

Belfast School of Architecture and the Built Environment

Research & Innovation Annual Report
01 August 2022 – 31 July 2023



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1 Foreword



1. Foreword:
Research Director
Prof Jayanta Mondol

In presenting the Annual Report for the Architecture, Built Environment, and Planning for the academic year 2022-2023, I am delighted to share the success achieved across various areas of activity. The year has marked significant accomplishments in terms of grant income, research outputs, active participation in collaborative projects, the establishment of research networks at both local and international levels, and extensive engagement with broader communities through outreach activities. This foreword offers a brief overview of the activities undertaken by our research centres within the unit. The main sections of the report delve into the specifics of PhD projects and the accomplishments of graduating PhD candidates. It also highlights research publications, and newly secured research grants, and provides insights into a selection of ongoing and impactful research projects.

The **Centre for Sustainable Technologies (CST)** remains dedicated to pioneering innovative solutions in energy-related projects, addressing a diverse range of challenges. Notably, efforts are underway to facilitate the integration of new participants in the energy market in Northern Ireland, leveraging the region's substantial potential for wind-derived electricity production. The centre is actively involved in projects focused on advancing the next generation of energy systems on an all-Ireland scale. CST's commitment extends to the development of advanced building projects, featuring initiatives such as Switchable Insulation Panels and Passive Houses equipped with Integrated Zero Emission Climate Control Systems. These activities run in parallel with ongoing projects dedicated to the decarbonisation of industrial heating and space heating. The overarching support for these initiatives comes from the Collaborative Research Support Fund - Theme Leader Energy (NICP), hosted at Ulster University, providing a solid foundation for the centre's impactful contributions to sustainable technologies in the energy sector.

The **Hydrogen Safety Engineering and Research (HySAFER)** stands as a prominent global contributor to hydrogen safety research and education. The completion of the H2020 project, HyResponder, coordinated by Ulster University in May 2023, marked a significant milestone. The EU project ELVHYS commenced on January 1, 2023 focusing on liquid hydrogen safety. Looking ahead, two new HORIZON EUROPE projects will commence in January 2024. One project is dedicated to researching the inherently safer transfer of liquid hydrogen at high rates in various environments, while the other aims to establish the European Hydrogen Academy, focusing on the development of teaching materials for higher education. HySAFER remains at the forefront of advancing hydrogen safety research and education in the UK through active participation in EPSRC projects. HySAFER is a key contributor to the UK Clean Maritime Research Hub, where it has taken on the mantle of advancing research previously initiated by HySAFER. This includes investigations into ammonia safety, the maritime application of hydrogen, and the development of the IGF Code, building upon the groundwork laid by projects such as CMDC1, CMDC2, and HYLANTIC. The centre is still actively engaged in

the EPSRC Centre for Doctoral Training in Sustainable Hydrogen. This commitment underscores Ulster's dedication to nurturing expertise and fostering innovation in the field of sustainable hydrogen.

HySAFER has embarked on a new trajectory by exploring the integration of hydrogen blending into gas networks. This expansion is accompanied by a concerted effort to address knowledge gaps within this domain. The Invest NI CASE project titled "Safety of Hydrogen Blends in the Northern Irish Gas Network (Phase I)" is currently underway with the support of three gas providers in Northern Ireland. This initiative underscores Ulster's commitment to staying at the forefront of hydrogen safety research and actively contributing to the safe and sustainable integration of hydrogen into diverse energy supply networks.

The safety technology featuring explosion-free characteristics in a fire composite tank for hydrogen storage has undergone successful testing under extreme scenarios. This ground-breaking technology is currently under examination through the H2020 project SH2APED, which focuses on conformable storage tanks. Additionally, it is being investigated in the Invest NI CASE project, aimed at enhancing tank manufacturing capabilities in Northern Ireland.

Dr. Donatella Cirrone, a Research Associate at HySAFER, received the Hydrogen Europe Research Young Scientist Award in 2022. This prestigious award serves as a testament to the high international standing and recognition achieved by HySAFER in the field of hydrogen research and safety.

The **Research on Property and Planning (RPP)** research centre has continued to expand its research scope in response to industry needs and policy transition. RPP has been at the forefront of informing the decarbonisation agenda within Northern Ireland with members working with industry stakeholders and policymakers to enhance knowledge and to mobilise green retrofit interventions across the housing and commercial property sectors. RPP staff play a pivotal role within the Belfast City Council Retrofit HUB Initiative facilitating and contributing to a series of roundtable events and seminars centred on (i) green finance; (ii) upscaling retrofit capacity and (iii) overcoming barriers to the decarbonisation within the commercial property sector.

The EU funded CRREM project ended in 2022 culminating in the production of a series of bespoke decarbonisation pathways for the commercial real estate sector as well as a series of risk assessment and scenario-based tools. Since its cessation as an EU funded project, CRREM has received funding from the Laudes Foundation to facilitate further concept development and decarbonisation pathway development. In March 2023, CRREM entered into a partnership with ULI [Urban Land Institute] and the Lawrence Berkeley National Laboratory [Berkeley Lab] to increase the granularity of the regional US and Canada CRREM pathways.

RPP further enhanced its international reputation in the areas of property taxation via a series of keynote addresses at the International Real Estate Development and Management Conference (ICREDM) in Ankara, Turkey in February 2023, The African Tax Institute (ATI) in June 2023 and at the International Property Tax Institute (IPTI) in December 2023. Ongoing interaction with international stakeholders including the Government of Uzbekistan regarding land reform, UNIDO with regards to Municipal Finance in India and UN HABITAT on Land Based Finance in Fragile States has culminated in the authorship of a UN HABITAT publication on the issue. Through membership of the Centre for Appraisal Research & Technology (CART) and in conjunction with the Lincoln Institute of Land Policy, RPP members have contributed to the creation of the Lincoln Institute Vertical Equity App, a mass valuation audit tool. Members of RPP are represented on the International Association of Assessing Officers (IAAO) Leadership Research and Education Committees, receiving IAAO President Citation for efforts in this capacity.

In partnership with the International Centre for Local and Regional Development (ICLRD), University College Dublin, University of Limerick and O’Keeffe Social Research, members of the RPP group sought to elucidate the impacts of pre- and post-COVID commuting on people and place. Taking an island of Ireland perspective, the research examined the interplay between home, community and workplace across seven settlements that experience varying levels of (pre-COVID) out-commuting and considered the implications for planning and place-making. The research serves to highlight that place-based health and well-being outcomes are not well articulated in development and planning policy across the island of Ireland. The widened scope of RPP research and the need for the centre to be responsive to societal evolution and needs is perhaps best encapsulated by the CHOICE (Challenging Health Outcomes/Integrating Care Environments) project. The AHRC funded project has seen RPP members with local and international stakeholders to tackle the issues of social exclusion and poor physical health among people living with severe and enduring mental health problems.

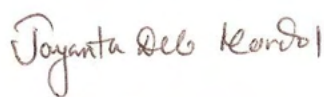
Within **Fire Safety Engineering Research and Technology (FireSERT) Research Centre**, notable progress has been made across the four core areas of research activity: fire dynamics and materials, structural fire engineering, fire protection, numerical modelling, and human behaviour in fire. Several live projects during this period include the development of façade assessment and hazard identification for high-rise buildings in collaboration with the NIHE/MHCLG. Another project focuses on novel processing technology to address challenging-to-recycle plastic food waste packaging from the Ecosurety Exploration Fund. FireSERT is engaged in a project for low-cost alternative water treatment for the removal of pharmaceuticals in domestic wastewater in Lagos, Nigeria, supported by an International Exchange Grant.

Key initiatives supported by the Korean National Fire Agency involve the development of emergency response training facilities and the creation of an optimum firefighting strategy for battery electric cars. A project funded by the Royal Society aims to improve the fire resistance of styrene-based polymers through P-N synergism of reactive fire retardants. The strategic partnership between FireSERT and the British Board of Agrément (BBA) will facilitate crucial connections with industry leaders. This collaboration is anticipated to bring additional resources to both partners, fostering collaborations, efficiencies, and resource optimisation. Collaboration extends globally, with FireSERT researchers working alongside the Ghana National Fire Service (GNFS) to access fire data. This collaboration will lead to the development of a community fire safety campaign and strategy based on the collected data. Plans are underway to engage with the Ministry of Education in Ghana to explore the integration of fire safety education into the school curriculum.

The Highways England and Transport Infrastructure Ireland road authorities-funded project on highway skid resistance is approaching its conclusion. This collaborative initiative involves Nottingham, UCD, Trinity, and Cork universities, as well as AECOM and Pavement Testing Services. The research findings from the project were shared at international conferences, specifically at the Pavement Functional Design and Management Conference in Portugal and Hawaii. SABER researchers were involved in conducting large-scale on-site trials, including the resurfacing of Donnington in November 2022 and Knockhill in May 2023 racing circuits. These trials were executed in partnership with R3 Ltd, Aggregate Industries, and Driven Circuit Design, showcasing a collaborative effort in advancing skid resistance research and application.

Within our school, the Post Graduate Researchers play a pivotal role in driving research innovation. In the course of this reporting period, a total of 58 students were enrolled in PhD studies, either on a part-time or full-time basis, with 14 completing their degree.

Further details of our research activities, research facilities, staff profiles and research expertise can be found at <https://www.ulster.ac.uk/research/topic/built-environment> or by contacting Ms Marcella McCann (Academic Excellence Executive Assistant) at Email: m.mccann1@ulster.ac.uk; Ph: +44 28 9536 7356



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

Unit of Assessment 13. Architecture, Built Environment and Planning

REF2021 Research Excellence Framework

13. Architecture, Built Environment and Planning ([ulster.ac.uk](https://www.ulster.ac.uk))



“We provide exceptional research facilities and support to facilitate research of world-leading and internationally excellent quality and enabling outstanding impact.” Jayanta Mondol
Research Director

2 Research Students

Name	Project Title
Abdulai, Yahaya	Fire Safety for Vulnerable Groups (FSVG)
Affoh, Peter	Fire Defence/Factors contributing to rate of death and loss of properties in high rise buildings fire outbreak in UK
Alkadi, Sanaa	An Investigation of the Adaptation of the Southern Syrian Vernacular Dwelling
Amponsah, Richmond	An investigation of risk perception and behaviour in communicable disease control
Baby, Aloshy	Synergistic Effect of Phosphorus and Nitrogen Containing Groups in Fire Retardancy of Polystyrene
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
Carlin, Kieran	Urban universities as catalysts for public-private regeneration strategies to benefit more liveable and healthy inner-city communities
Cassidy, Peter	Design and evaluation of community fire safety educational programmes
Chang, Roma	Multifunctional Building Integrated Solar Technologies
Collen, Peter	Further investigation of surface dressing failures through 2D and 3D modelling
Cooke, Helen	Spatial planning on the island of Ireland: developing the Dublin-Belfast Economic Corridor (DBEC) concept
Davidson, Sean-Luc	What's happening in your marine backyard? The role of Marine Spatial Planning in Marine Renewables on the island of Ireland
Donkoh, Emmanuel	Development of A Sustainable Preconstruction Performance Management Model for Traditional Lump Sum And PPP-DBFOM Transport and Health Infrastructure Projects Stakeholders
Ebne Abbasi, Hazhir	CFD model of fuelling through the entire equipment of a hydrogen refuelling station
Gawale, Atish	Safety strategies and engineering solutions for hydrogen heavy-duty vehicles
Ghoraishi, Mohammad	Advanced Multifunctional Energy Efficient Building Facades
Gibson, Zoe	SuperStudio Pedagogy: Innovation through a Responsive Studio Learning Ecology
Hasnain, Syed Ali	Experimental and Numerical Investigation of Fire in Li Ion Battery Energy Storage System
Hermans, Lucas	Model-to-Model Validation: an Extended Framework for Quality Assessment and Comparison of Automated Valuation Models for Residential Real Estate
James, Ben	Climate Resilient, Net and Autonomous Zero Emission Buildings and Communities (NZEB) – Definitions and Prototypes for the UK/Northern
Johnston, Ryan	Visualisation and Immersive technology to improve stakeholder participation in net Zero Emission Buildings and Neighbourhoods (ZEN) in Smart Cities
Kazemi, Mina	Stability of hydrogen flames

Kearney, Matthew	Rationalising Institutional Change: An investigation into the governance of Developer Contributions in Northern Irish Planning
Kennedy, Robert	Legibility in Urban Design and Conservation Area Practice
Kishel, Katlin	Influence of racetrack surface attributes on braking patterns, overall racing performance
Liang, Hongyuan	The Development of a Strategic Performance Measurement Framework for Assessing Xiongan New Area in China
Lynch, Frances	Healthy place-making and youth wellbeing: Role of neighbourhood heritage
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
Mackel, Aedan	Architecture, Planning and Desegregation: An evaluation of current practice
Magennis, Lawrence	Saving Earth from Humans: Earth-focussed Sustainable Development
McGuinness, Siobhan	Co-Designing Child Friendly Places: Growing the Resilience of Children through Inclusive Planning
Oakes, Luke	The development of high performance, fibre reinforced geopolymer cladding systems with integral foamed insulation
Obasi, Gerard	Advanced Heat Pumps and Power Cycles
Park, Woojung	Prevention and mitigation of incidents involving hydrogen use in a domestic setting
Parke, Daniel	Renewable Energy and Storage for Outdoor Events Sector (RESOES)
Quigley, Mura	Enabling a resilient future: exploring the leadership and governance of urban design
Ramirez, Miguel	Design & development of a High Temperature Heat Pump (HTHP) for industrial applications.
Robinson, Amy	The Impact of policy and the application of regulatory controls on the achievement of overarching sustainability goals.
Rolfe, Angela	Advanced simulation and modelling to ensure technoeconomic and environmental sustainability of new process development
Shahzadi, Iram	Energy system model for Northern Ireland
Sheldon, Lisa	An investigation of flood risk awareness, flood interventions and flood communication for residents living in Areas of Potential Significant Flood Risk in Northern Ireland
Sivaraman, Srinivas	Safety of Using Ammonia in for the Hydrogen Economy
Son, Kwangho	Development of Emergency Response Training Facilities for Alternative Vehicles under Fire
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	Investigation into the microscopic characteristics of pedestrian movement in congested space
Umer, Muhammad	Biohydrogen from waste through biomass electrolysis: challenges and opportunities
Velanparambil Ravindran, Rahul	Reversible Heat Pump/Organic Rankine Cycle
Wilson, Bailie	Energy positive Multifunctional Building Facades Incorporating Energy Storage for nearly Zero Energy Building standards
Zehra, Bintul	3D printed cementitious architectures to deliver sustainable infrastructure assets with enhanced structural and durability resilience

Graduated December 2022

Name	Thesis Title
Ademulegun, Oluwasola	Locational Net Benefit Analysis (LNBA) for mass energy storage
Charlier, Marion	Advanced modelling of travelling fire for structural design: Experimental, numerical and analytical investigations

Graduated July 2023

Name	Thesis Title
Abid, Mohammad	Variable speed heat pump compressor for demand side management and network stability
Alnaseem, Nijood	Private equity infrastructure investment in emerging infrastructure markets
Ansong, Joseph	Pathways towards integrated cross-border marine spatial planning
Bani Mostafa, Motasem	Battery energy storage systems in hospitals for flexibility, resilience and arbitrage
Bhutta, Rumeel	Thermal protective performance of turnout gear at high heat flux intensity
Coyles, David	Cartographies of conflict: Belfast's hidden architectures of territory and division
De Priall, Oisin	Performance study and validation of the downdraft biomass gasification process for combined heat & power plants from under-utilised biomass and bio-waste
Islam, A K M Khabirul	Evaluation of cost effective and recycled anode materials in microbial electrolysis cells for hydrogen production from wastewater
Jankowiak, Corentin	Optimal integrated energy storage solutions for the electrification of heat and transport at a domestic level
Nakkasunchi, Shalini	Water-energy nexus of the wastewater treatment plants
Ratajczak, Leonia	The smart city: Spatial planning, partnership, governance
Sanders, Peter David	The characterisation of road surface friction as a factor in vehicle safety

3 Publications

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.

<https://pure.ulster.ac.uk/>.

3.1 Journal Articles

Ademulegun, O, MacArtain, P, Oni, B & Hewitt, N 2022, 'Multi-Stage Multi-Criteria Decision Analysis for Siting Electric Vehicle Charging Stations within and across Border Regions', *Energies*, vol. 15, no. 24, 9396, pp. 1-28.

<https://doi.org/10.3390/en15249396>

Ansong, JO, Ritchie, H, Gee, K, McElduff, L & Zaucha, J 2022, 'Pathways towards integrated cross-border marine spatial planning (MSP): insights from Germany, Poland and the island of Ireland', *European Planning Studies*, vol. 31, no. 12, pp. 2446-2469.

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Cirrone, D, Makarov, D & Molkov, V 2023, 'Rethinking "BLEVE explosion" after liquid hydrogen storage tank rupture in a fire', *International Journal of Hydrogen Energy*, vol. 48, no. 23, pp. 8716-8730.

<https://doi.org/10.1016/j.ijhydene.2022.09.114>

Cirrone, D, Makarov, D, Friedrich, A, Grune, J, Takeno, K & Molkov, V 2022, 'Blast Wave Generated by Delayed Ignition of Under-Expanded Hydrogen Free Jet at Ambient and Cryogenic Temperatures', *Hydrogen*, vol. 3, no. 4, pp. 433-449.

<https://doi.org/10.3390/hydrogen3040027>

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<https://doi.org/10.4236/eng.2022.1412046>
- De Priall, O, Brandoni, C, Gogulancea, V, Jaffar, M, Hewitt, N, zhang, K & Huang, Y 2022, 'Gasification of Biowaste Based on Validated Computational Simulations: A Circular Economy Model to Handle Poultry Litter Waste', *Waste and Biomass Valorization*, vol. 13, no. 9, pp. 3899-3911.
<https://doi.org/10.1007/s12649-022-01815-9>
- Delmond, B, Tretsiakova-McNally, S, Solan, B, McDermott, R & Audoin, A 2023, 'A Sustainable Method to Reduce Vancomycin Concentrations in Water using Timber Waste', *Water, Air, & Soil Pollution*, vol. 234, no. 2, 81, pp. 1-17.
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storage tank', *International Journal of Hydrogen Energy*.

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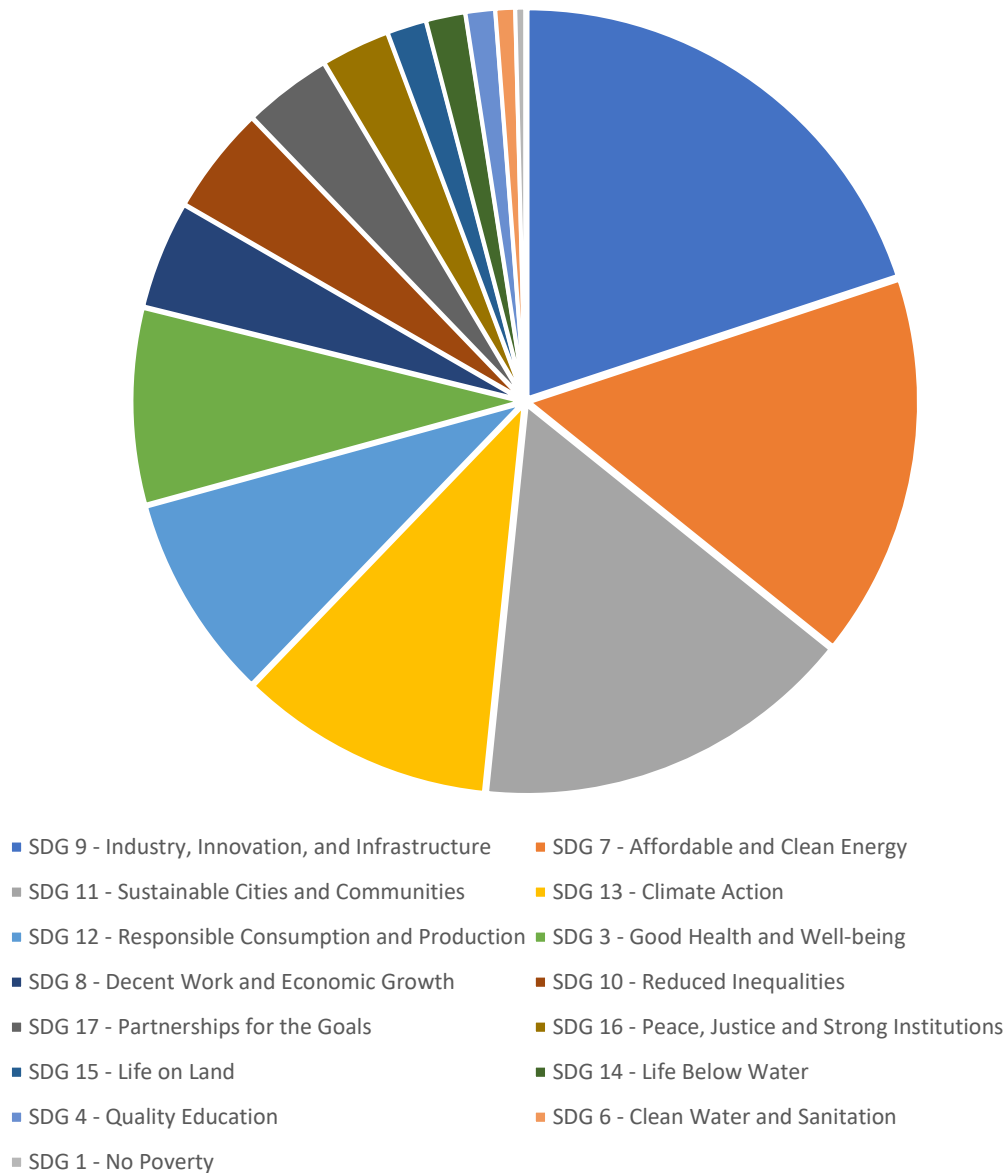
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Universities and knowledge institutions globally have a critical role to play in the achievement of the [United Nations Sustainable Development Goals \(SDGs\)](#)

Here is a breakdown of the research outputs and their SDG's.



4 Research Funding

Portfolio of Research Grants awarded during period 1 August 2022 - 31 July 2023

Unit of Assessment Member	Title of Award	Funding Body	Value	Date
Prof Grainne McKeever Dr John McCord	Understanding and supporting legal participation for litigants in person: Survey of the impact of Covid-19 on the family courts in N.I.	The Nuffield Foundation	£72,402.66	01/08/22
Dr Gavan Rafferty	Planning, Place-Making and the Changing Spatial Relationships between Home and Workplace	ICLRD International Centre for Local and Regional Development	£25,587.69	23/09/22
Dr Patrick Keatley	New Energy Market Participants in NI	DfE NI Department for the Economy	£134,032.09	08/11/22
Prof Ali Nadjai Dr Svetlana Tretsiakova	Roof Material Investigations and its Performance in Fire Conditions	SPAR SPAR - Trench Road	£1,812.10	14/11/22
Dr Mervyn Smyth Dr Adrian Pugsley Dr Aggelos Zacharopoulos Prof Jayanta Mondol	Switchable Insulation Panels - Market Discovery	Innovate UK	£29,253.16	12/12/22
Dr Aggelos Zacharopoulos Dr Mervyn Smyth Prof Jayanta Mondol Dr Nikhilkumar Shah Dr Trevor Hyde	Passive House With Integrated Zero Emission Climate Control Systems (Resubmission)	DfE NI Department for the Economy	£249,856.00	19/12/22
Prof Neil Hewitt	Collaborative Research Support Fund - Theme Leader Energy (NICP) 2022	Department for the Economy	£72,828.00	01/01/23

Prof Neil Hewitt	Next Generation Energy Systems	SFI Science Foundation Ireland	£111,660.43	06/01/23
Dr Volodymyr Shentsov Dr Dmitriy Makarov Sile Brennan	Development and validation of a new magnetocaloric high-performance hydrogen liquefier prototype	HE-IFS Horizon Europe – Innovate UK Guarantee via IFS	£277,615.00	07/02/23
Prof Vladimir Molkov Dr Dmitriy Makarov Donatella Cirrone	ELVHYS	H2020 European Commission	£150,634.00	07/02/23
Dr Sergii Kashkarov Prof Vladimir Molkov Dr Dmitriy Makarov	CMDC2 - Hydrogen Fuel Cell Range Extending eFoil System	Innovate UK	£278,234.00	10/02/23

Note from the Associate Dean

It is my pleasure to endorse the Research & Innovation Annual Report from the Belfast School of Architecture & the Built Environment (BSABE) for the 2022-23 Academic Year. The report provides a concise account of the core research activities undertaken and the outputs achieved in the period.

The research and innovation activities reported here build on the excellent outcomes that colleagues in the School achieved in the 2021 Research Excellence Framework (REF 2021) and contribute to our ambition for an even better performance in the next REF exercise.

The achievements reported here are fully aligned with the Ulster University Strategy, People, Place & Partnerships: Delivering Sustainable Futures for All ([Strategy - People, Place and Partnership \(ulster.ac.uk\)](https://www.ulster.ac.uk/strategy)) and the Ulster University Research Strategy 2023-28 ([Ulster University Research Strategy 2023-2028](https://www.ulster.ac.uk/research-strategy)). As such, they contribute significantly to the Faculty of Computing, Engineering & the Built Environment Operational Plan in respect to the delivery of our collective goal of research excellence, inclusion, and impact.

Professor Brian J. Meenan
Associate Dean, Research & Innovation
Faculty of Computing, Engineering & the Built Environment

Research Centres and Groups

[Centre for Sustainable Technologies \(CST\)](#)

[Research on Property and Planning \(RPP\)](#)

[Fire Safety Engineering Research and Technology Centre \(FireSERT\)](#)

[Hydrogen Safety Engineering and Research \(HySAFER\)](#)

[Studies Allied to Built Environment Research \(SABER\)](#)

[Architecture Research Group \(ARG\)](#)

