Project Call for 2022 ERBE Cohort

MaREI Supervisor	Dr. Hannah Daly
Institution	MaREI/ERI/UCC
Co-Supervisor & Institution (if known – please note this is not a requirement at application stage):	Not currently known
PhD Proposal Title:	The built environment in a net-zero emissions energy system: Modelling integrated approaches to decarbonising the embodied energy and emissions of buildings and infrastructure in the context of constrained carbon budgets
Alignment with ERBE Themes: (200 words max – please specify if the project aligns with 1 or more of the ERBE Themes)	The project aligns with the Technology and System Performance Project Area. By examining the embodied energy and carbon within buildings, infrastructure and the wider built environment, this project will demonstrate how both demand and supply options can enable that the built environment contributes to the low-carbon energy transition, consistent with Ireland's very ambitious carbon budgets and net-zero emissions target.

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PhD Proposal Abstract: (500 words max)	The direct energy demand and carbon footprint of the built environment – for example through heating buildings and driving cars – are well covered both in energy modelling and policy. This project will focus on modelling pathways for reducing the embodied (or embedded) energy and carbon emissions of the built environment. This will examine the indirect impacts of the construction and maintenance of both buildings and infrastructure, including the transport and energy systems. The main aim is to provide policy insights on the role of decarbonising the built environment in the context of deep and ambitious decarboniation pathways consistent with the Paris Agreement climate goals, while at the same time meeting society's needs for housing, energy and services. For examine, buildings, roads and energy infrastructure require different materials, which are mined, manufactured and transported. Decarbonising these sources of CO_2 in the carbon footprint of the built environment can be achieved through many different mitigation options: Switching from cement to low-carbon materials, like timber where possible; using alternative fuels for heat in the manufacture of cement; using carbon capture and storage (CCS) to capture the CO_2 from cement manufacture; creating buildings with a lower material footprint; compact urban and town development; recycling products. Each of these options have consequences for emissions in different sectors and fall under the remit of different agents. This is why the integrated energy systems modelling – the approach which this research will take – is important and valuable for understanding cost-effective mitigation measures in the context of very constrained carbon budgets. This research will develop energy- and emissions- intensities for elements of the built environment, distinguishing between domestic intensities (those accounted for within national greenhouse gas inventories) and international emissions, as accounted for in consumptions-based accounts, imported through materials. In this way, the research will inform the carbon budget associated with the built environment in the future under different scenarios, and also quantify the potential global impact on emissions from domestic policy.

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	Overview:
	• Quantify energy and GHGs (within energy balances and GHG inventories) of the built environment (buildings, energy system & transport infrastructure).
	  ○ Using lifecycle analysis (LCA) databases and construction activity data, build a bottom-up model of the materials and energy inputs to Ireland's built environment and infrastructure. Distinguish between domestic inputs and imported materials, quantify the domestic and international carbon footprint.
	  ○ Create a new sector within the TIMES Energy System Model (TIM) which captures the embodied energy and carbon of the built environment, and reallocate activities within the model's industry and transport sectors to the built environment through emission factors developed in previous steps
	• Mapping demand and supply options for decarbonising the embedded carbon in the built environment, example the potential for:
	  ○ Demand options: Compact development – implications for buildings and for transport system (roads, public transport)
	  ○ Supply options: Circular economy & recycling materials, decarbonising cement (e.g., CCS; alternative fuels for high-temperature heat); materials substitution (e.g., forestry)
	• Examine implications for climate policy in the context of constrained carbon budgets and a net-zero emissions energy system by 2050.

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PhD Proposal Summary for inclusion in Student Call Document: (300 words max – please note the student will be indicating their order of preference for all submitted proposals; please ensure this summary includes a project overview & introduction to the supervisor & institution)	The carbon footprint of the built environment is substantial and complex, and pathways for reducing its climate impact is under-studied. The embodied emissions of buildings and the transport and energy systems as a result of their construction and maintenance must be reduced in line with stringent carbon budgets and climate mitigation goals. Options span a range of technology, structural and demand measures, which have interactions with the development and mitigation pathways for other sectors. For example, building a zero-carbon electricity grid, along with the necessary infrastructure to decarbonise passenger transport and buildings, may require an increase in energy- and carbon-intensive materials such as cement, some of which may be imported. Options for decarbonising the footprint of buildings includes using alternative materials like timber (with consequences for land use) or cement with carbon capture and storage (with consequences for industry). The footprint of both transport and buildings may become lighter with denser and more compact urban development, or grow with urban sprawl. This proposed PhD will address these questions, examining the challenge of decarbonisation of the built environment from an energy systems perspective with the TIMES-Ireland Model. The PhD researcher will work with a dynamic, diverse and solutions-focussed research group led by **Dr Hannah Daly**, who is a lecturer in energy systems modelling in UCC. As a member of the Climate Change Advisory Council's Carbon Budgets Committee, and media commentator, Daly regularly communicates climate action research insights to policy and society. Based at **the Environmental Research Institute (ERI) and MaREI**, these centres have national and international recognition for climate action-oriented research and expertise, combining the expertise of a wide range of research groups and industry partners and with the shared mission of solving the main scientific, technical and socio-economic challenges across the climate, energy and marine spaces.