Graduate Research Student Opportunities

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Director of the **Solar Energy Systems Laboratory**

Director of the **Centre for Advanced Building Envelope Research**

Graduate student opportunities exist in the areas of:

- Energy Efficient and Net-Zero Energy Buildings
- Solar Energy Heating and Cooling
- Advanced Thermal Storage Concepts
- Advanced Building Envelope Materials Research

Carleton UNIVERSITY

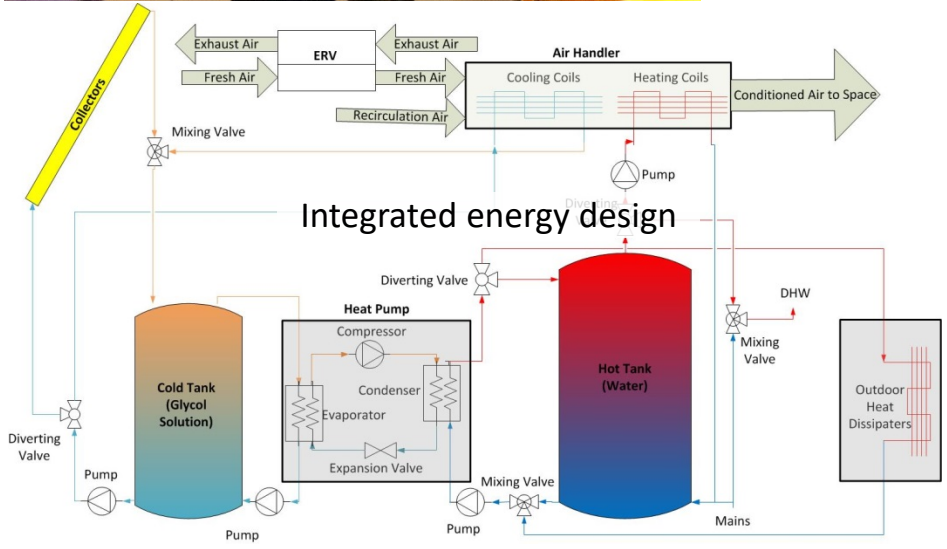
Department of Mechanical and Aerospace Engineering

Research Facilities: Solar Energy Systems Laboratory (SESL)

- The SESL provides training to graduate and undergraduate students in fundamental and applied research associated with the development and optimization of new solar building energy technologies for the heating and cooling of buildings.

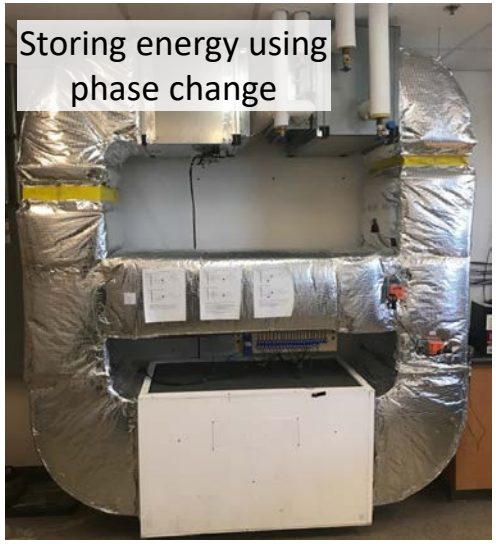
Hands on training combined with experimental design and modelling

Study of solar-assisted heat pumps



Integrated energy design

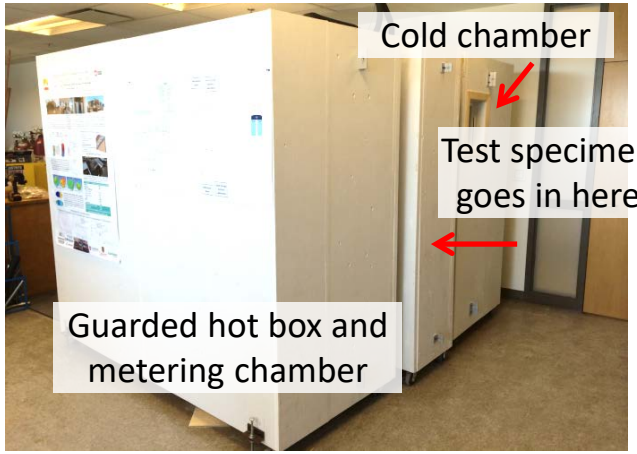
Solar absorption cooling

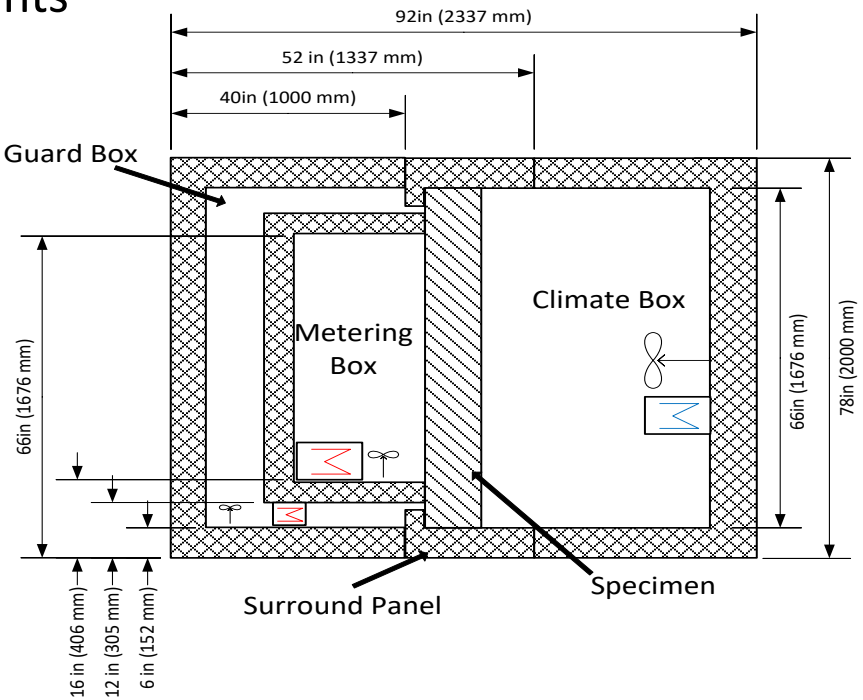


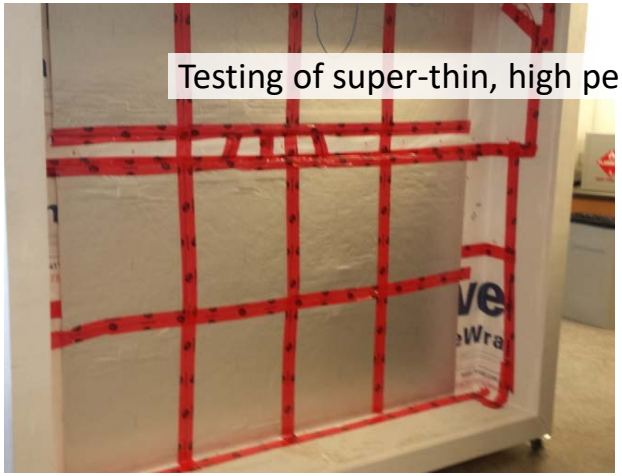
Storing energy using phase change

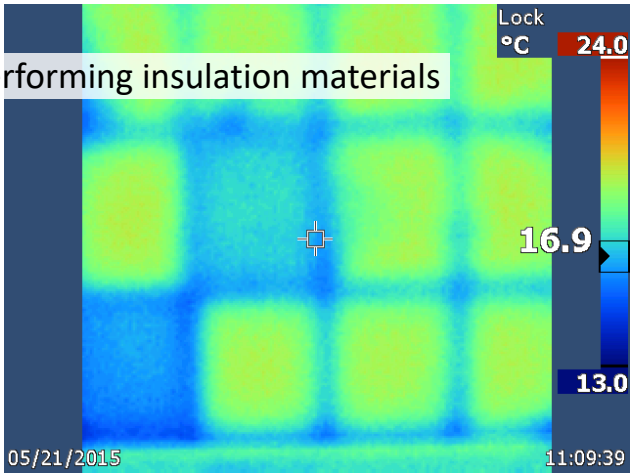
Research Facilities: Guarded Hot Box (GHB) at Carleton University

- Carleton's GHB facility allows the thermal performance of building envelope components to be tested under steady-state conditions
- Facility fully instrumented and calibrated
- Funded by CanmetENERGY-Ottawa



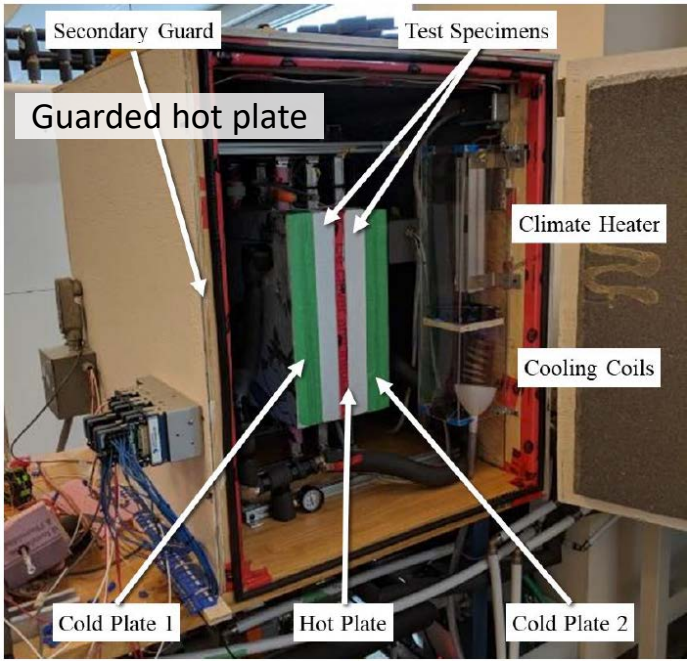


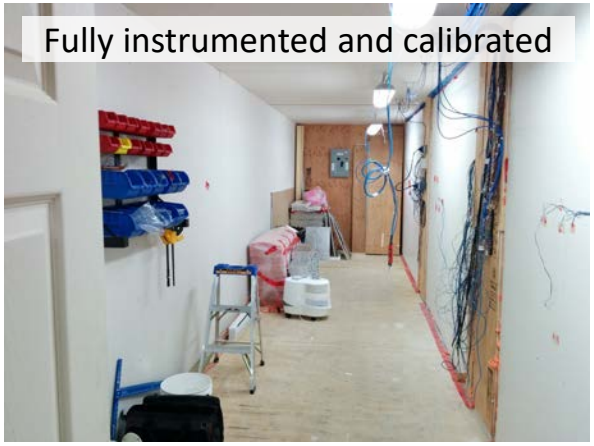




Other Facilities

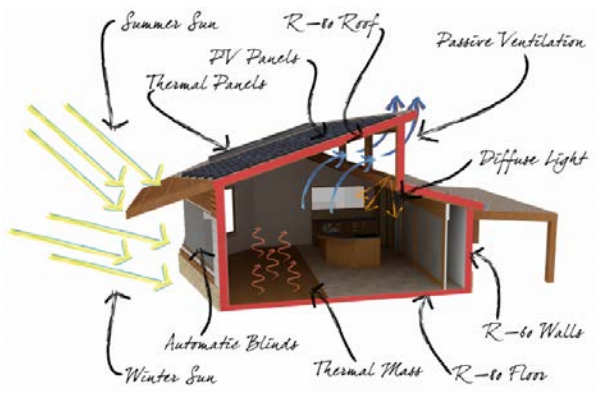
- Guarded hot-plate for high accuracy thermal conductivity measurements across a range of temperatures
- Temperature and humidity testing for moisture permeability testing and ageing of materials
- Access to NRCan's in-situ building envelope test hut
- Student work experience (instrumentation, commissioning, monitor, analysis of data)

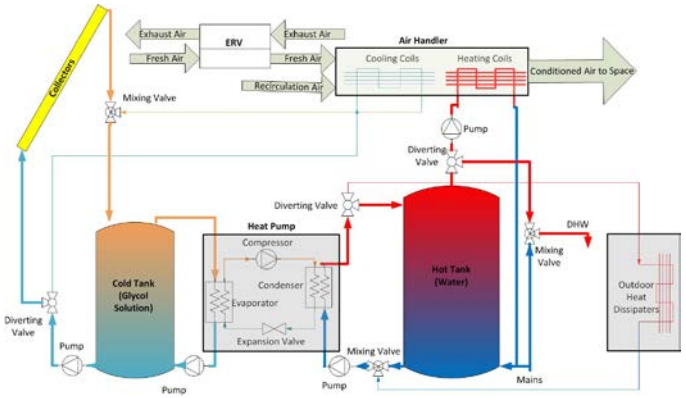




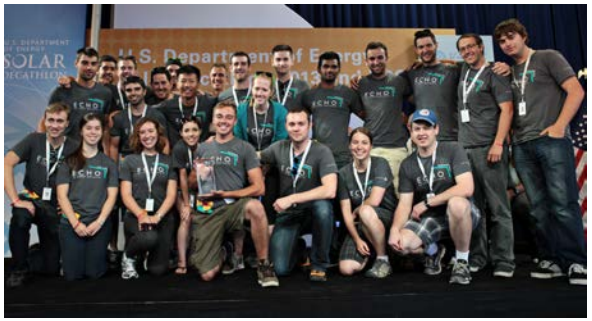
Team Ontario 2013 Solar Decathlon Competition

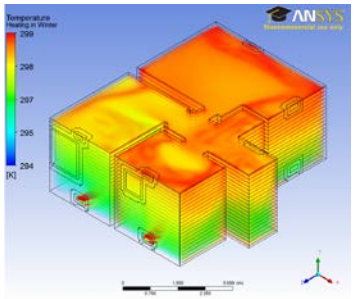
- Team Ontario, a multidisciplinary team of students and faculty from Carleton University, Queen's University, and Algonquin College, was one of 19 teams to compete in the 2013 Solar Decathlon Competition and placed 1st in Engineering.





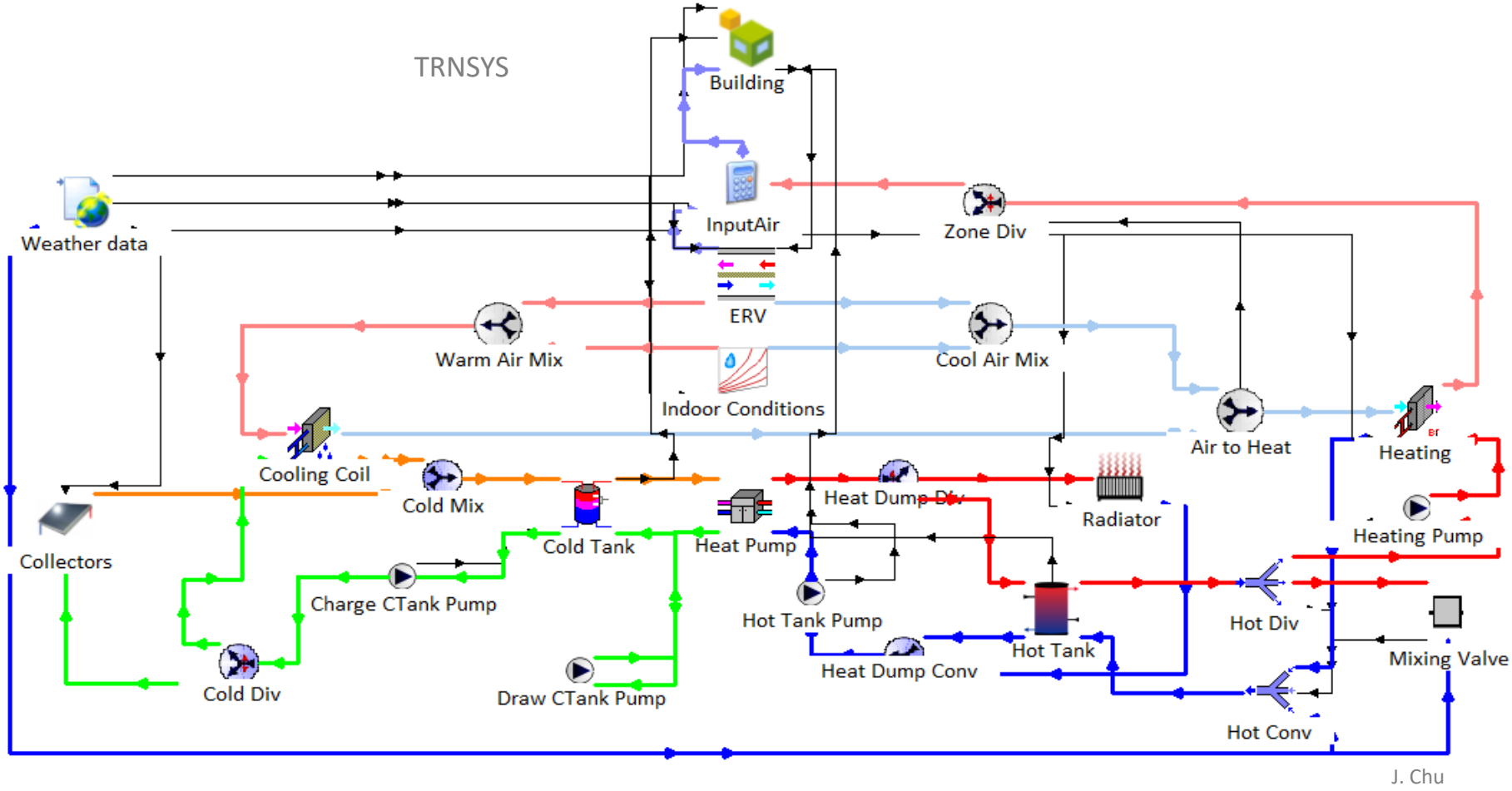
Our research activities build on student successes such as Team Ontario's participation in the Solar Decathlon in 2013.





Energy Modelling and Building Performance Simulation Tools

- To complement their experimental work, graduate students use energy modelling and building simulation tools such as TRNSYS, EnergyPlus, WUFI, DELPHIN, THERM



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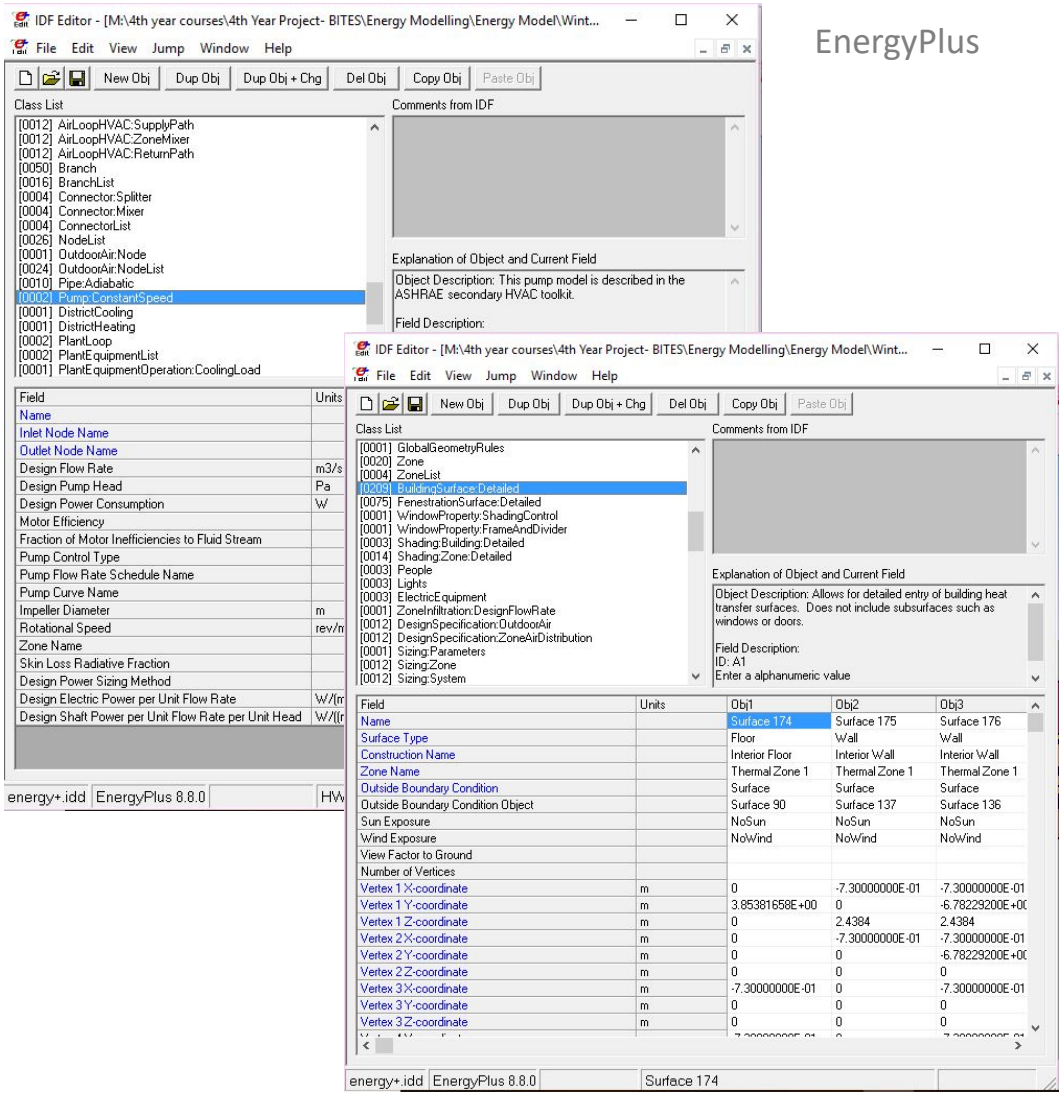
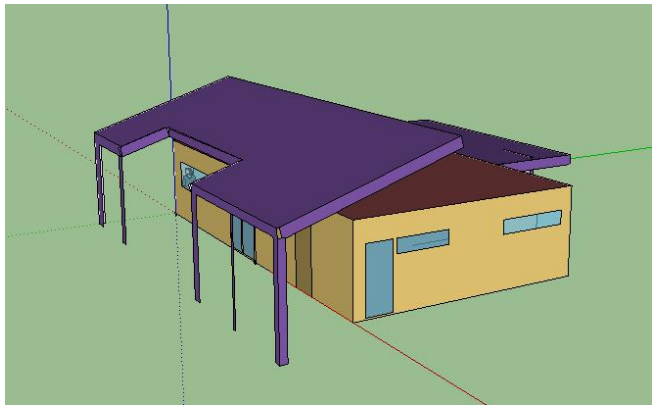
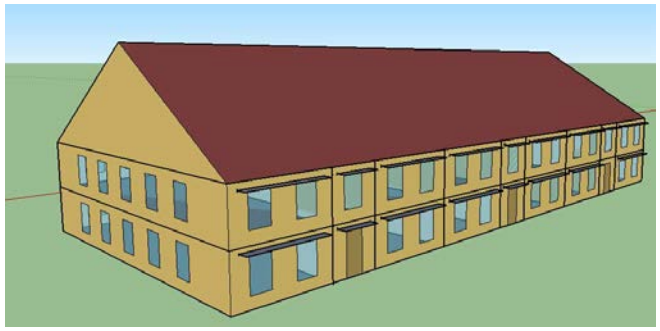
EnergyPlus



SketchUp



M. Brown



M. Katukurunda

Energy Modelling and Building Performance Simulation Tools

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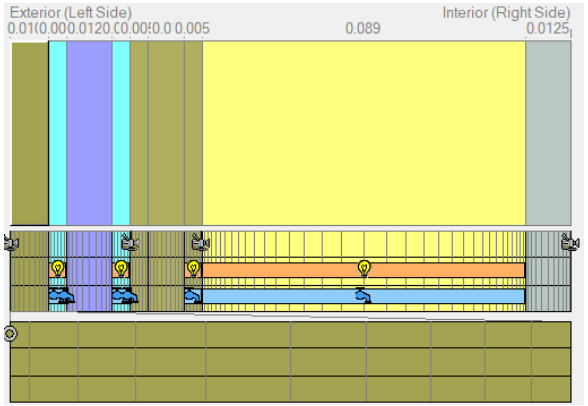
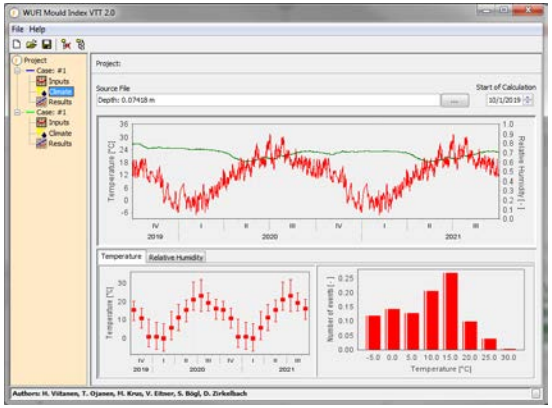
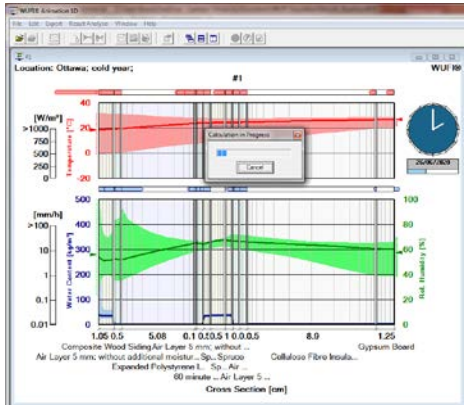
WUFI

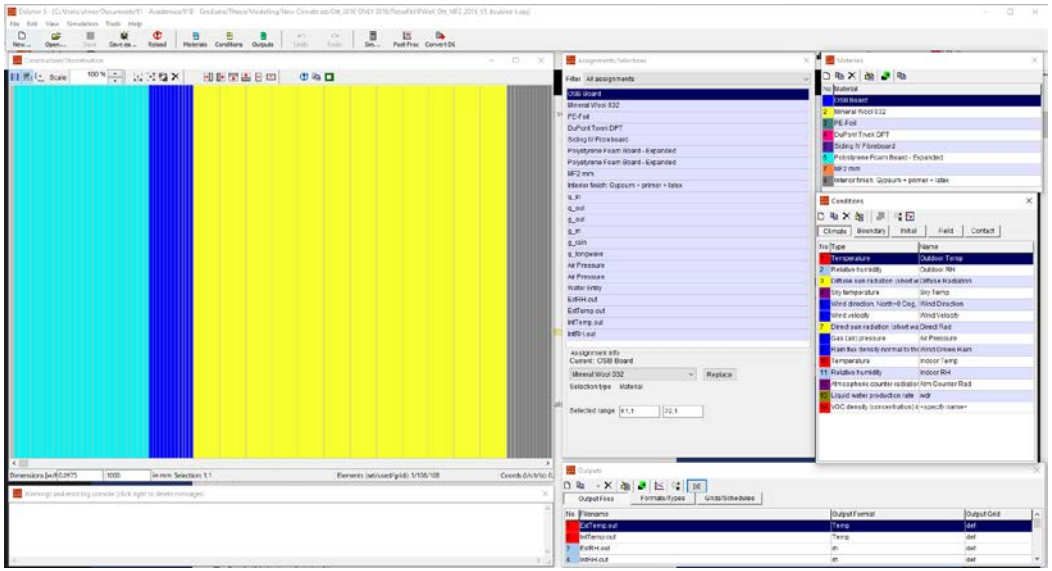






B. Conley

DELPHIN

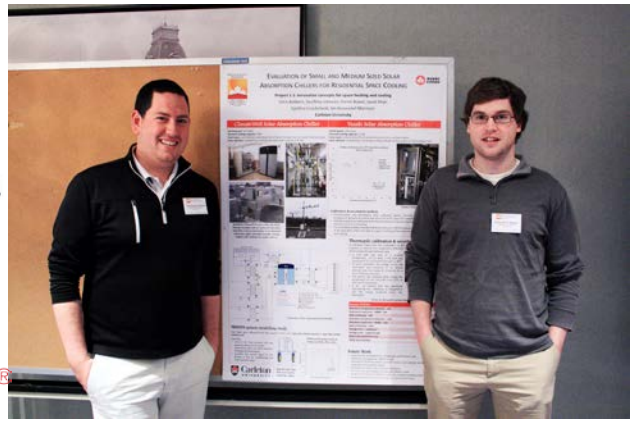


T. Ulmer

Graduate Student Training

- Students have access to state of the art facilities and receive training in both experimental work and energy modelling.
- Students are also encouraged to publish the results of their work, through peer-reviewed journals and academic conferences (photos).
- Past students have found employment at:

Natural Resources Canada
Ressources naturelles Canada
CanmetENERGY
CMHC SCHL
Canada
NRC·CNRC
Environment and Climate Change Canada
Régulvar
Indigenous and Northern Affairs Canada
Canadian Nuclear Laboratories
OWENS CORNING
ecobee



Graduate Student Recruitment

- Several fully funded graduate positions are available in my group.
- Priority will be given to domestic students with strong CGPAs (at least 10/12 or A-). International students with a strong building science and/or energy storage background, high CGPA and TOEFL/IELTS scores (100 or above) are also encouraged to apply. Students with external funding (NSERC, OGS) will receive additional funding during their scholarship period.
- The following skills/experience are considered an asset for my graduate positions, however are not required:
  - Experience using LabVIEW
  - Experience working in a research lab or setting
  - Experience in developing experimental set-ups or test benches
  - Experience working with instrumentation (temperature and pressure sensors, flow meters, heat flux meters), calibration equipment, uncertainty analysis
  - Experience with energy modelling and building simulation programs
- If you are interested, please contact me directly through e-mail (Cynthia.Cruickshank@Carleton.ca) and attach your current CV, most recent academic transcript and two technical reports you have authored.

Graduate Project Descriptions

Evaluation of an Integrated Energy System for Space and Water Heating using a Heat Pump, Solar Thermal Energy and Heat Recovery (MASc or PhD)

- Heat pumps naturally integrate with renewable power and thermal generation technologies
- The use of heat pumps can alleviate the temporal energy mismatch associated with solar energy availability and building occupant demands
    - Energy can be stored in short-term/diurnal and long-term/seasonal storage
- This project will investigate the integration of thermal storage with heat pumps for space conditioning and domestic hot water
    - Will focus on determining the feasibility and potential configurations to minimize the required electrical energy to meet the energy demands of the building

Investigating the use of Air-Based PCM for Solar Space Heating Applications (MASc or PhD)

- Phase change materials (PCM) have high thermal storage densities, and are tunable to almost any temperature of phase change
- The objective of this project is to investigate the potential use of PCM to improve the solar energy utilization in an air heating system
- PCM encapsulated in stainless steel plates with varying melting temperatures will be experimentally evaluated
- The models will be used to size complete systems and determine the feasibility of storing collected solar energy in air based phase change materials

Graduate Project Descriptions (cont'd)

Investigating the Use of Thermal Storage to Capture Excess Renewable Electricity (MASc)

- Solar photovoltaics on the roof of residential buildings are able to generate large quantities of electricity on sunny days
- Excess solar energy can be stored on site for later use
  - Batteries are typically used, but have a high capital cost and limited storage capacities
- This project will examine the potential in converting the surplus electricity to heat or cooling potential and stored in thermal storages within the building
  - This stored potential can then be used to meet demand when solar is not available, reducing electricity required from the grid

Validation of an Ice Thermal Storage Model (MASc)

- Ice provides a high thermal storage density to store cooling potential
  - This can be used to control when a chiller operates, allowing electrical consumption to be shifted off-peak period
- A model has been developed by a previous student and validated against a one-pipe experimental test set-up but needs to be further validated
- This project will involve modifying the existing experimental test to incorporate multiple pipes and validating the model based on pipe configuration

Graduate Project Descriptions (cont'd)

Experimental Evaluation of the Moisture Transmission and Subsequent Ageing of Vacuum Insulation Panels (MASc)

- Vacuum insulation panels offer thermal resistance in excess of 10x that of traditional batt insulations
- However many challenges exist on their integration into building envelopes – primarily how panels age in different building applications
- To determine ageing of panels, it is imperative that the vapour transmission rates through all components of the exterior foils are first determined
- This project will focus on the development of a method to experimentally measure the water vapor transmission through the foil and any seams in the panels

Development and Calibration of Low-Cost Moisture Content Sensors for Long-Term In-Situ Measurements (MASc)

- Accurate moisture sensors are required to measure and monitor the moisture present in structural members and wall sheathing. This information can then be used to model moisture transfer within a building envelope incorporating new materials and assembly methods
- This project will focus on the development of a new low-cost sensor, built within the lab to measure moisture content of the wood
- The sensor will then be calibrated to the different types of wood products used within building envelopes for accurate, long term monitoring

Graduate Project Descriptions (cont'd)

Modelling the Ageing Mechanism of Vacuum Insulation Panels within Building Envelopes (MASc or PhD)

- To determine the life-span of vacuum insulation panels in residential walls, detailed moisture modelling is needed. This also requires the creation of detailed weather files that are appropriate for moisture calculations for locations across Canada
- A two-dimensional model of a building envelope will be developed, to determine the conditions on each face of a vacuum insulation panel to determine the degradation of the panel over time
- Design recommendations and expected life spans of the panels will be developed for typical installations

Development of Pre-Fabricated Wall Panels Using Super Insulating Materials for Northern Applications (MASc or PhD)

- Many challenges exist with construction of residential buildings in the North
- A panelized approached using super insulating materials could address all of these concerns
- This project will develop and test highly insulated panels, reducing the volume and weight of panels required for constructing homes, and all quick assembly
- Additionally, both hygrothermal modelling, and experimental evaluation using both steady state and in-situ measurements of proposed panel designs will be conducted

Thank you for your interest!

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