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Graduate Positions – Centre for Advanced Building Envelope Research

The Centre for Advanced Building Envelope Research (CABER) is a new research facility and program focused on the advancement of residential and commercial building envelope materials and designs. Energy use in residential and commercial buildings accounts for 27% of Canada's secondary energy consumption and 22% of greenhouse gas (GHG) emissions. Nearly two-thirds of this energy is used for space heating, which is predominantly caused by heat transfer through the building envelope (including air infiltration, and conduction through ceilings, walls, windows and doors). As such, the building envelope has a significantly impact on the energy use, utility costs and GHG emissions. CABER will develop new technologies that can improve insulation and air-sealing in new construction and in retrofit applications. Drawing upon advances in super-thin insulation materials, prefabricated construction and panelized retrofits, CABER researchers will seek technical innovations that cut heat loss in housing and buildings by 65% or more, and reduce the cost associated with Net-Zero Ready and Deep Energy Retrofit construction.

Dr. Cruickshank is currently seeking candidates who have successfully completed an undergraduate or Master's degree in Engineering with a background in thermodynamics, heat and mass transfer, building modelling, building physics and/or experimental methods. Candidates should have a research interest in building energy systems, building energy efficiency, and construction methods. Projects will involve a mix of experimental and modelling work, so any experience in instrumentation, data acquisition and the use of energy modelling software will be considered an asset but not required. Candidates are currently sought for the following projects:

All Projects are for degrees beginning in January, May or September 2023

M.A.Sc. Projects

1. Development of Laboratory Testing Methodologies for Retrofit Projects

****This project will partially take place at CABER's off-campus location. The successful candidate must be able to commute as needed to this lab to complete their studies. Due to security requirements, you must be a Canadian Citizen and able to obtain a Government of Canada Security Clearance upon acceptance to work on this project ****

As Canada stives to meet its emission targets, including net-zero by 2050, it is imperative that Canada not only builds better new buildings, but starts to undertake deep-energy retrofits of its existing and ageing building stock. The retrofit of buildings poses a number of technical and building science challenges associated with adding additional insulation and reducing air changes within the existing buildings, including moisture build-up, leaks, and the potential for mould and rot formation. As such, before these retrofits can be implemented, extensive testing and modelling is required. Currently, no standard test methodology exists to evaluate retrofit solutions within laboratory settings. As such, Dr. Cruickshank is looking to recruit an M.A.Sc. student who will develop and validate a standard test methodology with which to evaluate all future retrofit projects.

2. Modelling and Optimization of a Zero-Carbon Off-Grid House

In partnership with a homeowner based in North-Western Ontario, the potential for creating a zero-carbon, passive house certified, off-grid home will be explored. To achieve this, a variety of technologies will be explored, such as coupling photovoltaic panels, battery storage, solar thermal panels, heat pumps and thermal storage systems. To complete this project, Dr. Cruickshank is looking to hire an M.A.Sc. student to develop and calibrate a model of the previously built passive house, develop conceptual layouts of three separate solutions using the aforementioned technologies, and create models of the systems within TRNSYS to optimize for zero carbon emission operations. Based on these models, a single solution will be selected, and an economic analysis completed.

3. Integration of Air Based Thermal Storage for Demand Side Management Using Phase Change Materials within Multi-Unit Residential Buildings

As Canada's supply of housing in increasingly constrained, the use of multi-unit residential buildings (MURBs) are becoming more common. These buildings, with many occupants and individual units provide a unique opportunity for demand side management (control of when energy is used during the day), as it will be rare that all units are simultaneously occupied. As such, systems can be incorporated into MURBs that balance energy use across the day, eliminating significant consumption peaks. One potential method is to integrate air-based thermal storage systems using phase change materials, storing energy during low demands, and releasing it during high demand. To complete this project, Dr. Cruickshank is looking to recruit a M.A.Sc. student to complete a modelling study to determine the potential impact of these strategies within various sized MURBs and upon optimizing the design, the strategy will be experimentally evaluated in an existing set up in Dr. Cruickshank's lab. This work will be complemented with a policy scan and surveys/ interviews/focus group sessions with relevant actors. This project will be co-supervised with Dr. Alex Mallett from the School of Public Policy and Administration as part of the Hybrid Thermal Electric Microgrid (HyTEM) CREATE Program led by Simon Fraser University.

4. Development of Pre-Fabricated Wall Panels Using Super Insulating Materials for Northern Applications

****This project will partially take place at CABER's off-campus location. The successful candidate must be able to commute as needed to this lab to complete their studies. Due to security requirements, you must be a Canadian Citizen and able to obtain a Government of Canada Security Clearance upon acceptance to work on this project ****

Many challenges exist with construction of residential buildings in the North, including a lack of skilled trades, short construction season and high shipping costs for materials. As such, a panelized approached using super insulating materials could address these concerns. Dr. Cruickshank is currently looking for an M.A.Sc. student to work with industry and government partners to develop highly insulated building panels incorporating super-insulating materials to be used in new and retrofit of single and multi-family residential buildings in the arctic. The use of super-insulating materials would significantly reduce the volume and weight of panels required for constructing homes, leading to lower shipping costs, while providing excellent thermal performance. This increased thermal performance compared to homes in the rest of Canada is required to combat harsh arctic climate and being resilient enough to withstanding the high interior relative humidities typically seen in arctic residences. These panels must be able to be quickly assembled, allowing many homes to be constructed in a short period of time with limited labour requirements. This project involves design development, thermal and hygrothermal modelling, prototyping and experimental evaluation under both steady-state and in-situ conditions.

5. Assessment of Plant-Based Materials for Low-Carbon Latent Thermal Storage within Buildings

****This project will partially take place at CABER's off-campus location. The successful candidate must be able to commute as needed to this lab to complete their studies. Due to security requirements, you must be a Canadian Citizen and able to obtain a Government of Canada Security Clearance upon acceptance to work on this project ****

Latent thermal storage via phase change materials (PCMs) is a compact thermal storage solution that can be used to store midday solar gains and shift the period during which the thermal energy is transferred to the space to evening or overnight periods. To date, most research on PCMs has been on carbon-intensive paraffin-based compounds. However, plant-based oils such as coconut oil, are an emerging PCM option that exhibit similar properties to those of the paraffin PCM counterparts. Despite its benefits, additional knowledge of these plant-based oils are critical to predict the performance within buildings; this includes greater knowledge of melting and solidification rates and performance within buildings. The objective of this project will be to integrate a plant-based oil within the walls of one of the two in situ chambers at CABER, while comparing the thermal performance of the chamber and PCM to the reference in situ chamber. This project will include determination of an encapsulation method for the PCM and corresponding integration strategy for the material into the chamber walls, followed by the full experimental testing of the PCM to illustrate its performance in situ.

Ph.D. or M.A.Sc. Projects

6. Modelling Interior Building Surface Temperatures

****This project will partially take place at CABER's off-campus location. The successful candidate must be able to commute as needed to this lab to complete their studies. Due to security requirements, you must be a Canadian Citizen and able to obtain a Government of Canada Security Clearance upon acceptance to work on this project ****

Current modelling methods assume a single uniform temperature throughout each surface within a space. This causes significant challenges when trying to model and design complex systems, including the integration of thermal storage systems like phase change materials (PCM) and thermal comfort of a space. Solar gains are typically the driving force of surface temperatures within a room, as well as temperature discrepancies throughout the space. As such, new and improved numerical building models providing local surface temperatures will help facilitate the design of PCM integrated walls and bring forth better designs based on exposure to direct solar radiation during different periods of the year. Most importantly, this approach will allow the overall impact on thermal comfort and energy consumption to be quantified accurately. Dr. Cruickshank is currently looking for a Ph.D. student to develop a numerical model of a space that can be integrated into existing building software (such as EnergyPlus), and be used to determine the surface temperature distribution within a building. This model will then be validated using data from temperature sensors, IR cameras and radiation sensors from CABER.