Project Call for 2022 ERBE Cohort

MaREI Supervisor	Dr Paul D O'Sullivan
Institution	Munster Technological University
Co-Supervisor & Institution (if known – please note this is not a requirement at application stage):	UCL or Loughborough University. (TBD)
PhD Proposal Title:	Resilient Passive Cooling Strategies for Nearly Zero Energy Buildings
Alignment with ERBE Themes: (200 words max – please specify if the project aligns with 1 or more of the ERBE Themes)	The project addresses aspects under all three of the ERBE themes; Flexibility & Resilience, Technology & System Performance and Comfort, Health & Well-being. *Flexibility & Resilience*: The project will evaluate the indoor thermal resilience of passively cooled nearly zero energy buildings. A recent literature survey has shown that little empirical evidence exists on the climate/thermal resilience of these indoor spaces the there is a significant risk of vulnerability "lock-in" under current design practices and building regulations guidance. *Technology & Systems Performance*: The performance of complimentary building cooling strategies under extreme warming events will be evaluated with solutions to increase recoverability in the event of system failure. *Health & Well-being*: At the core of this research is ensuring the health, safety and well-being of vulnerable building occupants in highly urbanised neighbourhoods in a warmer world. This project is a risk mitigation plan in the event of global heating beyond current predicted levels.

PhD Proposal Abstract: (500 words max)	The quality of future living circumstances for many will be contingent on how nearly zero energy indoor spaces in large scale, highly urbanised neighbourhoods, respond to the threat from increasing population density and accelerated ambient warming. Super insulated and airtight nearly zero energy indoor spaces that are occupied by vulnerable populations are particularly at high risk to thermal shock from both short term and long-term ambient heating events given their inability to continually dissipate heat build-up through the structure. Inadequate evaluation of the thermal resilience of a buildings design can also lead to significant vulnerability "lock-in" for the operational lifetime of the building. This is a major challenge for designers of passively cooled buildings; to ensure the cooling strategy is sufficiently resilient to climate change (i.e. it's vulnerability); ensuring the performance of the passive cooling system in the building allows it to withstand indoor comfort disturbances due to overheating (i.e. It's resistance potential); adopt the appropriate strategies in the event of failure (i.e. it's robustness) to mitigate further degradation of indoor thermal comfort; and identify the extent of the increased need for space cooling energy to ensure recoverability from thermal shocks. Through a combination of numerical simulation and lab-based studies, this PhD project will focus specifically on evaluating passive cooling strategies for low energy buildings and develop novel approaches that ensure the buildings of the future are resilient to the consequences of climate change and urban densification. The research will look at establishing a hierarchy of passive cooling approaches with increasing levels of resilience, at what trade off these approaches come at (i.e. mechanical cooling and demand response constraints on electricity grids including sensitivity to power outages), and at what boundaries they operate at, see Figure 1 below. This will have practical implications for designers and policy makers as well as building operators.

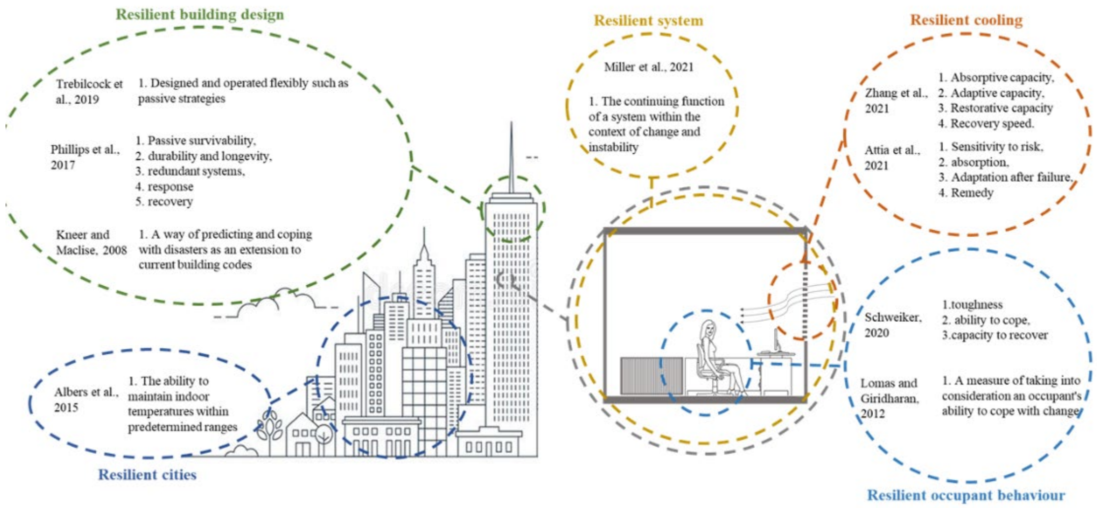

Figure 1: Resilient cooling definitions at varying thermal boundaries (overview developed by MeSSO Research Group)

The project can also include an early design stage methodology based on simplified, reduced order modelling to evaluate a holistic building level resilience strategy at design stage, providing recommendations to designers. The strategy could consider at first low capacity air based solutions, and then move towards evaporative and supplementary systems; include resilient solutions such as ventilation technologies, temporary climate shelters and the role remote working flexibility can play in resilient cooling of workspaces, redefining the thermal boundary for work-life roles. The research

	will be undertaken under the supervision of Dr Paul D O'Sullivan and his team at MeSSO Research in MTU. The group has a proven international track record in ventilation, cooling, and thermal comfort performance of low energy spaces. The National Energy Retrofit Testbed (NBERT) will be used for proof of concept of developed solutions. The group is also currently undertaking Project RESILIENCE for the Irish Govt and this project will offer a rich, textured data source for over 40 low energy buildings to utilise in demonstrating the real world performance of resilient cooling strategies. https://www.seai.ie/data-and-insights/seai-research/research-database/research-projects/details/project-resilience. The successful candidate will work with leading experts and high performing students in a culturally diverse and exciting research environment with many opportunities to develop a strong career network with international experts in the field of building energy research.

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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)	Climate Change is a planetary scale threat to the sustainability of civilisation as we know it. In an increasingly warmer world cooling will be the dominant challenge for the buildings we live and work in. The quality of future living circumstances for many will be contingent on how nearly zero energy indoor spaces in large scale, highly urbanised neighbourhoods, respond to the threat from increasing population density and accelerated ambient warming. Super insulated and airtight nearly zero energy indoor spaces that are occupied by vulnerable populations are particularly at high risk to thermal shock from both short term and long-term ambient heating events given their inability to continually dissipate heat build-up through the structure. Inadequate evaluation of the thermal resilience of a buildings design can also lead to significant vulnerability "lock-in" for the operational lifetime of the building. This is a major challenge for designers of passively cooled buildings; to ensure the cooling strategy is sufficiently resilient to climate change (i.e. it's vulnerability); ensuring the performance of the passive cooling system in the building allows it to withstand indoor comfort disturbances due to overheating (i.e. It's resistance potential); adopt the appropriate strategies in the event of failure (i.e. it's robustness) to mitigate further degradation of indoor thermal comfort; and identify the extent of the increased need for space cooling energy to ensure recoverability from thermal shocks. Through a combination of numerical simulation and lab-based studies, this PhD project will focus specifically on evaluating passive cooling strategies for low energy buildings and develop novel approaches that ensure the buildings of the future are resilient to the consequences of climate change and urban densification. The research could include resilient solutions such as ventilation technologies, temporary climate shelters and the role remote working flexibility can play in resilient cooling of workspaces. The research will be undertaken under the supervision of Dr Paul D O'Sullivan and his team at MeSSO Research in MTU, Cork, Ireland. The group has a proven international track record in ventilation, cooling, and thermal comfort performance of low energy spaces.