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



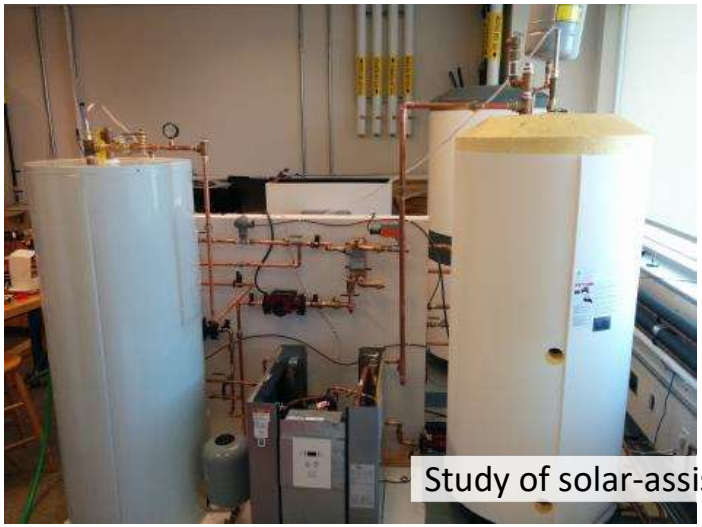

Carleton UNIVERSITY

Department of Mechanical and Aerospace Engineering

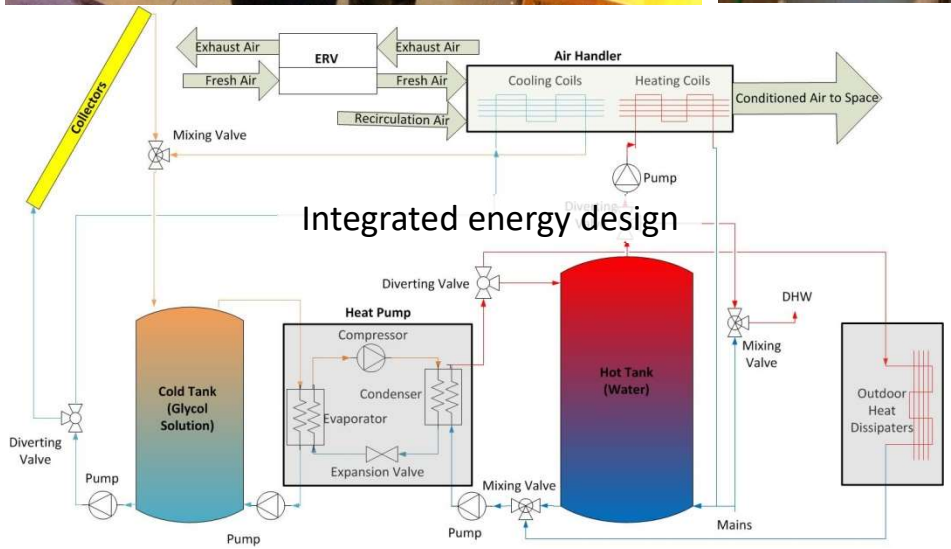
Research Facilities: Solar Energy Systems Laboratory (SESL)

- 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

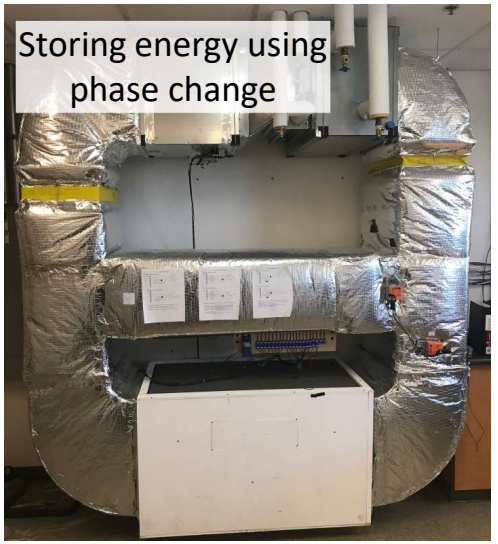


Study of solar-assisted heat pumps



Integrated energy design

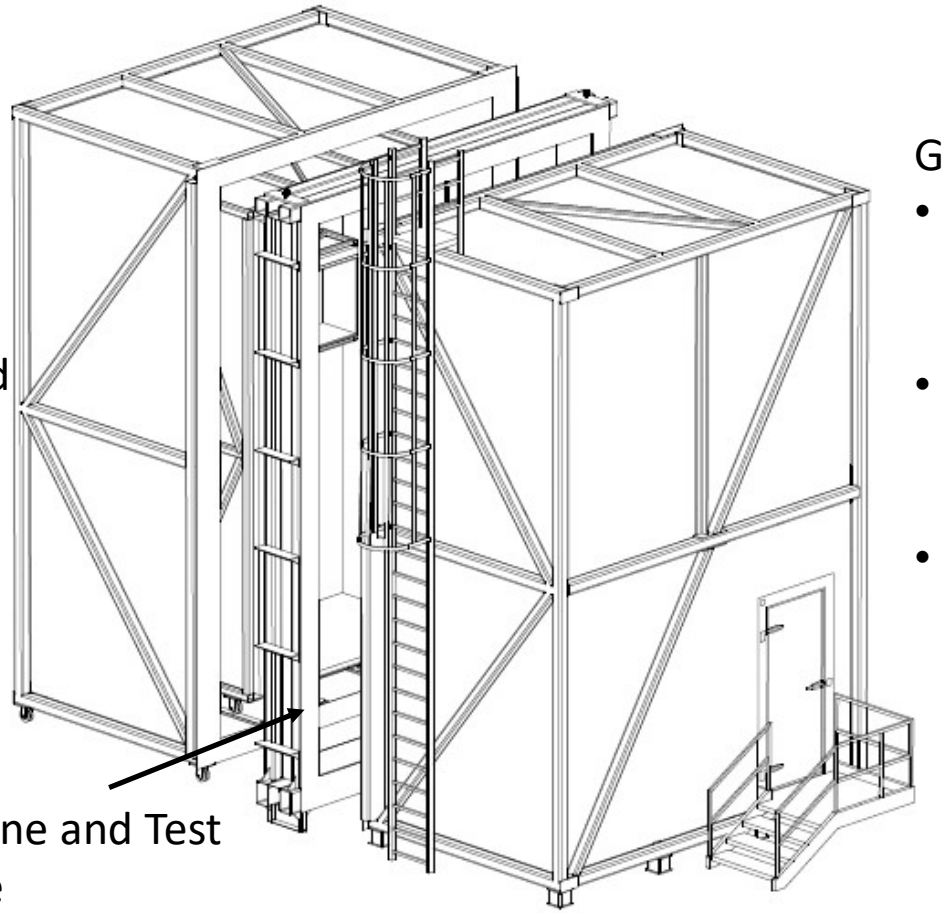
Solar absorption cooling



Storing energy using phase change

Research Facilities: Centre for Advanced Building Envelope Research (CABER)

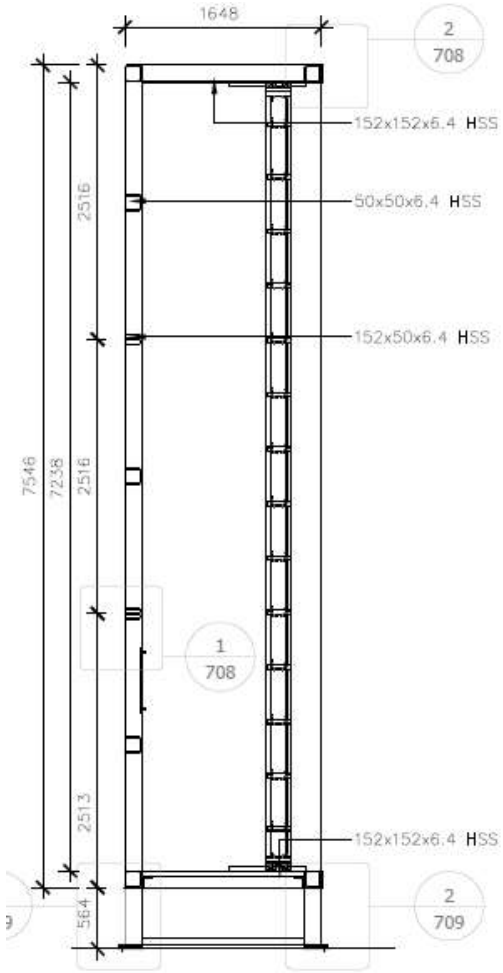
- Facility currently under construction in partnership with CanmetENERGY Ottawa
- Contains large scale and small scale test equipment to measure heat, air and moisture transfer in wall assemblies

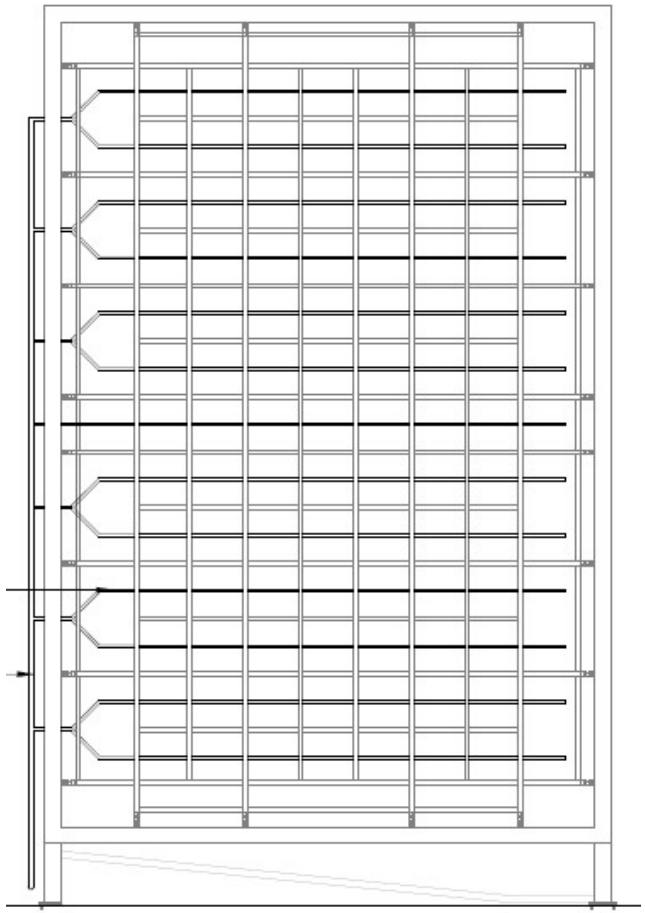


Guarded Hot Box (under construction)

- Test large scale wall samples for thermal and hygrothermal performance
- Capable of varying climate temperatures from -35°C to 55 °C and 10%-95% Relative Humidity
- Will be used to support graduate projects that examine new insulating materials, air leakage and resiliency of building designs

Research Facilities: Centre for Advanced Building Envelope Research (CABER)





Pressurized Spray Rack(under construction)

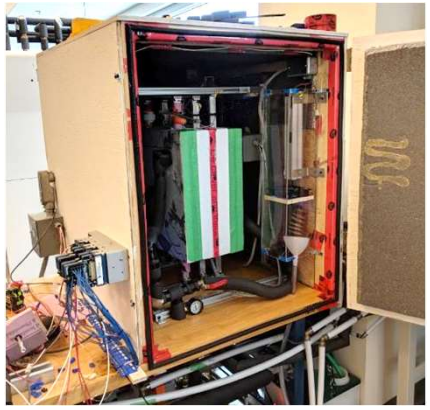
- Test large scale wall samples for moisture and air leakage and failures
- Will be used to support graduate projects that examine exterior building materials, failure methods, sealing methods and air leakage

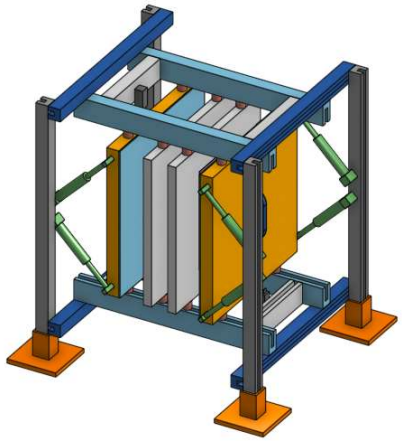
Research Facilities: Centre for Advanced Building Envelope Research (CABER)

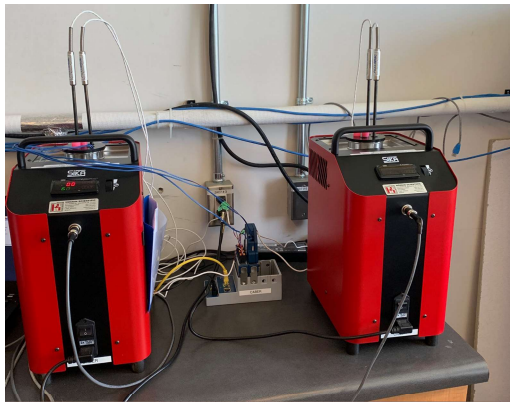
Small Scale Testing Equipment

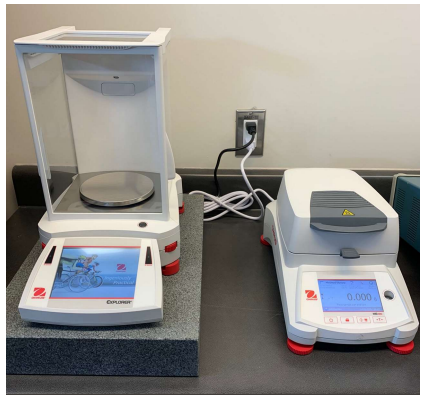
Occupant Comfort Testing

Climate Chambers







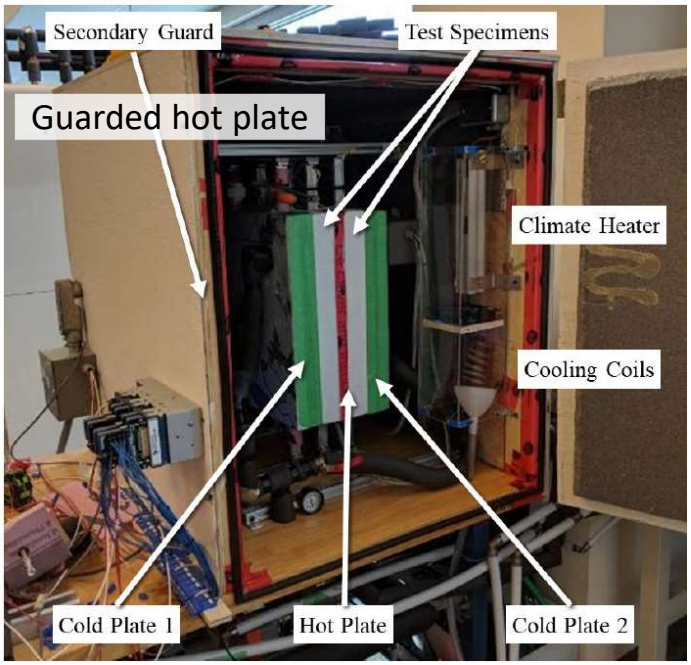


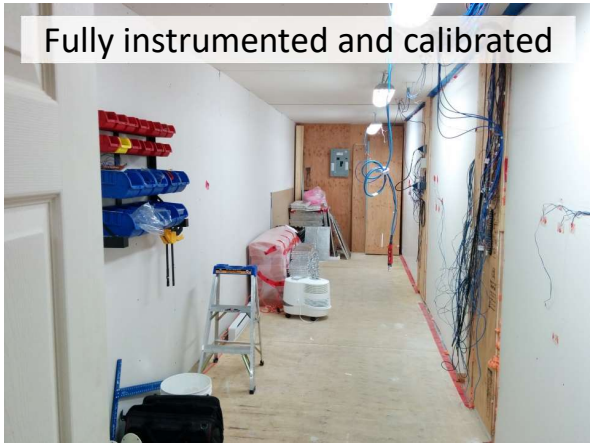
Guarded Hot Plate, Heat Flow Meter, Temperature Baths, Scales

Other Facilities

- Small scale Guarded Hot Box
- 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)

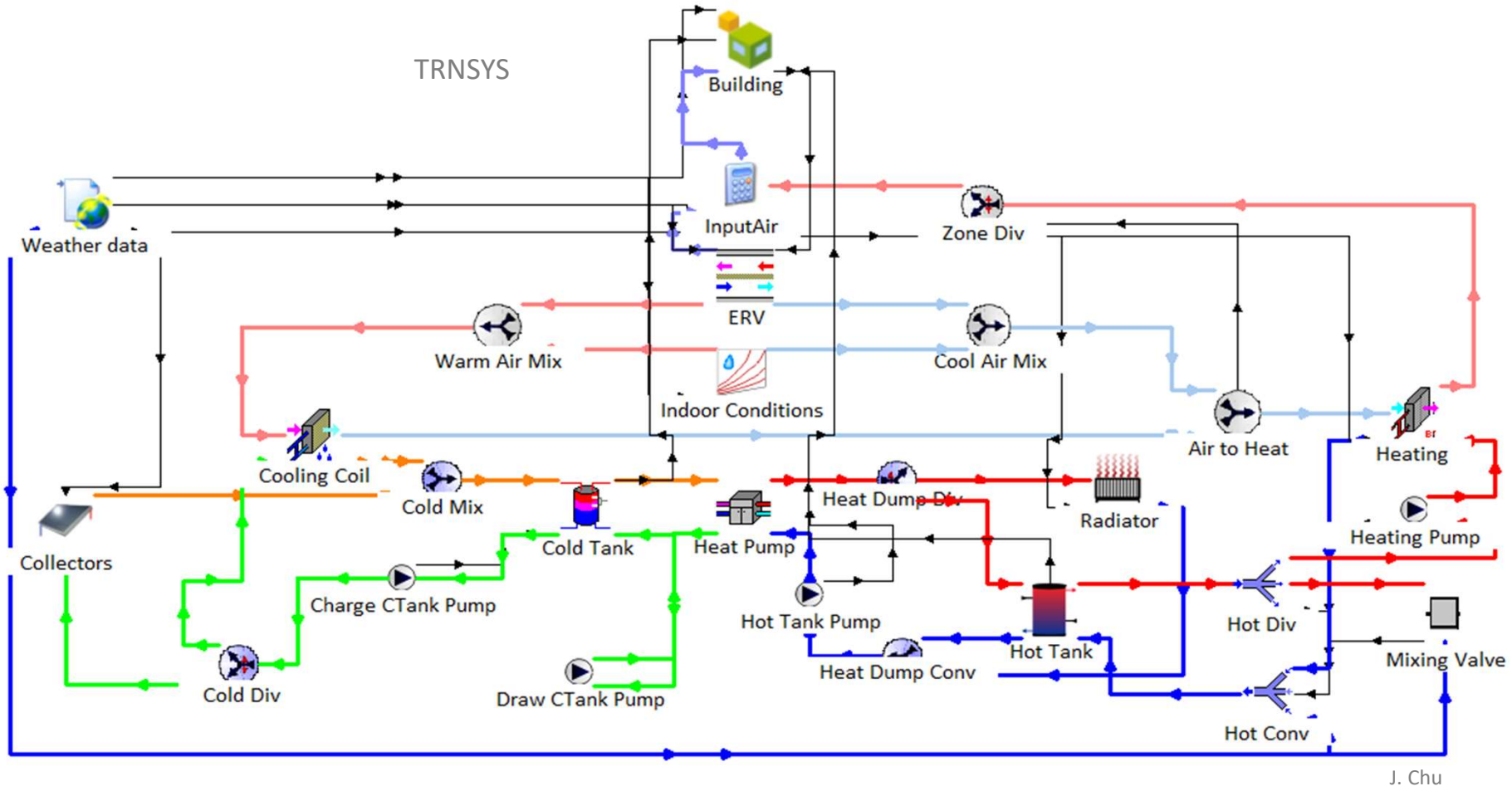
NRCan's Building Envelope Test Hut





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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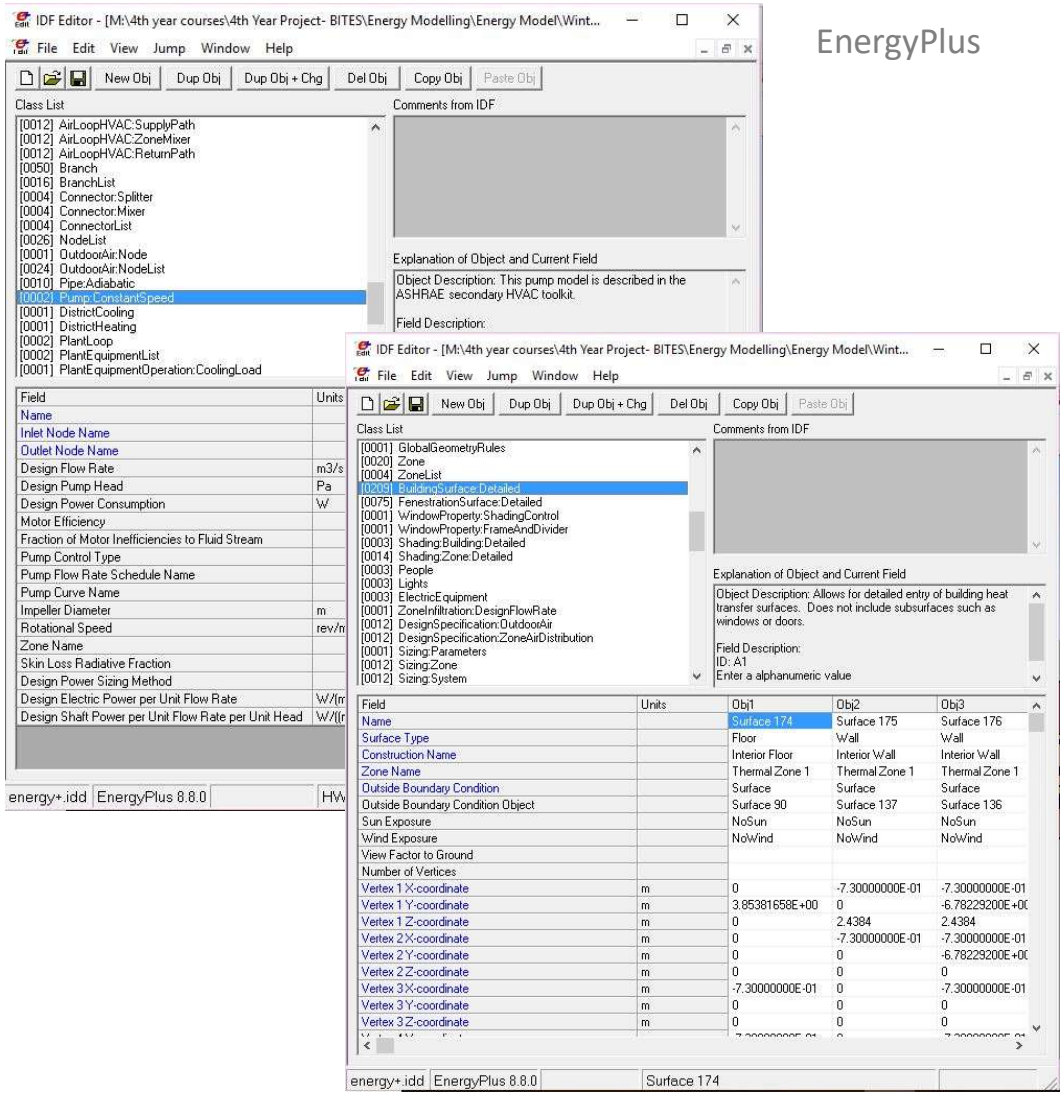
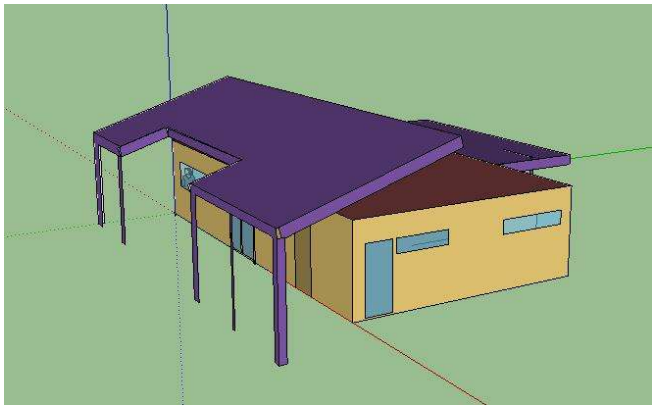
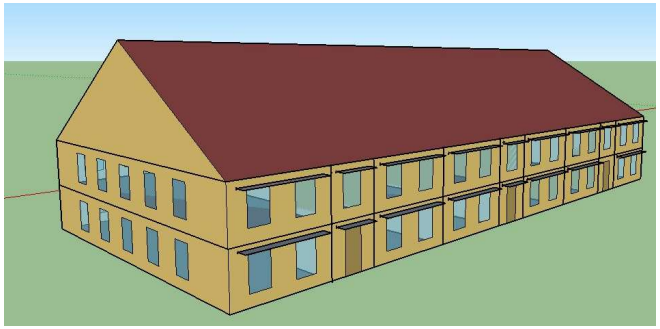
EnergyPlus



SketchUp



M. Brown



M. Katukurunda

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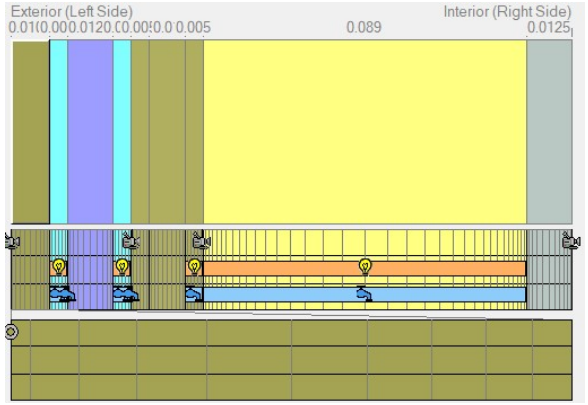
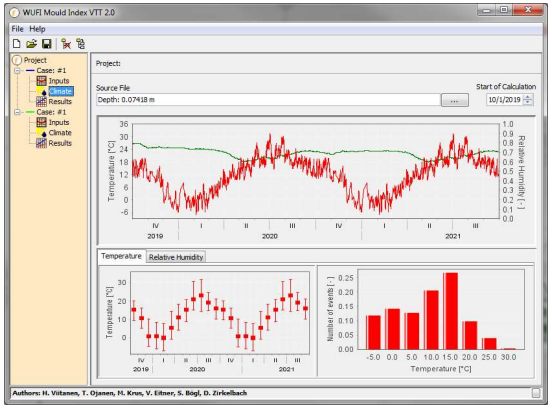
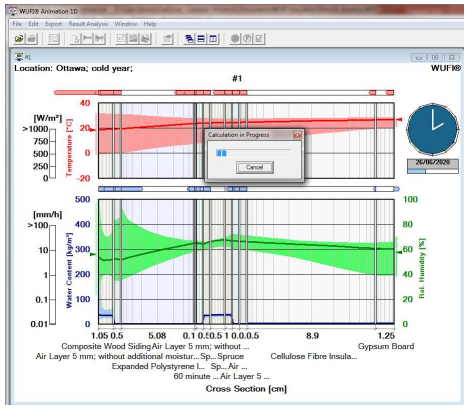
WUFI

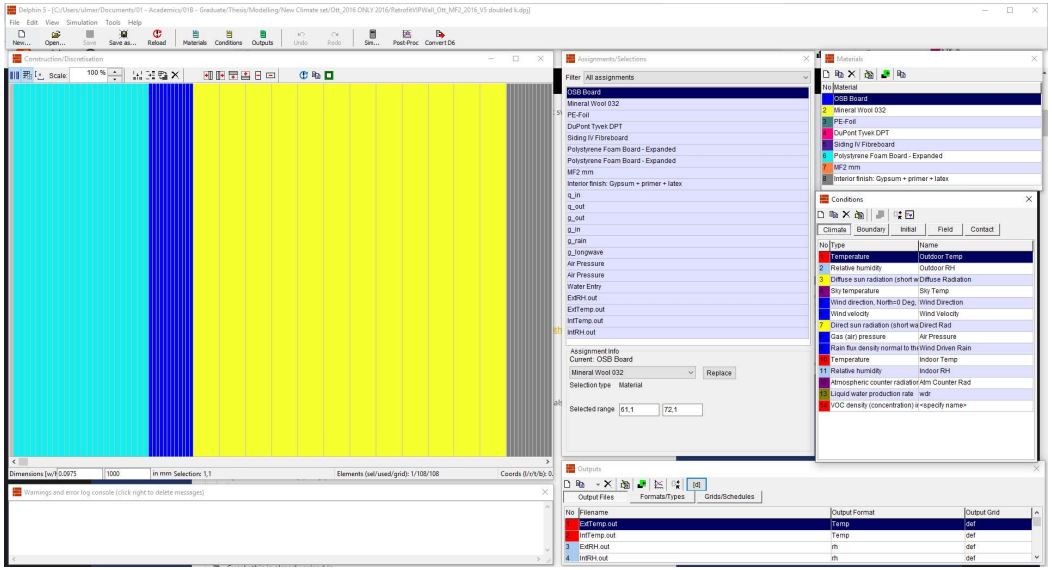






B. Conley

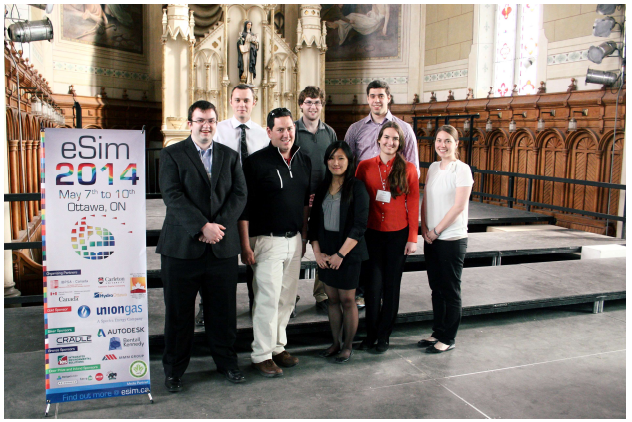
DELPHIN

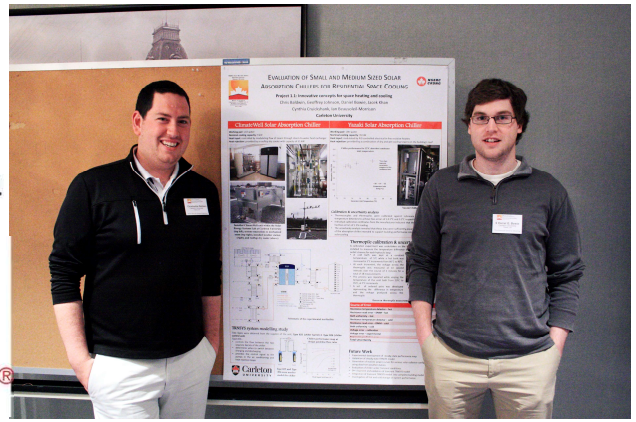


T. Ulmer

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:





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

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

- Accurate moisture sensors are required to be installed within walls to measure the moisture content of different materials, most notably wood materials
- This project will focus on the development of new methods to experimentally evaluate the long-term impact of moisture content sensors across the complete range of materials used within building envelopes
    - Focus is on materials type, temperature and the length of time the sensors have been installed, and how these all impact the experimental uncertainty of the sensors

Developing a System for Measuring and Recording Interior Building Conditions (MASc)

- Currently it is very difficult to validate the surface temperature distribution that is present within a given space, as no method exists to measure and easily assess the surface temperature distributions
- This makes modelling of both occupant comfort and temperature driven systems (i.e. materials with integrated phase change materials) difficult and inaccurate
- his project will develop a methodology to experimentally determine surface temperature distributions within a space over an extended period of time
    - The student will utilize Infrared Cameras and Matlab to develop a program that measures and provides surface distributions given a set of conditions

Graduate Project Descriptions (cont'd)

Integration of Low Embodied Carbon Insulation Material (MASc)

- As buildings have become more energy efficient, the amount of carbon required to manufacture and transport insulating materials to the building site is becoming more important
- This project will examine the potential in converting building envelope designs that typically and traditionally used plastic and foam based materials to use biogenic fibre based materials
    - The applicability and benefits to using these materials will be examined based on the Canadian building industry and practice, environmental benefits, and availability and applicability of the materials

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

- Vacuum insulation panels (VIPs) are thin panels consisting of a core material contained within an envelope placed under a vacuum. VIPs currently provide a thermal resistance of ~10x that of fiberglass panels
- The vacuum within the panels however can degrade over time reducing the performance of the panels, typically as a result of water vapour transmission through the envelope and into the core material
- This project will develop a model using experimentally developed correlations to determine and predict the lifespan of the panels for a given application, and optimize the building design to protect and extend panel life

Graduate Project Descriptions (cont'd)

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, including a lack of skilled trades, short construction season and high shipping costs for materials
- A panelized approached using super insulating materials could address these concerns
- This project will focus on the development 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 project will include both the modelling and experimental evaluation of the proposed solutions to determine applicability and resiliency of the solution

Modelling Interior Building Surface Temperatures (PhD)

- Current modelling methods assume a single uniform temperature throughout a space
- This causes significant challenges when trying to model and design complex systems
- This project will focus on the development a numerical model of a space that can be integrated into existing building software (such as EnergyPlus)
    - This model will be used to determine the surface temperature distribution within a building and validated using data from temperature sensors, IR cameras and radiation sensors

Thank you for your interest!

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