal Srl, Italy), HySAFER is involved in the SH2APED project developing a conformable and cost-effective hydrogen storage system with increased efficiency and unprecedented safety performance. This innovative storage system is expected to have 20% lower costs compared to the state-of-the-art Type IV tanks. The project is also supported by the leading vehicle manufacturers such as Daimler, Toyota, Audi, Geely, FIA, GreenGT, etc.

HySAFER is providing ongoing support in training and supervising doctoral students on hydrogen technologies in the EPSRC CDT SuShy project. The team is the leading safety vector of this multidisciplinary research and will train 7 PhD researchers within this project.

The HySAFER's research is making a significant impact on global technical regulations on hydrogen and fuel cell vehicles and has made a contribution to the Parliamentary Office of Science and Technology Research Briefing document 'Low-carbon hydrogen supply'.

In collaboration with FP Mccann, FIRECERT is developing precast sandwich panel façade systems with advanced construction materials aiming to increase the safety level. The project will generate unique knowledge and data related to material performance, testing methods, assembly methods/designs and strengthen the UK's market through IP generation.

The RPP centre continued to contribute to housing and planning policy development across the island of Ireland and witnessed a series of noteworthy attainments that served to showcase the increased diversity of research focus and enhance the profile of several early career researchers. The RPP group continued to engage with policymakers and inform policy development. Alongside colleagues in the Economic Policy Centre, the RPP Group completed a series of commissioned reports for the Department for Finance on the impacts of the Covid-19 pandemic on public income generation and the need for fiscal relief for businesses over the course of enforced lock-downs restrictions. Two reports were produced, namely the Non-Domestic Rates Review and the Land Registration Income Review. This body of research served to inform Department of Finance market intervention and funding relief packages for businesses, Regional Government Departments and Local District Councils during the Covid Pandemic. March 2021 witnessed the launch of a joint research report by Ulster University and Dublin City University on the growth opportunities afforded through focussed commitment to the development of the Belfast-Dublin Economic Corridor. The report received wide acclaim and serves as an evidence base to initiate informed discussion on the potential economic growth potential by enhancing links between the two main cities on the island.

Internationally, the RPP group continues to diversify and grow relative to key societal and environmental challenges. The European Commission funded project entitled Carbon Risk Real Estate Monitor (CRREM) concluded in January 2021 to significant acclaim and informing the development of the European Union Sustainable Finance Taxonomy. The CRREM risk assessment tools have also been endorsed by over 50 of the largest commercial real estate investment companies across Europe including Allianz and Aberdeen Standard. Going forward, the Laudes Foundation will continue to financially support the updating and further development of CRREM tools. Meanwhile, the project team has recently teamed up with Global Real Estate Sustainability Benchmark (GRESB) and the Partnership for Carbon Accounting Financials (PCAF) to support the roll-out of the CRREM framework within the financial services sector to address the financial implications of carbon intensity within the commercial real estate sector.

In January 2021, the RPP researchers along with researchers from School of Psychology had launched Belfast-THRI(VES), a pilot practical research project between Ulster University and Belfast City Council (BCC) to support BCC, NI Department for Infrastructure and NI Department for Communities to better inform decisions for enhancing the liveability of the city and wellbeing of its inhabitants. This innovative pilot

programme has been designed to study holistic health and wellbeing-led models for planning, designing and managing the city centre's public spaces. Through the project delivery and dissemination, Belfast will take inspiration from cities around the world, working with governments, developers, and researchers, who have pioneered health and regeneration initiatives from one-off projects to city-region-wide strategies. The project delivered a symposium on 16-17 June 2021, with the public invited to hear from international and local keynote speakers and panel discussions contributing to mapping health-related data, designs, and attitudes on key transformative projects.

Given our commitment to transformative educational experiences, our ARG and CST researchers have engaged with Belfast City Council (BCC) through our Architecture of Change project to deliver a student lead training programme to educate senior business leaders. The training programme focuses on identifying the gaps in knowledge and skill related to net-zero carbon building and a sustainable built environment with vital interests in improving the health and wellbeing of the citizens. The project is placing students – our future leaders at the centre of a sustainability training programme that will support environmentally and socially sustainable practice within organisations and energise current business leaders, thereby bridging the generation gap. This joint University-Council approach will enable us to collect evidence, raise awareness and promote business/industry preparedness – processes that are needed as a foundation for delivering adaptation actions.

Our collaboration with industries is extended through new funded projects. CST is delivering a project 'Solar Energy Storage in combination with innovative Low-Energy Dwellings ('SoLow') in partnership with Geda Construction Ltd, Setanta Construction Ltd, GP Developments (NI) LLP, McAlister Architects Ltd, the Electric Storage Co and MosArt Ltd. The FireSERT is collaborating with the South Korean Government Development of Emergency, Fuzhou University (China), Arcellor Mittal, The University of Naples Federico II, The University State of Michigan, The Northern Ireland Fire & Rescue Services (UK), Severfield (NI) Ltd, Crossfire Ltd and the Sean Timoney Glass Ltd. The partnership between FireSERT and Efectis (France) is consecutively running for the fifth year. We are also working closely with Belfast City Council, Donegal County Council, and National Roads Authority to contribute to regional sustainability agendas. International partnership is developed through the Royal Society Exchange programme such as with North China Electric Power in the area of hydrogen and bio gas production from waste materials.

We have made valuable contributions to various outreach activities through active engagement with professional bodies, keynote addresses at conferences, membership of Journal editorial boards, participation in international networks, serving as a committee member in scientific, technical and international advisory boards. For example, Dr Boyce was Co-chair of the Communications Committee for 13th International Symposia International Association of Fire Safety Science held in 26-30 April 2021, Waterloo, Ontario. Dr Tretsiakova-McNally is a guest editor of a special issue 'Polymer Science, Technology and Engineering beyond 2020: Novel, Safer and Sustainable Materials' in Polymers Journal. Dr Jianping Zhang has guest-edited a special issue, 'Asymmetry in Fire Dynamics and Modelling' in Symmetry Journal. Dr Mondol is the lead guest editor of the special issue, 'Advances in Solar Thermal Technologies' in Entropy Journal and 'Advanced Renewable Energy Technologies' in Energies Journal Dr Caterina Brandoni has joined the Expert Committee "Green and The Environment" in the new national Irish campaign. Prof Hewitt is the UK lead in IEA HPT Task 35/55 Comfort and Climate Box. Prof Houlihan Wiberg is contributing to IEA Annex 72 (Assessing Life Cycle Related Environmental Impacts Caused by Building). Dr Tretsiakova-McNally has been appointed as a panel member of UK Department for Environment, Food and Rural Affairs (DEFRA) Horizon Scan for Future Chemical Issues. Prof Nadjai is the nominated expert and member of the National Standards Authority of Ireland (NSAI).

Prof Hewitt delivered a talk on the 'How to make use of and distribute Geothermal Heat – latest technology and case studies in Building Back Better: A Future for Geothermal Energy in Northern Ireland'. He was also an invited speaker for IoR Annual Conference, Beyond Refrigeration 2021 held on 21-22 April. Prof Nadjai

presented the oral evidence on Building Regulation in Northern Ireland in the NI Assembly. The session was televised live throughout Parliament Buildings and on the BBC Democracy Live website.

During this reporting period, 58 PhD researchers are enrolled, including 18 part-time and 22 overseas students, and 8 PhD researchers have completed their degrees. Our PhD researchers have received prestigious international awards for their outstanding research. Hossein Tavanarezaei was the 2021 recipient of the SFPE Dr Guylene Proulx OC Award, and Robert Bray received second place at the 2020/2021 IFV-VVBA Thesis Award and a third-place at the Ernst Achilles Award.

This brief overview presents our engagements and research and impact contributions in the 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 <https://www.ulster.ac.uk/research/topic/built-environment> or by contacting Marcella McCann (Academic Excellence Executive Assistant) at Email: m.mccann1@ulster.ac.uk ; Ph: +44 28 9536 7356



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

2. Research Students

The following research students were registered on research degree programmes during 2020-21.

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	Assessing demand flexibility as a new business model for decarbonising social housing.
Alkadi, Sanaa	An Investigation of the Adaptation of the Southern Syrian Vernacular Dwelling.
Alnaseem, Nijood	Private Equity Infrastructure Investment in Emerging Economies.
Ansong, Joseph	Coastal Governance on the Island of Ireland: challenges and opportunities in a new era.
Baby, Aloshy	Synergistic Effect of Phosphorus and Nitrogen Containing Groups in Fire Retardancy of Polystyrene.
Bani Mustafa, Motasem	Distributed energy storage models for DNO/DSO operations.
Bhutta, Rumeel	Personal protective equipment for accidentally high risk circumstances under extreme conditions.
Bradley, Briegin	Healthy Urban Environments. Assessing the needs and expectations of Young People across European Cities.
Bray, Robert	An experimental and computational study of flame ignition and extinction of polymeric materials in under-ventilated environments.
Byrne, Raymond	A heuristic evaluation of the energy performance of a Vestas V52 wind turbine in a peri-urban wind environment.
Carlin, Kieran	Urban universities as catalysts for public-private regeneration strategies to benefit more liveable and healthy inner-city communities.
Casey, Thomas	Friction after polishing a probabilistic framework for improved roads management on national roads in Ireland.
Cassidy, Peter	Design and evaluation of community fire safety educational programmes.
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.
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.
Coyles, David	Spatial legacy of the Troubles: A historical assessment of security led ideology in the redevelopment of inner-city Belfast 1969-1994.
Czerwinska, Anna	Fuel Poverty - Retrofitting as a policy solution.
De Priall, Oisín	Performance Study and Validation of the Downdraft Biomass Gasification.
Diamond, Declan	Sustainable City Regeneration through Infrastructure Investment.
Donkoh, Emmanuel	Improving project performance: Application of system dynamics modelling in managing construction stakeholders influences and challenges.
Ebne Abbasi, Hazhir	Assessment and mitigation of hydrogen-fuelled vehicle hazards.
El Samra, Kristine	The City Other. A people-centred analysis on the detachment of the Beirut Central District.
Ferguson, Jason	The detrimental effect of water on asphalt pavement durability.
Ghoraishi, Mohammad	Advanced Multifunctional Energy Efficient Building Facades.

Hamill, Mark	Development of innovative management strategies to address proliferation of littering in the built environment.
Islam, A K M Khabirul	Water-Energy Nexus: Developing Technology to Produce Hydrogen from Wastewater.
James, Ben	Climate Resilient, Net and Autonomous Zero Emission Buildings and Communities (NZEB) – Definitions and Prototypes for the UK/Northern.
Jankowiak, Corentin	Optimal Integrated Solutions for Energy Storage, Electrification of Heat and Transport at a Domestic level.
Johnston, Ryan	Visualisation and Immersive technology to improve stakeholder participation in net Zero Emission Buildings and Neighbourhoods (ZEN) in Smart Cities.
Kazemi, Mina	Prevention and mitigation of accidents with hydrogen-powered vehicles in confined spaces.
Kearney, Matthew	Regeneration and Resilience: Practical Solutions to Real World Problems.
Kennedy, Robert	Legibility in Urban Design and Conservation Area Practice.
Liang, Hongyuan	The Development of a Strategic Performance Measurement Framework for Assessing Xiongan New Area in China.
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.
McAleenan, Aoife	Using Irish road infrastructure as a means of connecting essential pollinator habitat corridors.
Murray, Martin	Passive House Strategies, using Ireland as an exemplar.
Nair, Ajay Muraleedharan	Phase Change and Alternative Materials for Domestic Thermal Energy Storage.
Nakkasunchi, Shalini	Water and energy nexus in water utilities.
Novaes, Marcio	Oilseed rape as a potential feedstock for domestic boilers.
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.
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.
Robinson, Amy	The Impact of policy and the application of regulatory controls on the achievement of overarching sustainability goals.
Sanders, Peter	The characterisation of road surface friction as a factor in vehicle safety.
Sheldon, Lisa	Community resilience, health and wellbeing - exploring community resilience in flood prone areas considering the increase in flooding prevalence.
Sreekumar, Sreehari	Nanoparticles based Solar Energy and Energy Storage (Nano_SEES) System.
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	The Friction Measuring Tyre Contact Patch.
Velanparambil Ravindran, Rahul	Reversible Heat Pump/Organic Rankine Cycle.

Graduated December 2020

Name	Thesis Title
Sakr, Mohamed	Modelling and large eddy simulation of large-scale hydrogen-air deflagration and deflagration-to detonation transition.
Wulme, Dery	High-pressure hydrogen storage tank rupture in confined space.

Graduated July 2021

Name	Thesis Title
Akagwu, Paul	Experimental and numerical study on bolted web-flange steel connections in fire.
Coon, David	The impact of transport induced environmental noise on the wellbeing of residents adjacent to major traffic infrastructure routes in Northern Ireland.
Huynh, An	Development of innovative semi-flexible composite materials for pavement applications.
O'Brien, Vincent	Design, development and characterisation of a novel building integrated photovoltaic concept for energy collection and passive solar shading.
Patton, Marcus	A tendency to cowp things: An exploration of building and conservation in Northern Ireland since 1945 through oral history.
Wang, Shurui	I-SEM, DS3 and Great Britain/France interconnection electricity marketing modelling.

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 & Moreno Jaramillo, AF 2020, 'Power Conversion in A Grid-Connected Residential PV System with Energy Storage Using Fuzzy-Logic Controls', International Transactions on Electrical Energy Systems, pp. 1-17.

<https://doi.org/10.1002/2050-7038.12659>

Ademulegun, O, Keatley, P & Hewitt, N 2021, 'Techno-Economic Analysis of Energy Storage within Network Constraint Groups for Increasing the Share of Variable Renewable Energy', The Electricity Journal, vol. 34, no. 6, 106974, pp. 1-15.

<https://doi.org/10.1016/j.tej.2021.106974>

Ademulegun, O, Keatley, P, Agbonaye, O, Moreno Jaramillo, AF & Hewitt, N 2020, 'Towards A Sustainable Electricity Grid: Market and Policy for Demand-Side Storage and Wind Resources', Utilities Policy, vol. 67, 101116, pp. 1-12.

<https://doi.org/10.1016/j.iup.2020.101116>

Agbonaye, O, Keatley, P, Huang, Y, Ademulegun, O & Hewitt, N 2021, 'Mapping demand flexibility: A spatio-temporal assessment of flexibility needs, opportunities and response potential', Applied Energy, vol. 295, 117015.

<https://doi.org/10.1016/j.apenergy.2021.117015>

Agbonaye, O, Keatley, P, Huang, Y, Bani Mustafa, M & Hewitt, N 2020, 'Design, Valuation and Comparison of Demand Response Strategies for Congestion Management', Energies, vol. 13, no. 22, e6085, pp. 1-29.

<https://doi.org/10.3390/en13226085>

Agbonaye, O, Keatley, P, Huang, Y, Bani Mustafa, M, Ademulegun, O & Hewitt, N 2020, 'Value of

demand flexibility for providing ancillary services: A case for social housing in the Irish DS3 market', Utilities Policy, vol. 67, 101130, pp. 1-12. <https://doi.org/10.1016/j.iup.2020.101130>

Alam, N, Maraveas, C, Tsarvdaridis, K & Nadjai, A 2021, 'Performance of Ultra Shallow Floor Beams (USFB) exposed to standard and natural fires', Journal of Building Engineering, vol. 38, 102192, pp. 1-12.

<https://doi.org/10.1016/j.jobe.2021.102192>

Alam, N, Nadjai, A, Hanus, F, Kahanji, C & Vassart, O 2021, 'Experimental and Numerical investigations on Slim Floor Beams Exposed to Fire', Journal of Building Engineering. <https://doi.org/10.1016/j.jobe.2021.102810>

Ansong, J, McElduff, L & Ritchie, H 2020, 'Institutional integration in transboundary marine spatial planning: A theory-based evaluative framework for practice', Ocean and Coastal Management, vol. 0, no. 0, 105430, pp. 1-12.

<https://doi.org/10.1016/j.ocecoaman.2020.105430>

Arya, F, Hyde, T, Henshall, P, Eames, P, Moss, R, Shire, S & Uhomoibhi, J 2021, 'Fabrication analysis of flat vacuum enclosures for solar collectors sealed with Cerasolzer 217', Solar Energy, vol. 220, pp. 635-649.

<https://doi.org/10.1016/j.solener.2021.02.040>

Asimakopoulou, E, Zhang, J, McKee, M, Wiczorek, K, Krawczyk, A, Andolfo, M, Kzlecki,

T, Scatto, M, Sisani, M, Bastianini, M, Karakasidis, A & Papakonstantinou, P 2020, 'Effect of Layered Double Hydroxide, Expanded Graphite and Ammonium Polyphosphate additives on thermal stability and fire performance of polyisocyanurate insulation foam', *Thermochimica Acta*, vol. 693, 178724.

<https://doi.org/10.1016/j.tca.2020.178724>

Ballentine, M, Blair, N, McGreal, S & McIlhatton, D 2021, 'Conceptualising and prototyping a decision support system for safer urban unmanned aerial vehicle operations', *Urban, Planning and Transport Research*, pp. 1-21.

<https://doi.org/10.1080/21650020.2021.1906939>

Bhagwat, VV, Roy, S, Das, B, Shah, N & Chowdhury, A 2021, 'Performance of finned heat pipe assisted parabolic trough solar collector system under the climatic condition of North East India', *Sustainable Energy Technologies and Assessments*, vol. 45.

<https://doi.org/10.1016/j.seta.2021.101171>

Biglarbeigi, P, Strong, A, Finlay, D, McDermott, R & Griffiths, P 2020, 'A Hybrid Model-Based Adaptive Framework for the Analysis of Climate Change Impact on Reservoir Performance', *Water Resources Management*, vol. 34, pp. 4053-4066.

<https://doi.org/10.1007/s11269-020-02654-w>

Bray, R, Barton, J, Madsen, D & van Hees, P 2021, 'Burning material behaviour in hypoxic environments: An experimental study examining a representative storage arrangement of ABS, PE bubble wrap and cardboard layers as a composite system', *Fire and Materials*, pp. 1-16.

<https://doi.org/10.1002/fam.3002>

Coyles, D, Hamber, B & Grant, A 2021, 'Hidden barriers and divisive architecture: The role of “everyday space” in conflict and peacebuilding in Belfast', *Journal of Urban Affairs*, pp. 1-24.

<https://doi.org/10.1080/07352166.2021.1930017>

Das, B, Mondol, J, Negi, S, Smyth, M & Pugsley, A 2021, 'Experimental Performance Analysis of a Novel Sand Coated and Sand Filled Polycarbonate Sheet Based Solar Air Collector', *Renewable Energy*, vol. 164, pp. 990-1004.

<https://doi.org/10.1016/j.renene.2020.10.054>

Davis, P, McCord, M, Bidanset, P & Cusack, M 2020, 'Nationwide Mass Appraisal Modeling in China: Feasibility Analysis for Scalability Given Ad Valorem Property Tax Reform', *Journal of Property Tax Assessment and Administration*.

Dou, M, Hemphill, L & Lim, JL-C 2020, 'Development land valuation accuracy in China – a case study of Beijing', *Journal of Property Investment and Finance*, vol. 0, no. 0, pp. 1-24.

<https://doi.org/10.1108/JPIF-06-2020-0072>

Giannissi, SG, Tolia, IC, Melideo, D, Baraldi, D, Shentsov, V, Makarov, DV, Molkov, V & Venetsanos, AG 2020, 'On the CFD modelling of hydrogen dispersion at low-Reynolds number release in closed facility', *International Journal of Hydrogen Energy*.

<https://doi.org/10.1016/j.ijhydene.2020.09.078>

Haran, M, Lo, D & Milcheva, S 2020, 'Performance drivers in private infrastructure funds', *Real Estate Finance*, pp. 1-47.

Haran, M, Lo, D, McCord, M, Davis, PT & Lim, JL-C 2020, 'Impact of firm-level attributes on listed real estate company performance', *Journal of Property Investment and Finance*, vol. 0, no. 0, pp. 1-26. <https://doi.org/10.1108/JPIF-03-2020-0030>

Hollberg, A, Kiss, B, Rock, M, Soust-Verdaguer, B, Houlihan Wiberg, A, Lasvaux, S, Galimshina, A & Habert, G 2021, 'Review of visualising LCA results in the design process of buildings', *Building and Environment*, vol. 190, 107530.

<https://doi.org/10.1016/j.buildenv.2020.107530>

Huang, Y, Rolfe, A, Rezvani, S, Hidalgo Herrador , J, Franco , F, Pinto , F, Snape, C & Hewitt, N 2020, 'Converting Brown Coal to Synthetic Liquid Fuels through Direct Coal Liquefaction Technology: Techno-Economic Evaluation', International Journal of Energy Research, vol. 44, no. 14, pp. 11827-11839. <https://doi.org/10.1002/er.5823>

Huynh, A, Magee, B & Woodward, WDH 2020, 'A preliminary characterisation of innovative semi-flexible composite pavement comprising geopolymer grout and reclaimed asphalt planings', Materials, vol. 13, no. 16, 3644. <https://doi.org/10.3390/ma13163644>

Huynh, A, Nguyen , QD, Xuan , QL, Magee, B, Chung , T, Tran, KT & Nguyen , KT 2020, 'A Machine Learning-Assisted Numerical Predictor for Compressive Strength of Geopolymer Concrete Based on Experimental Data and Sensitivity Analysis', Applied Sciences, vol. 10, no. 21, 7726, pp. 1-16. <https://doi.org/10.3390/app10217726>

Islam, AKMK, Dunlop, PSM, Hewitt, N, Lenihan, R & Brandoni, C 2021, 'Bio-Hydrogen Production from Wastewater: A Comparative Study of Low Energy Intensive Production Processes', Clean Technologies, vol. 3, no. 1, 3, pp. 156-182. <https://doi.org/10.3390/cleantechnol3010010>

Jankowiak, C, Zacharopoulos, A, Brandoni, C, Keatley, P, MacArtain, P & Hewitt, N 2020, 'Assessing the benefits of decentralised residential batteries for load peak shaving', Journal of Energy Storage, vol. 32, 101779. <https://doi.org/10.1016/j.est.2020.101779>

Jha, P, Mondol, J, Das, B & Gupta, R 2020, 'Energy metrics assessment of a photovoltaic thermal air collector (PVTAC): a comparison between flat and wavy collector', Energy Sources, Part A: Recovery, Utilization, and Environmental Effects, vol. 42. <https://doi.org/10.1080/15567036.2020.1809563>

Joseph, A, Sreekumar, S & Thomas, S 2020, 'Energy and exergy analysis of SiO₂/Ag-CuO plasmonic nanofluid on direct absorption parabolic solar collector', Renewable Energy, vol. 162, pp. 1655-1664. <https://doi.org/10.1016/j.renene.2020.09.139>

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Lu, K, Wang, Z, Ding, Y, Wang, J, Zhang, J, Delichatsios, M & Hu, L 2020, 'Flame behavior from an opening at different elevations on the facade wall of a fire compartment', Proceedings of the Combustion Institute. <https://doi.org/10.1016/j.proci.2020.07.094>

Makarov, D, Shentsov, V, Kuznetsov, M & Molkov, V 2021, 'Hydrogen Tank Rupture in Fire in the Open Atmosphere: Hazard Distance Defined by Fireball', Hydrogen, vol. 2, no. 1, pp. 134-146. <https://doi.org/10.3390/hydrogen2010008>

McCann, L, Hutchison, N & Adair, A 2021, 'Calibration of stakeholder influence in the UK higher education sector', Studies in Higher Education, vol. 46, pp. 1-22. <https://doi.org/10.1080/03075079.2021.1916908>

McCord, M, Haran, M, Davis, PT & McCord, J 2020, 'Energy performance certificates and house prices: a quantile regression approach', *Journal of European Real Estate Research*, vol. 13, no. 3, pp. 409-434. <https://doi.org/10.1108/JERER-06-2020-0033>

McDermott, R 2020, 'A Comparison of the Operational Energy Demand of Both Low Pressure and Vacuum Collection Systems', *The Journal of Water Resource and Protection*, vol. 12. <https://doi.org/10.4236/jwarp.2020.129044>

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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

Colclough, S 2020, 'Are nZEBs nearly near zero enough? Considerations of nZEB housing and standards as a solution to building associated climate change', Paper presented at Passive Low Energy Architecture 2020, A Coruna, Spain, 1/09/20 - 3/09/20.

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Rolfe, A, Huang, Y & Hewitt, N 2021, Technical and Environmental Analysis of Methanol Synthesis from Solid Recovered Fuel and Lignite. in 8th International Conference on Sustainable Solid Waste Management. pp. 1-11, 8th International Conference on Waste Management, Thessaloniki, Greece, 23/06/21.

4. Research Funding

Ongoing and Active Research Projects, notably:

Unit of Assessment Member	Title of Award	Funding Body	Value	Project Dates
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
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 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 N Hewitt Dr M Huang Angeles Rivero Pacho, Warwick University Bob Critoph, Warwick University David Ealmes, Warwick University Graham Maidmont, London South Bank Phil 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				
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 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	PRESLHY: Pre-normative Research for Safe Use of Liquid Hydrogen	CEC-H2020-JTI-FCH	£204,181	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 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	IDEAS	CEC-H2020-LC-SC3-RES-4-2018	£510,330.00	2019- 2022

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				
Dr SK Choi	Development of Emergency Response Training Facilities	Korean National Fire Agency	£330,000	2019-2024
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
Dr J Mondol Dr A Zacharopoulos Dr MA Smyth	SolaNetwork	EPSRC	£211,716	2019-2022
Prof V Molkov Noel McCutcheon	H2FC Hub Extension	EPSRC	£94,926.00	2019-2021
Prof WS McGreal Dr J McCord Dr M McCord Miss U McAnulty Prof Alastair Adair	House Prices, Rents and Affordability - additional funds	NIHE	£25,000.00	2019-2020
Dr SK Choi	Development of Emergency Response Training Facilities	Korean National Fire Agency	£330,000.00	2019-2024
Dr SL Brennan Dr DV Makarov Prof V Molkov	HyResponder - European Hydrogen Train the Trainer Programme for Responders	CEC-H2020-FCH	£250,360.00	2020-2022
Prof D Coyle Prof AJ Bjourson Prof V Molkov	Northern Ireland HPC - Kelvin-2	EPSRC	£494,698.00	2020-2023

Prof JAD McLaughlin Mr S Orr, Catalyst Inc Mr S Trotter, Dell Corporation Ltd Prof R Woods, QUB				
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

Portfolio of Research Grants awarded during period 1 August 2020 - 31 July 2021

Unit of Assessment Member	Title of Award	Funding Body	Value	Project Dates
Prof N Hewitt Dr N Shah Dr M Huang Dr I Vorushylo	HP-FITS Heat Pump Fully Integrated with Thermochemical Store	EPSRC End Use Energy Demand Technology Centre	£601,001	2020-2024
Dr N Shah	Travel and Conference Grant	EPSRC via Supergen Energy Storage Network	£1,000	2020-2022
Dr H Ritchie Dr L McElduff	Northern Ireland knowledge exchange for transboundary Marine Spatial Planning across the Irish Sea	DAERA European Maritime and Fisheries Fund	£28,304	2020-2022
Dr L McElduff	Provision of services for report on strategic strengths and future strategic direction study for Buncrana, County Donegal. A socio-economic and geo-spatial study	Donegal County Council	£2,746	2019-2020
Dr TJ Hyde Mr D Murray, Geda Construction Ltd Mr M Gribbon, Setanta Construction Ltd Mr G Quinn, GP Develoments (NI) LLP Mr P McAlister, McAlister Architects Ltd Mr E McGoldrick, The Electric Storage Co Mr T O'Leary, MosArt Ltd	SoLow Solar Energy Storage in combination with innovative Low-Energy Dwellings	Interreg InterTrade Ireland Co-Innovate	£53,569	2020-2022
Prof A Nadjai Dr S Tretsiakova-McNally	KTP Programme between University of Ulster and FP McCann Limited	Innovate UK/INI and FP McCann Limited	£188,208	2020-2022
Dr J Mondol Dr A Zacharopoulos Dr MA Smyth	COVID-19 Grant Extension Allocation University of Ulster reference cc 92256R	EPSRC	£36,877	2021-2021

Prof V Molkov Dr DV Makarov Dr V Shentsov Mr M Franzoni, Omb Saleri Spa Dr G Mair, Bundesanstalt Fuer Materialfo Mr A Seifert, OPTIMUM CPV	SH2APED Storage of hydrogen: alternative pressure enclosure development	CEC-H2020-JTI-FCH- 2020-1	£367,778	2021-2023
Mr S Golden Prof G Leavey Mr G Rafferty	BelfastTHRIVES - Transformative Health and Regeneration Initiatives for Vibrancy, Equality and Sustainability	Belfast City Council	£30,000	2020-2021
Prof N Hewitt Mr M Morrow	FASTER (Facilitating A Sustainable Transition to EVs in the Regions)	INTERREG IVA	£1,187,129	2021-2023
Dr SK Choi	Fire Safety Evaluation technology and infrastructure development project for high energy lithium rechargeable batteries.	Korea Testing Certification	£52,678	2020-2022
Dr C Brandoni Prof Y Huang Prof N Hewitt Prof K Zhang, North China Electric Power	Economic and environmental analysis of cleaner fuel/hydrogen production from biowaste with a focus on digestate and sewage sludge	The Royal Society - Int Exchange Scheme	£11,960	2021-2023
Raffaella Folli Dr J Mondol Prof A Houlihan Wiberg	Architects of Change	Belfast City Council	£24,000	2021-2022
Dr MA Smyth Dr A Zacharopoulos Dr J Mondol Dr A Pugsley	SwanaSmartStore	EPSRC IUK Energy Catalyst	£3,210	2021-2021
Dr WDH Woodward Dr P Millar	A probabilistic framework for improved roads management	NDP - National Roads Authority	£29,704	2015-2021

Dr K Crinion Dr J Henderson, University of Edinburgh	Embracing Social Learning in the Management of Ecosystem Services in Chonquene District, Gaza Province	UKRI AHRC Rising from the Depths Call 3	£2,638	2020-2020
Prof N Hewitt	Collaborative Research Support Fund - Theme Leader Energy (NICP) 2021	Department for the Economy	£68,614	2021-2021
Prof N Hewitt Dr P Keatley	DDCGE - Decarbonisation of Data Centres with Geothermal Energy	Invest NI via Case	£206,841	2021-2023

