SNEBRN Newsletter Issue 4 - NOVEMBER 2015

# NSERC Smart Net-Zero Energy Buildings Strategic Research Network

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**INSIDE THIS ISSUE:**



## Planning the Fifth Year of the Network

### By A. K. Athienitis, Scientific Director

The Network completed its 4th Annual General Meeting in Saskatoon in May 2015 with an extensive range of activities, including an Industry Day with much participation from industry partners, particularly from Western Canada. This extensive issue of the newsletter reports on some of the Network achievements and activities and recent events, as well as planning for the 5th AGM.

Network researchers and students received several best paper awards and distinctions from organizations such as NSERC, ASHRAE and CMHC, which are overviewed in this issue. Major distinctions and honors such as honorary doctorates awarded to our Board Chair and solar energy pioneer Dr. Terry Hollands and to Network researcher and wind engineering authority Dr. Ted Stathopoulos are also reported.

Key outputs under IEA SHC Task 40 / EBC Annex 52 are overviewed, including an advanced book on modelling, design and optimization of NZEBs mainly written by Network researchers and students. About 10 SNEBRN researchers and doctoral students contributed to this important publication. Students acquired important expertise and skills under this IEA collaboration and have completed their doctoral degrees, with several joining Canadian Universities as professors. In this issue, we follow the career progress of several recent SNEBRN graduates that have joined universities, industry and government.

The Network and its partners played a key role in several major events. A "Symposium on Smart Net Zero Resilient Buildings and Communities" was organized at Concordia in August 2015. It consisted of two workshops (Aug. 20 and 21) with nearly 70 speakers and delegates from 16 countries (mainly APEC and European countries) with presentations and discussions on the latest progress on NZEB Best Practices and enabling technologies. About 40 graduate students from the Network participated in the event that included training and networking opportunities. This important symposium is described in this newsletter. The "Experts Research Forum on Intelligent Buildings", co-organized by CanmetENERGY and Concordia University, is also described in this newsletter.

We look forward to seeing you in Hamilton at McMaster University in May 2016 for the 5th AGM and for Canada's Building Simulation Conference eSim 2016, where much of the work of the Network will be presented. This year, the scope of eSim has been expanded to include modelling, simulation and related experimental work. In addition, the conference will include several building simulation workshops that our students may participate in and for which some Network support is available. More details about the AGM and the eSim 2016 conference can be found on the SNEBRN and eSim websites respectively: www.solarbuildings.ca and http://esim.ca.

# Saskatoon AGM Overview

Gerald Parnis, Concordia University

The 4th SNEBRN AGM was held in Saskatoon, Saskatchewan, May 19-22, 2015 and featured presentations from Network researchers and industry representatives from Saskatoon and Alberta, giving the AGM a distinctive Western Canadian orientation.

Day 1 of the AGM began with welcome speeches by Mr. Donald Atchison, Mayor of Saskatoon and Dr. Karen Chad, V.P. Research, University of Saskatchewan.

Saskatoon Mayor Mr. Donald Atchison (left) and Dr. Karen Chad, V.P. Research, University of Saskatchewan (right).

This was followed by three Workshops comprised of industry representatives, the majority from Western Canada, discussing topics involving Net-Zero Energy Buildings (NZEBs): communities, components, high performance buildings and Building Integrated Photovoltaic/Thermal (BIPV/T) envelope systems. University of Saskatchewan Engineering Professor Emeritus Robert Besant gave a well-received luncheon speech highlighting the impacts that climate change will have on the built environment and related engineering practices.

The first Workshop (*The Design of NZEB Communities*) comprised mostly of descriptions of high performance and NZEB domestic building designs, given from the perspective of Western Canadian developers (Daniels Wingerak Engineering, Landmark Homes, independent consultants). Common stressed themes included: effective use of solar energy, air tightness, high insulation levels, high quality glazing and heating energy efficiency. Network Researcher and University of Calgary Assistant Professor Caroline Hachem-Vermette discussed smart community designs in London, Ontario; West Campus, Calgary; and another large development in Alberta. The design aims include the communities being Net-Zero Energy, family-oriented, sustainable and economical, while promoting healthy and environmentally low impact living. Good solar energy utilization in community design was stressed through optimal house orientations and shapes, proper use of shading devices and PV technology. Other community design aspects such as infrastructure, waste management, food growth and smart technologies were also discussed.

AGM Workshop 1: (L-R) Ronn Lepage, Michael Nemeth, Haitao Yu, Remi Charon, Caroline Hachem-Vermette.

Saskatoon SNEBRN AGM...continued

Workshop 2 centered on the design, components and performance of NZEBS. Network Researcher and University of Saskatchewan Engineering Professor Carey Simonson introduced the panel with a similar presentation he gave in Ottawa when he received an NSERC Synergy Award (an announcement appears in this newsletter). He described the successful collaboration with Venmar CES in developing a liquid to air membrane energy exchanger (LAMEE), stressing the importance of government funded university-based research and industrial partnerships.

AGM Workshop 2: (L to R) Ryan Huizing, Ryan Jansen, Louie Azzolini, Murray Guy, Ken Coutu, Chris Richards, Carey Simonson.

Ken Coutu from Nortek Air Solutions, the parent company of Venmar CES, continued the discussion on the fruitful collaboration with University of Saskatchewan. He described the details and potential of the liquid desiccant-based dehumidification/humidification systems in Net-Zero Energy houses. These systems employ vapour permeable membranes to accomplish air to liquid desiccant transfer and are more efficient than conventional and desiccant-wheel-based systems.

Ryan Huizing (dPoint Technologies) pointed out that as airtightness of buildings/houses improves, good ventilation for indoor air quality becomes a higher priority, motivating the use of high efficiency ventilation energy recovery systems, especially for NZEBs. He described various Energy Recovery Ventilation (ERV) systems, exchangers and other associated technologies that contribute to efficiency improvements of ventilation systems.

Louie Azzolini (AEA: Artic Energy Alliance, a new Network Partner) presented a Northern Canadian perspective on buildings, housing and energy efficiency. Characteristics of northern regions that create unique obstacles for NZEB development include harsh climates, high energy use/costs, skilled labour shortages and sparsely populated remote communities that are difficult to access. The AEA identified the top 3 retrofit recommendations for the north as unoccupied temperature set back, space temperature setting reductions and the conversion of High-Intensity Discharge (HID) exterior lighting to LED lighting.

The final Workshop 2 presentations by Murray Guy (EcoSmart Developments) and Ryan Jansen (Good Steward Solutions) illustrated the viability of NZEB construction using the examples of the Mosaic Centre, Edmonton, AB and the Saskatoon Net-Zero Home.

Continued...

Saskatoon SNEBRN AGM ...continued

Building Integrated Photovoltaic, Thermal (BIPV, BIPV/T) systems were discussed in Workshop 3 with firstly Josef Ayoub (CamnetENERGY, NRCan) presenting NRCan's major role in the promotion and support of BIPV and BIPV/T research and development in Canada. Examples of NRCan's participation include the support of and partnership with SNEBRN and internationally through the IEA. Josef described both the barriers to mainstream adoption of BIPV/T in the building sector, as well as the the drivers. He presented implementations of BIPV/T that had significant NRCan involvement including the BIPV/T system of the John Molson Building at Concordia University.

AGM Workshop 3: (L to R) Sevag Pogharian, Costa Kapsis, Getu Hailu, Alan Fung, Josef Ayoub

Network Researcher Alan Fung (Associate Professor, Ryerson University, Toronto) gave a detailed presentation of the technology and performance of the test house at the Toronto and Region Conservation Authority Kortright Centre which includes a BIPV/T system and an air source heat pump (ASHP). Simulations of the test house were performed to compare the performance of the ASHP operating independently and coupled with the BIPV/T system. The results suggested a potential 20% reduction in annual electricity consumption and a seasonal COP increase from 2.74 to 3.45 when an ASHP and a BIPV/T system are coupled. This coupling would require an appropriate ASHP.

Getu Hailu, former Network graduate student and now Assistant Professor at the University of Alaska, described the challenges and potential of greater uptake of BIPV/T technologies in Alaska. Alaska is the 3rd highest state for energy consumption per person and is the 2nd highest state in percentage of electricity generated from fossil fuels in US. With many dispersed small energy grids and some off-grid housing, rural communities rely primarily on diesel-based electricity. Alaska is aiming for 50% of its energy consumption to come from renewable sources by 2025 and a 25% increase in overall energy efficiency by 2020. Getu described many unique examples of BIPV and BIPV/T installations in Alaska.

Concordia doctoral candidate Costa Kapsis (Concordia University) described Semi-Transparent PV (STPV) technology, a relatively new technology that has the potential of becoming a standard building façade component and contributing towards/beyond NZEB status. Given the popular preference for highly glazed façades on commercial and high-rise buildings, STPV windows are poised to contribute direct energy production and energy savings through daylighting provision (electrical lighting energy reduction) and solar heat gain reductions while also improving daylighting comfort and providing a partial or full view to the outdoors. Other possible applications of STPV include (electric) vehicle sunroofs, bus stop enclosures and greenhouse glazing (standalone to industrial scale). As part of the Refined Manufacturing Acceleration Process (ReMAP) Network (a BL-NCE initiative) led by Celestica, Inc., Costa and other researchers at Concordia University will participate in a project which aims to bring 'plug-and-play' (easily installed) STPV Window products to market.

Network Partner, Sevag Pogharian (Montréal ZERO Inc.) presented his vision of BIPV/T as a scalable energy system that provides 100% of the heating and power requirements of a high performance building, contributing to the energy autonomy of buildings and communities. Making this vision a reality will require efficient, simple and robust plug-and-play designs of BIPV/T components. Montréal ZERO is committed to implementing case studies and testing of BIPV/T installations as a way to help bring this technology to maturity.

Day 2 of the AGM was dedicated to SNEBRN Project and Theme presentations which showcased the broad scope of research on NZEB topics taking place across Canada under the SNEBRN.

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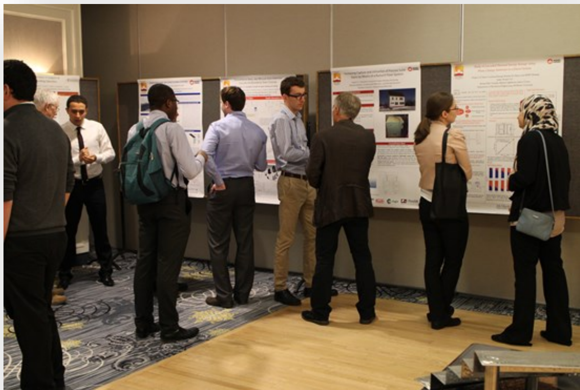
Saskatoon SNEBRN AGM ...continued

**AGM Posters:** Throughout the AGM, posters of Network research were on display in the coffee break area where Researchers and graduate students met to plan and discuss their work, future collaborations and other Network activities.



Network Researchers and graduate students with Network posters at the 4th SNEBRN AGM

Over 2 days, the Network Scientific Committee ranked the 39 Network posters according to 3 criteria: composition, technical content and visual presentation. Prizes consisting of funding for future conference expenses were awarded for the top 3 posters listed below. Congratulations to the SNEBRN graduate students and Researchers listed below, whose posters were ranked as the top 3.

PDF files of all 2015 AGM poster submissions have been placed in the Network secure document sharing system and are available through the Network website: www.solarbuildings.ca.

Poster awards at the SNEBRN AGM networking dinner

| Rank | Poster Title | Authors |
|---|---|---|
| 1 | *Diamond-Like Carbon (DLC) based Spectrally Tunable Active Coatings* | A. Khalatpour, P. Mahtani, H. Daneshvar, R. Ko, J. K. Clark, N.P. Kherani |
| 2 | *Energy Impact of Frosting-Defrosting in HRV/ERVs* | M. R. Nasr, J. L. Zhang, F. Fathieh, A. Fung, C. Simonson |
| 3 | *Initial analysis of Halifax Solar City measured domestic hot water consumption data* | D. George, N. S. Pearre, L. Swan |

## The Next SNEBRN AGM

The next (5th and final) AGM will be held over one day in conjunction with the eSim 2016 conference at McMaster University, Hamilton, Ontario. SNEBRN Theme and Project presentations will take place on May 2, 2016 while the eSim conference will take place over May 3-6, 2016. Network Researchers and students will present peer-reviewed papers at the eSim conference. More information about eSim 2016 is available at the conference web site: www.esim.ca.

# Concordia University hosts the CZEBS-iiSBE-APEC Net-Zero Built Environment Symposium

Gerald Parnis, Concordia University & Remi Charron, Consultant

Over 70 researchers, government and industry representatives from 16 countries[1] gathered over August 20-21, 2015 at Concordia University to discuss a broad scope of topics related to Smart Net-Zero Resilient Buildings and Communities. The symposium consisted of panel discussions of eight themes relating to Net-Zero Energy Buildings, including: Building Design, Building Case Studies, Communities, Standards and Incentive Measures, Architecture and Engineering Education, Enabling Technologies and Renewable Energy Integration. The Centre for Zero Energy Building Studies, Concordia University (CZEBS) hosted this event and while many CZEBS researchers and students participated in this symposium, the majority of attendees originated from three umbrella organizations/networks: Asia-Pacific Economic Cooperation (APEC), the International Initiative for a Sustainable Built Environment (iiSBE) and the Smart Net-Zero Energy Buildings Strategic Research Network (SNEBRN).

The Symposium was co-chaired by Dr. Andreas Athienitis, (Scientific Director of SNEBRN and Director of CZEBS) and Dr. Bruno Lee (CZEBS). SNEBRN Researchers gave several presentations or chaired panels while about 40 SNEBRN students from 8 Canadian universities attended the Symposium with training support from NSERC Strategic Network Enhancement Initiative (SNEI). About 10 SNEBRN industry and government experts and 20 APEC delegates participated in the Symposium.

SNEBRN at the Symposium. Rows 1 & 2, L to R: Dr. Cynthia Cruickshank, Dr. Patrick Oosthuizen, Dr. Bruno Lee, Dr. Shicong Zhang (APEC), Dr. Andreas Athienitis, Dr. Caroline Hachem-Vermette, Dr. Ted Stathopoulos

The Symposium began with brief introductions by Dr. Andreas Athientis and Nils Larsson (iiSBE) followed by a brief presentation by Prof. Wei Xu, APEC NZEB Program Overseer and Director of China NZEB Alliance, China Academy of Building Research (CABR). Prof. Xu described the APEC Nearly (Net) Zero Energy Building Program, run by CABR. This included outlining the positioning of the program within the larger APEC framework, describing various past workshops that included SNEBRN participation and listing international partners including SNEBRN, CZEBS, Carleton University and S2E (a SNEBRN Industrial Partner). Dr. Benoit-Antoine Bacon, Provost of Concordia University, formally opened the Symposium and welcomed participants to Montreal and Concordia University. This was followed by the opening plenary.

[1]Countries represented at the CZEBS-iiSBE-APEC Symposium: Canada, USA, China, Korea, Japan, Chile, Brazil, Cyprus, France, Italy, Mexico, Indonesia, Thailand, Singapore, Belgium, Hong Kong.

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**Plenary Presentations**

Plenary Sessions were held in the morning and during the lunch break of both days of the Symposium. In the opening Plenary entitled *Moving the Mainstream towards Net-Zero Energy Buildings*, Dr. Paul Torcellini (Eastern Connecticut State University, USA) presented lessons learned from the new National Renewable Energy Laboratory (NREL) facility in Colorado, the largest net-zero energy building in the world. Paul described the early conceptual phase of a new building project in terms of vision, goals and strategies and how these impact and determine the roles of the various players (owners, project leaders, architects, engineers, etc.) at the early design phase of a project. An important role for the owner is the writing of the Request For Proposal (RFP), defining what the building could accomplish and in collaboration with the design/build team, a list of prioritized objectives is generated as part of the RFP. In the case of the NREL facility, the RFP included mission critical objectives (e.g. LEED Platinum), highly desirable objectives (e.g. max 79 kWh/m$^2$ energy consumption) and "if possible" objectives (e.g. net-zero energy, visual displays of real-time energy efficiency). Using this approach, design teams were able to innovate and develop a design that would meet net-zero energy consumption at a lower cost than conventionally designed buildings of similar type and size.


Day 1 Plenaries were given by Dr. Paul Torcellini (left) and Edward Mazria (right)

The lunch time Plenary entitled *Road To ZERO* was given by Edward Mazria, founder and CEO of *Architecture 2030*, a non-profit organization seeking to bring about significant and effective reductions in greenhouse gases (GHG) generated by the building sector. Edward discussed the importance of moving the building stock to have net-zero carbon emissions by 2050 and presented a path to get there for new and existing buildings as well as building components. In order to have an 85% chance for global warming to stay below 2°C, global emissions need to peak soon and go down to zero by 2050. This statement is supported and illustrated by the IPCC Representative Concentration Pathways (RCPs) Green House Gas trajectories, presented in the 5th Assessment Report of the IPCC in 2014, included in the Architecture 2030 submission to the IPCC, *Roadmap to Zero Emissions* and presented by Edward at the symposium. In addition to this 2050 initiative (roadmap), Edward presented the 2030 Challenge: *all new buildings, developments, and major renovations shall be carbon-neutral by 2030*, led by Architecture 2030 and being taken up in the US by leading Architects, Building Product Developers, State, District and Municipal governments. These initiatives of Architecture 2030 highlighted the importance of the research work being done, advancing the state of net-zero energy buildings.

The day 2 morning plenary, *Towards Smart Net-Zero Energy Buildings and Communities: Challenges and Opportunities*, was given by Dr. Andreas Athienitis, the Symposium co-chair and Scientific Director of SNEBRN. Andreas discussed research achievements to date including advanced BIPV/T installations in the John Molson School of Business Building, Concordia University and EcoTerra House as well as the NZEB library design at Varennes, Québec. He gave an overview of SNEBRN including its academic makeup, partners, vision, goals, structure and some of the solar technologies being investigated and developed: BIPV/T, Semi-Transparent PV (STPV, e.g. windows), advanced fenestration systems. He outlined a number of challenges that remained, stressing that more work is needed in the integration of solar technologies with energy efficiency, within the building architecture and the building envelope itself. This integration needs to make use of more intelligent building operation that in turn makes use of predictive control, with not only a focus on energy conservation, but also on peak load

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CZEBS-iiSBE-APEC Symposium ...continued

shifting. There is a need to further develop building integrated PV systems with thermal energy capture in order to maximise the renewable energy utilised from the building envelope in order to achieve net-zero energy targets in larger multi-storey buildings.


Day 2 Plenaries were given by Dr. Andreas Athienitis (left, Symposium co-chair) and Nils Larsson (right)

In the final plenary, Nils Larsson, Executive Director of the International Initiative for a Sustainable Built Environment (iiSBE), presented: *A systems model for small urban zones that may bring us closer to nearly-zero*. After briefly introducing iiSBE, he discussed the "*potential role of very small urban areas, or building clusters, in improving the aggregate performance of buildings*", that is, "*synergistic*" performance improvements in energy consumption, emissions, water consumption and waste management. His vision includes how clusters of buildings could work together to make the required energy savings more achievable by, for example, taking advantage of diverse occupancy profiles of different types of buildings within a cluster. Prospects at the scale of building clusters offer the potential of inter-building synergies. Synergy zones could benefit from optimization of supply and demand of thermal energy, DHW, grey water, and DC electric power from building of different uses (residential, office, retail, schools, etc.) with an additional result of resiliency gains. The Sustainable Built Environment (SBE) 2016 international conference schedule was presented including the SBE16 conference in Toronto (Sept 2016).

**Panellist Presentations**

About 40 international and Canadian researchers made up the 8 Symposium Panels discussing topics dealing with various aspects of *Smart Net-Zero Resilient Buildings and Communities*. The panellists presented a number of different near-zero building demonstration projects; from individual houses, to large commercial buildings and small communities. There were many important common points raised in the various projects and studies presented. There is a need to optimise passive elements first, with an emphasis on passive solar, daylighting and natural ventilation, followed by efforts to maximize the energy efficiency of lighting and HVAC systems. Finally renewable energy technologies are introduced. The design considerations should also include optimal building operation using control strategies, as well as the implementation of continuous monitoring and commissioning. These general design guidelines are applicable to buildings across different locations while differences in climate, energy mix and local programs/politics have an influence on a number of design attributes. There were also a number of presentations that discussed the importance of codes and standards in terms of accelerating the adoption of net-zero energy buildings.

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CZEBS-iiSBE-APEC Symposium ...continued


Dr. Bruno Lee, Symposuim co-chair, presents during Panel 4,
*Education for Net-Zero Energy: Challenges for Architecture and Engineering Programs*

The education system needs to adapt in order to train the architects and engineers to work together as a collaborative team and this was discussed in Panel 4. Not only do architects need to better consider the engineering aspects, engineers need to consider the architectural and social impacts of their technologies. Only through deep collaboration and tight integration at the early design phase, can a truly resilient net-zero built environment be designed and implemented. In fact, a common view expressed at the Symposium is that there is no fundamental conflict between any of the architectural/social-cultural values of the design and the technical considerations of the implementation. However, there is a lack of both a common language that could translate conceptual ideas across different professions and a platform that could facilitate exchange in a quantitative manner. Research is needed to develop such a process. The education system also plays a crucial role in engaging both architectural and engineering students as a team through project based learning and studio work.

There were a number of panellists that discussed the importance of considering resilience in building design. Net-zero energy buildings are by nature more resilient than constructions completed following standard practices. However, with additional focus on resilience, buildings could be better prepared to adapt and respond to the changing climate and extreme weather events.


Dr. Christophe Ménézo, NSA-EDF, France discusses BIPV/T systems during Panel 6:
*Building Integrated Solar as an Enabling Technology for Net-Zero Energy and Resilience*

Continued...

CZEBS-iiSBE-APEC Symposium ...continued

A number of presentations were focused on PV/Thermal technologies in Panel 6. By both generating electricity and capturing thermal energy, more energy can be harvested by the building envelope helping buildings achieve net-zero energy status. Recent advances in cold-climate air-source heat pumps make them an increasingly popular technology for net-zero energy buildings and there is great potential to maximize heat pump performance by integrating it with a PV/thermal system. There was also a discussion on how electricity storage would need to be part of the design if there is widespread adoption of PV. Electricity storage would improve the ability of the grid to better manage the fluctuations in generated electricity. In addition, there is significant potential when considering the combination of net-zero energy houses and electricity storage interacting with smart-grids, to not only save energy but also to better manage peak loads.

At the end of day 1, Symposium attendees toured the Concordia P. Fazio Solar Simulator-Environmental Chamber Laboratory and the Building Integrated Photovoltaic/Thermal System of the John Molson Building.

The Symposium closed with a Q+A session led by the panellist co-chairs summarizing each Panel. A lively discussion ensued around the topics of barriers to technology adoption, bridging the architect-engineering divide and the relative merits of stressing carbon reduction versus energy efficiency outcomes and measures.


Symposium participants gather in the vicinity of the John Molson School of Business Building (JMSB), Concordia University.
The JMSB advanced BIPV/T Solar Wall can be seen in the top right section of the façade.

# Updates on IEA EBC Annex 66: Definition and Simulation of Occupant Behavior in Buildings

Burak Gunay, Liam O'Brien, Carleton University

It is well-established in the building simulation community that occupant behaviour represents one of the greatest impacts on building energy and comfort performance. Figure 1 shows the results of a survey of 200 building simulation users and indicates varying levels of confidence regarding the modelling assumptions of occupants' use of common building systems. An international collaborative effort was needed to set up a scientific framework for energy and comfort-related occupant behaviour modelling and simulation. IEA EBC Annex 66 is the first Annex to focus exclusively on occupant behavior modelling and simulation. Since its first experts meeting on March 2014 in Hong Kong, there were open forums, symposia, and experts meetings in Nottingham, San Francisco, and Karlsruhe, Germany. Currently, more than 100 researchers and industry professionals from 13 countries are actively contributing to Annex 66.

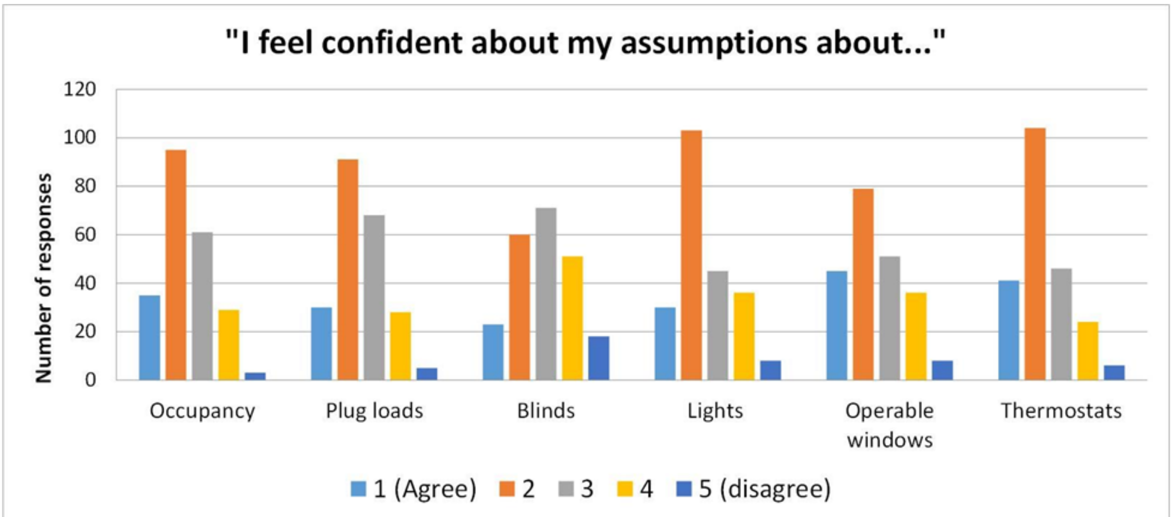



**Figure 1:** Sample results of survey of simulation users regarding their occupant modelling assumptions.

Prof. Liam O'Brien of Carleton University is the co-leader of the Annex responsible for setting the modelling and simulation guidelines for occupant behaviour in commercial buildings. Prof. O'Brien and his Ph.D. students Sara Gilani and Burak Gunay have been working to make occupant models reliable, scalable, transferable, and readily-available in building performance simulation tools. To this end, O'Brien and his team focus on occupant models that treat humans as a blackbox to seek statistically meaningful input-output relationships — instead of explicitly characterizing the human physiology. The light switch model by Prof. Christoph Reinhart from MIT is one early example of such occupant models. He monitored occupants' light switch behaviour in office spaces and came up with the relationship explaining the likelihood of light switch-on actions at occupants' arrival as a function of the workplane illuminance (see Figure 2).

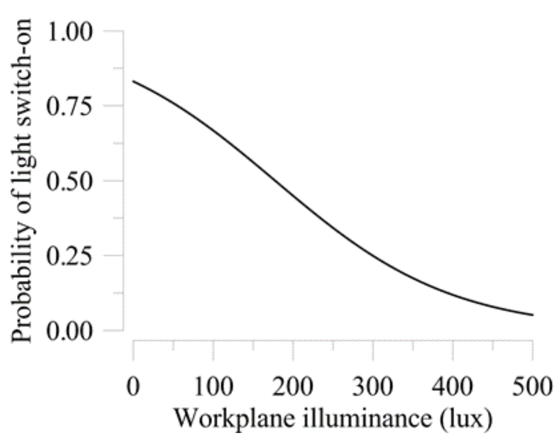



**Figure 2**: Sample of an occupant model, describing the probability that an occupant turns on their office light upon arrival (source: Reinhart, 2004).

Continued...

Updates on IEA EBC Annex 66 ...continued

Since 2004, there has been a surge of occupant behaviour models that attempt to mimic the way occupants interact with numerous building components (blinds, lighting, operable windows, thermostats, clothing, presence, plug loads). In time, the model complexity have escalated (to over several hundred lines of code) beyond what a typical building simulationist would be willing to incorporate in their building models. Thus, O'Brien and his team gathered a library of the occupant models from the literature for predicting occupancy and use of operable windows, blinds, lighting, and clothing for offices. They contrasted their predictive consistency and implemented them in the BPS tool EnergyPlus through its EMS application. They have made the model scripts publicly available at: http://carleton.ca/hbilab/2015/the-hbi-lab-has-implemented-20-occupant-behaviour-models-in-energyplus/ and a related journal article was published at the Journal of Building Performance Simulation titled "Implementation and comparison of existing occupant behaviour models in EnergyPlus".

Beyond incorporating occupant behaviour models in BPS tools, analyses of occupant behaviour-related performance data can provide invaluable insights for enhancing building operation. Occupant movement detection using motion detectors provides information about occupancy patterns and lighting use patterns provides information about visual comfort preferences. The availability of and demand for low-cost sensing technologies and building automation systems (BAS) in today's office buildings render the potential for developing data-driven occupant behaviour and presence models (e.g., Figure 3). O'Brien and his team have been working on an occupant modelling toolkit which inputs common data structures that exist in a building automation systems (BAS) (e.g., movement detections by a passive-infrared motion sensor and light switch actions) to generate a large number of occupant behaviour and presence models. The toolkit contains a series of computer programs that (1) access the BAS through an application programming interface, (2) develop models representing the occupancy, lighting, blinds use, and plug load characteristics, and (3) implement the models in the BPS tool EnergyPlus via its EMS application. The toolkit and a tutorial for using its functionalities are available at the Carleton Human Building Interaction Lab webpage (www.carleton.ca/hbilab).

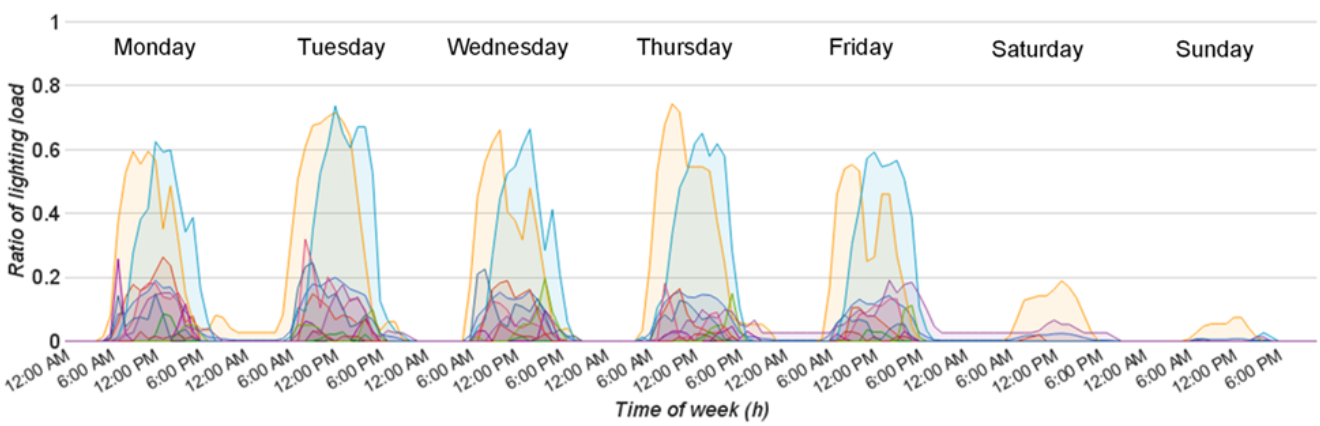



**Figure 3**: Average weekly lighting load in ten private professor offices at Carleton University.

Note: The participation in this IEA activity is funded by NSERC SNEI.

# Research outcomes of the 5-year IEA SCH Task 40/EBC Annex 52: Towards Net-Zero Energy Solar Buildings

Josef Ayoub, Liam O'Brien and Andreas Athienitis

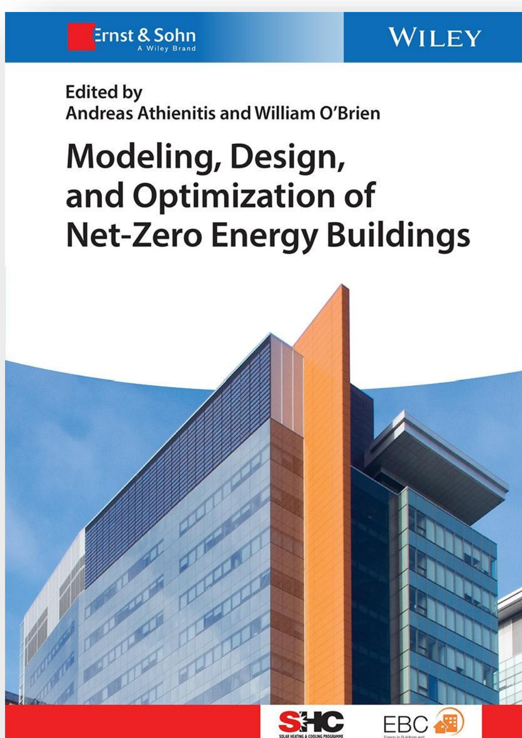
It is widely known that buildings are responsible for about 30-40% of energy use and greenhouse gas emissions on a global level. One effective and ambitious approach to address this is Net Zero Energy Buildings (Net ZEBs). The recently completed, 4-year, 82-expert, 19-country IEA SCH Task 40/EBC Annex 52 (T40/A52) research aimed to greatly increase our understanding of the design and technologies of Net ZEBs, while also disseminating this information to designers around the world.

The T40/A52 program had very significant involvement of researchers from SNEBRN and NRCan. The participants from Canada included Andreas Athienitis, Jose Candanedo, YuXiang Chen, Scott Bucking, and Liam O'Brien, Costa Kapsis and Veronique Delisle. Notably, this international engagement played an instrumental role for PhD students, many of whom became professors towards the end of the T40/A52 Project. The Project Operating Agent was Josef Ayoub.

Among the major achievements of T40/A52, technology transfer and dissemination to researchers and building designers was a major objective. Two recent projects include:

- an advanced book titled *Modeling, Design, and Optimization of Net-Zero Energy Buildings* and edited by Drs. Andreas Athienitis and Liam O'Brien (of SNEBRN) . This was mainly the work of subtask B co-led by Athienitis and O'Brien.
- a position paper titled *Actions Needed to Pave Way for Net Zero Energy Buildings* by Josef Ayoub of NRCan

The book, recently published by Wiley and Sons, involved approximately 20 international authors and covers a wide range of topics: modelling fundamentals for buildings; Net ZEB-enabling technologies; design processes and design team roles; simulation and optimization-aided design; grid-interaction issues; and case studies. The four case studies (shown below) represent an important part of the book as they provide a qualitative and quantitative assessment of performance. The authors of the case studies were involved from building conception to post-occupancy evaluation, and are thus intimately familiar with the buildings. Each case study also provides a simulation-based retrospective redesign, whereby the performance of various design and operational changes are assessed. The book is currently available directly from the publisher (see links at the end of the article).

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Four Net ZEB case studies (clockwise from top-left): ÉcoTerra house, Eastman, QC[1]; LEAF House, Italy[2]; EnerPOS, Reunion Island[3]; NREL RSF, Boulder, Colorado[4]

From his helm at Operating Agent of T40/A52, Josef Ayoub wrote a 10-page position paper. The paper represents a detailed summary of the hard work of the 80 T40/A52 experts from 19 member countries during 2009 to 2013.

One of the fundamental tasks of project was to establish a comprehensive list of Net ZEB definitions from member countries (see Marszal et al. 2011). While the definitions remain plentiful and incorporate nuances about carbon emissions, economics, and boundaries and scope, a widely understood definition is that a net-zero energy building collects enough on-site renewable energy to balance or exceed the building energy use on an annual basis. It is further understood that a near-optimal combination of passive design, energy efficiency, and renewable energy systems should be used. Moreover, integration of architecture and technologies is key. While net-zero energy could be achieved for standard buildings with over-sized renewable energy systems or purchased off-site renewable energy, this is strongly discouraged. This is because the target to collect renewable energy on-site represents a challenging and often ambitious goal that pushes designers to focus on integration and symbiotic opportunities. Furthermore, there is a grid-scale penalty if numerous Net ZEBs have high coincident demand from the grid and supply to the grid. As per the last point, T40/A52 devoted considerable effort into defining grid mismatch on different temporal scales.

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[1]Image courtesy of Agnieszka Koziol

[2]Image courtesy of Loccioni Group

[3]Image courtesy of Jérôme Balleydier

[4]Image courtesy of Dennis Schroeder, NREL

Continued...

The T40/A52 experts suggest the following steps for Net ZEB designers:

1. Optimize passive design including building form, window type and placement for daylighting and solar gains, envelope insulation, active/passive shading devices, and thermal mass.

2. Maximize efficiency of both the heating and cooling systems (including controls and operating strategies) and lighting and appliances.

3. Produce enough on-site or nearby renewable energy to balance the building energy use.

Rather than a linear design process, the above steps should be iterated between to achieve both high performance and economic feasibility. In many instances, the diminishing returns of efficiency measures can cause renewable energy to become more economical at a certain point.

A benefit to the widespread goal of net-zero energy buildings is that they are a major driver for innovation including technologies and software design tools. Regardless of the economics, there remain fundamental limits to the possible size of Net ZEBs since solar energy collection area is often limited to the roof and south façade. Major existing barriers regarding technology include:

- robust and reliable off-the-shelf heating and cooling technologies that integrate with solar collectors and short-term and seasonal thermal storage
- low-cost, high-efficiency building-integrated photovoltaic, solar thermal, and hybrid solar collectors that perform well in the Canadian climate (e.g., wide range of temperatures and snow cover)
- high-performance windows with smart solar gain control

Meanwhile, simulation tools are needed to aid with design and to demonstrate that a building will achieve net-zero energy. Net ZEBs typically use innovative technologies, technology configurations, and operating strategies that may not be available in existing tools. While research-grade tools (e.g., ESP-r and TRNSYS) can facilitate some of this design work, these tools are not well geared towards most designers. Thus simplified tools that enable designers to explore many different design options for Net ZEBs are needed.

In order to disseminate research findings, the experts documented many case studies (see references below) for numerous climates. While T40/A52 ended about two years ago, research remains more active than ever. Many of the collaborations that formed during the four-year project have continued, with new related IEA SHC or EBC Programme projects emerging frequently.

**More information:**

- T40/A52 main website: http://task40.iea-shc.org/.
- Textbook purchase: http://ca.wiley.com/WileyCDA/WileyTitle/productCd-3433030839,subjectCd-AR20.html
- Full A40/A52 position paper: https://www.iea-shc.org/data/sites/1/publications/IEA-SHC-NZEB-Position-Paper.pdf
- Report with 30 Net ZEB case studies: https://www.iea-shc.org/data/sites/1/publications/T40A52-DC-TR1-30-Net-ZEBs.pdf
- A.J. Marszal, P. Heiselberg, J.S. Bourrelle, E. Musall, K. Voss, I. Sartori, A. Napolitano, Zero Energy Building – A review of definitions and calculation methodologies, Energy and Buildings, Volume 43, Issue 4, April 2011, Pages 971-979

# SNEBRN Researchers at McMaster University Awarded Funding to Build an Integrated Energy Systems Facility

Kelton Friedrich, M.A.Sc., Sustainable Energy Analyst, Hatch Centre Project Coordinator

McMaster engineering and SNEBRN researchers Drs. Jim Cotton and Marilyn Lightstone are part of a research team aiming to improve system-wide energy efficiency and reduce power losses during major weather events. The team has received $1.9 million in funding from the Canada Foundation for Innovation (CFI) with matching funding from Ontario's Ministry of Research and Innovation to invest in the new Research Facility for Integrated Building Energy Harvesting System (ReFIBES) on the McMaster campus. ReFIBES will be an in-house system serving as a test lab within the Gerald Hatch Centre for Engineering Experiential Learning, currently under construction at McMaster University. The goal of this project is to advance knowledge of how buildings and their supporting energy networks can be designed together to improve system-wide efficiency while also providing structures with more resilience to power losses during major weather events.

Gerald Hatch Centre for Engineering Experiential Learning, McMaster University (estimated completion: early 2017)

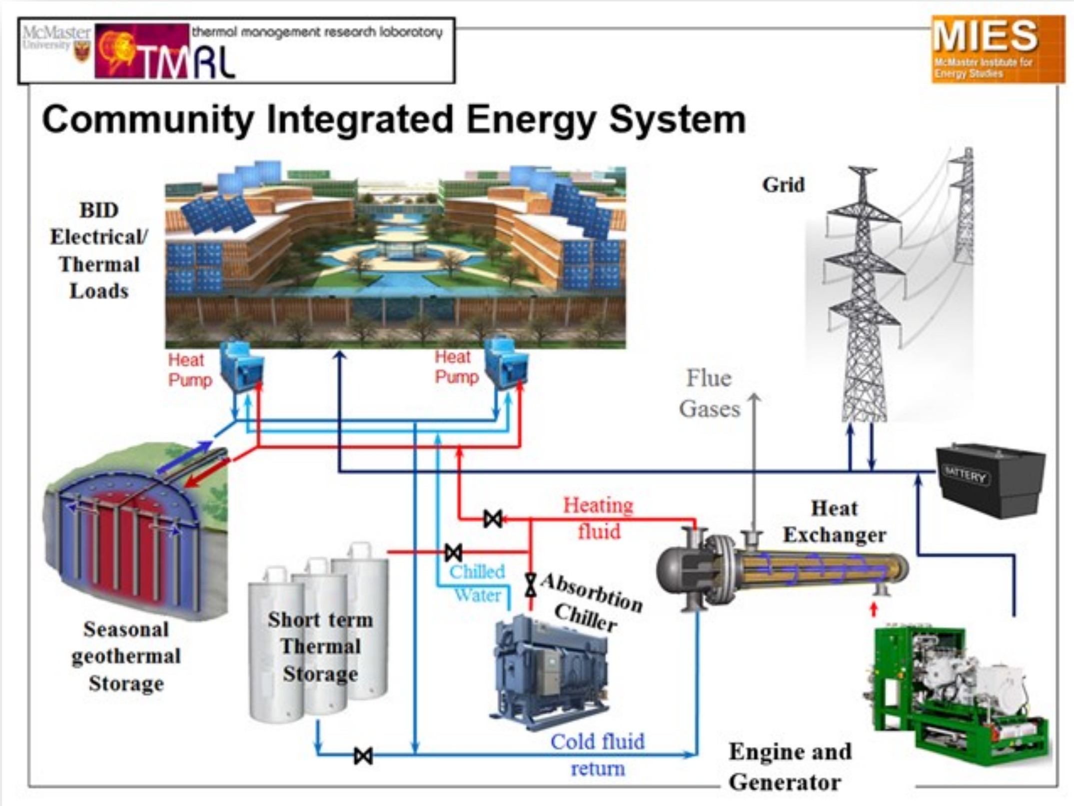
By integrating typically siloed energy pathways of electricity, natural gas, and transportation where these paths meet — at buildings in our communities — greenhouse gas emissions can be reduced and electrical grid peak power demand can be more effectively managed. This research will support the implementation of energy plans of more than half of Canadian municipalities.

This research facility will build on the work of SNEBRN, as net-zero energy buildings are high performance buildings that are the foundation of any community energy system. The research aims to advance smart buildings by going beyond focusing on individual building performance to focusing on the energy performance of all energy systems of which buildings are connected to. By intelligently linking buildings together through various energy pathways, further improvements to the performance of energy networks can be realized.

For example, by distributing thermal power generation near distributed loads, through Combined Heat and Power (CHP), there is the potential to harvest what would otherwise be waste heat for centralized thermal power plants. This distributed generation also reduces transmission line losses and, when arranged as a micro grid, can prevent power loss to buildings by avoiding dependence on transmission lines that can be disrupted by major weather events.

Continued...

Integrated Energy Systems Facility ...continued




CHP combined with building integrated renewable generation enables clusters of linked buildings to become neighbourhood Community Energy Nodes functioning like mini power plants that can help address peak electricity demand more efficiently and with less greenhouse gas emissions than current peaking power plants. Thus smart buildings in Community Energy Nodes contribute to the improved performance of the whole energy system, in addition to individual building performance gains and improved building resiliency (ability to provide local power during power outages). Investment in Community Energy Nodes spur local Economic Development as renewable generation on site and more efficient use of imported energy keeps more energy related expenditures within the local community.

The research facility will allow for investigations into how various technologies at the building and community energy node level can be integrated together to maximize the regional, provincial or national energy system performances. The initial equipment inventory includes:

Combined Heat and Power
Absorption Chiller
Water to Water Heat Pump
Renewables (Solar PV, Solar Thermal, Wind)
Direct Current Micro Grid (AC&DC Distribution)
Electrical Vehicle Charging
Thermal Storage (Phase Change, Geothermal)
Electrical Storage (Battery)
Energy Balance Sensor Array

The facility will have a data historian that will allow all sensor data to be accessed online. SNEBRN members are encouraged to reach out to the McMaster team if they are interested in collaborating. The 2016 SNEBRN AGM being held at McMaster University provides an opportune time to initiate collaboration with the McMaster team.

# Nano-thin Diamond-Like Carbon Smart Solar Control Coatings

**Nazir P. Kherani, University of Toronto**

Diamond-Like Carbon (DLC) based solar control coatings promise a new platform of low-cost optically and thermally smart tunable solar control coatings for buildings, greenhouses, windshields and transparent media.

With a drive towards energy efficient buildings, a key research focus in recent years has been the development of smart coatings that modulate energy transfer across windows in order to reduce heating and cooling loads, resulting in energy cost savings. One of the key sources of energy transfer through windows is radiative heat transfer by means of infrared radiation. Recent window designs include transparent optical coatings, known as solar control coatings, which are designed to reflect infrared radiation and reduce heat loss. Traditional coatings however are comprised of high-cost and functionally inflexible materials such as transition metal and rare earth oxides. Researchers at the University of Toronto have developed a low-cost carbon-based platform of highly tunable high-efficiency solar control coatings. The range of tunability allows for the development of unique solar control coatings that can be designed for specific climates and applied in niche applications such as coatings for greenhouses and urban farming.

The presentation entitled “Diamond-like Carbon based Passive and Smart Solar Control Coatings”, given by Kenji Clark with co-authors A. Khalatpour, P. Mahtani, H. Daneshvar, R. Ko, and N.P. Kherani, won the best poster award at the recent Smart Net-zero Energy Buildings Research Network conference held in Saskatoon. The nano-thin DLC based coatings are scalable and can be produced using low-cost industry standard plasma enhanced chemical vapour deposition processes on large area flexible substrates. Optimized DLC structures have the potential of achieving visible light transmissivity (VLT) values approaching 76% (with transmissivity in the visible at or greater than 80%) while concurrently providing total solar energy rejection (TSER) value of up to 0.61. Efforts are underway to transfer the technology to industry.

(Contact: Nazir P. Kherani, University of Toronto – Email: Kherani@ecf.utoronto.ca)

Sample of a high-transparency nano-thin diamond-like carbon based solar control coating on a glass substrate.

Best Poster Prize awarded to Kenji Clark by Dr. Terry Hollands; accepted by Dr. Nazir Kherani

# CanmetENERGY & Concordia University host the Experts Research Forum on Intelligent Buildings

Gerald Parnis[1], Concordia University

SNEBRN Researchers, graduate students and Government/Industry Partner Representatives met with other researchers and government/industry representatives from Canada and USA on April 21, 2015 at Concordia University, to discuss the roles of controls, algorithms and automation needed as part of the backbone of building operation and management. This Experts Research Forum on Intelligent Buildings was primarily organized by CanmetENERGY, NRCan and Concordia Centre for Zero Energy Building Studies (CZEBS) in collaboration with NSERC/Hydro Québec Industrial Research Chair and SNEBRN.

The forum was organized around 3 themes: Automated building performance and assessment; Advanced dynamic controls; and Responsive buildings to future smart grids. The morning session consisted of 2 keynote and 6 theme presentations (2 per theme). The afternoon consisted of two sections: 3 parallel breakout sessions where the current state, research gaps and future research and development directions were discussed for each of the themes; followed by a plenary during which the results and summary of the theme breakout discussions were presented to all participants.

The forum began with keynote presentations by Dr. Andreas Athienitis, Scientific Director of SNEBRN & CZEBS and George Hernandez, Staff Scientist, Pacific Northwest National Laboratory, US Department of Energy. Dr. Athienitis discussed controls in building research in terms of Model Based Control (MBC) and Model Predictive Control (MPC) strategies which take forecasts of weather, occupancy pattern prediction, energy loads and energy prices as inputs and determining optimal building operation over various time horizons. Building controls differ from traditional process controls due to the need to consider human comfort and behaviour. George Hernandez stressed the current state of play with controls in the US from a practical standpoint. Current sensor/control systems are not autonomous, that is they do not: self-configure, self-setup, or self-optimize and the continuous configuration effort required for stable and/or efficient operation, drives costs up. Advanced sensor/control systems are expensive, thereby hindering building operation optimization; thermostats are typically deployed across too large a space to achieve proper conditioning; and controls are isolated among components, systems and buildings. Cheap, reliable and open-source sensors are required to reduce costs and better sensor communications within buildings and between sensor/control systems and electrical grids are required to improve performance and efficiency.

Andreas Athienitis (left) and George Hernandez (right) deliver keynote presentations at the Intelligent Buildings Research Forum

[1]Content based on or quoted from the report: *EXPERTS RESEARCH FORUM ON INTELLIGENT BUILDING, CanmetENERGY, NRCan*

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Experts Research Forum on Intelligent Buildings ...continued

**Theme 1: Automated Building Performance and Assessment**

Under this theme, a variety of issues and topics related to automation of buildings controls were discussed. Before implementing advanced controls, it is important to ensure that a building functions according to its intended design; this is often incorrectly assumed. Automated Fault Detection and Diagnostics (AFDD) can contribute to ensuring this, but AFDD is in its infancy. Current AFDD research includes virtual sensors, plug-and-play AFDD and evaluation of FDD tools. Barriers to uptake of AFDD technology needing to be addressed by future research include the cost and the uncertainty of the benefits and performance. Future research needs include quantifying FDD benefits through cost/benefit analysis; decentralizing intelligence to the component/sensor level; development of data analysis techniques that are scalable and economical; and development of incentives for building managers/operators and equipment developers to adopt AFDD systems.

**Theme 2: Advanced Dynamic Controls**

Turning to a sub-category of Building Automation, this theme dealt with the many facets of dynamic building controls that show promise or require development. The complexity of building operation increases significantly with the integration of renewable energy and adoption of increased energy efficiency targets and this increased complexity motivates the use of Advanced Controls, involving the rich convergence of Computing Technology and Building Automation Systems (BAS). Issues such as BAS security, management/integration of various communication protocols (e.g. BACnet, LonTalk, ZigBee) and implementing financial transaction models for managing electric power generation/consumption are examples of complex challenges for Advanced Control Systems. In terms of scalability, adaptability and portability, current gaps in building control system cited by theme 2 participants include the lack of plug-and-play and inconsistent control performance across different buildings. Reliability and maintainability gaps were also highlighted with the suggestion that providing the proper amount of information about building-control system interactions to the building operator would contribute to removing these gaps. Data issues including availability, reliability and management are also significant when considering the implementation and operation of building control systems. On-site data often has periods of unavailable or inaccurate data (e.g. due to improperly calibrated sensors). Sophisticated data processing infrastructure must be considered due to the large amounts of data to transmit/store/share and the presentation of this data is a significant challenge. Incompatible data platforms also pose challenges to data integration for building-wide control systems. Therefore, building data standards are required.

Theme breakout discussions generated many ideas and issues concerning Building Controls, later presented to the forum

Issues relating to human interaction also impact the adoption and development of building controls. There is a lack of effective interaction/communication between the Engineering and Architectural disciplines: building engineers, operation engineers and architects each have varying involvement during various stages of the lifetime of a building. Occupants and homeowners often have limited knowledge of building control system functionality resulting in the underuse of the control system and its generated output information. Better collaboration between university and industry; and better regulated dissemination of building data and intellectual property, would improve controls development. Legal issues can become barriers to collabora-

Continued...

tion. The establishment of building data archives (including case studies) and presentation infrastructure, currently not promoted in Canada, would encourage collaboration and research in building controls. Researchers need to be encouraged to virtually test their innovative control solutions using this data that originates from various types of buildings.

Modelling is a critical activity for the development of novel building controls. Process dynamics is important (e.g. load/ variation of a smart grid) and more emphasis needs to be paid to adaptive/learning models. Adaptive models enable the application of system identification techniques without tampering with the operation of the building control system. Most present-day techniques apply to open-loop systems, resulting in the limitation of only being able to model a building using real data before occupancy. Occupant behaviour modeling is still a challenge and becomes more complicated when occupants are given limited operating options and attempt to locally take over or trick control system sensors. Model Predictive Control (MPC) is a concept/technique that originated in engineering disciplines not directly related to buildings, but is now applied to building operation and control. Unique aspects of MPC when applied to buildings are the type of data used, considerably long prediction horizons and various sampling rates for varying building types.

Finally, the use of energy storage devices needs to be promoted as this will play a key role in making advanced building control solutions more beneficial and cost-effective.

**Theme 3: Responsive Buildings to Future Smart Grid**

In the near future, the relationship between buildings and utility grids will become more dynamic, featuring a bidirectional exchange of energy and information. Energy grids themselves will become more resilient, flexible and dynamic and include more distributed energy sources. This theme dealt with roles that building controls will play in these changes in grid operation and functionality including the ability of building systems to be significantly more responsive to pricing signals and demand-response triggers.

A smarter, more robust grid will require both Demand Response (DR) functionality and the ability to incorporate distributed energy sources and these in turn require improved and secure communications between utilities and loads. In addition, improved grids will require knowledge of the characteristics of: users (impacts: comfort, productivity), storage (e.g. electric vehicles) and loads (as a function of time, DR). The aims of these grid enhancements are peak load shifting and peak demand reduction. The motivations for utilities to implement these changes are energy production/generation cost reductions, a reduced number of blackouts and overall improved operating efficiencies.

In order for buildings (residential and commercial) to effectively participate in DR a value proposition must exist; currently and especially in the residential sector, energy cost savings are too minimal to motivate utility customers. Québec does not have time-based electricity pricing. A secure and effective transaction protocol needs to be developed for DR information to be exchanged between buildings and utility grids. Challenges for Building Automation Systems include the ability to optimize operation while accounting for dynamic energy pricing (dealing with volatility), conversion or replacement of analog controls which are dominant in existing building stock, rationalizing the upfront costs and relinquishing some control.

DR technology gaps cited include the need for improved (load) forecasting methods; the need for online load building models (direct models are difficult to implement); BAS are currently oriented for comfort and not energy; and building sensor organization is ad hoc and difficult to map.

# AWARDS

### Ted Stathopoulos Receives the 2015 Honorary Doctorate Award from Eindhoven University, The Netherlands

On April 30, 2015, the Doctorate Board of the Eindhoven University of Technology (TU/e), The Netherlands, awarded Dr. Ted Stathopoulos, Network Researcher and Concordia University Professor, an honorary doctorate for his “outstanding achievements in the field of Building Physics, Urban Physics and Wind Engineering”. The decision to award Ted the 2015 Doctor Honoris Causea was made unanimously by the Doctorate Board at TU/e. This is the highest honour given by TU/e in recognition of Ted’s many “contributions to the modelling of wind load effects on structures with applications to building standards, forming the basis for wind design of low-rise buildings in the National Building Code of Canada”.

TU/e is active in the field of wind engineering and building aerodynamics and has collaborated with Ted on much research in this field. This award will strengthen the existing ties between TU/e and the Centre for Zero Energy Building Studies (CZEBS) at Concordia University fostered by Ted’s work. A detailed description of Ted’s research, contributions and achievements can be found here: *http://www.concordia.ca/faculty/theodore-stathopoulos.html.*

Ted was presented his honorary doctorate in a public session at TU/e on April 30, 2015 followed by a symposium held in his honour for which he gave a keynote address: Wind Effects on Buildings and Their Codification. A complete video recording of Ted’s doctorate presentation and acceptance speech can be found here: *https://youtu.be/pW1ZNRBoUl4.* Congratulations to Dr. Ted Stathopoulos for this prestigious and well-deserved award.

Ted Stathopoulos receiving the 2015 Honorary Doctorate Award at Eindhoven University, The Netherlands

### Scott Bucking, Andreas Athienitis and Radu Zmeureanu given the 2014 ASHRAE Technical Paper Award

The award was given for the SNEBRN Researchers’ paper: *Multi-Objective Optimal Design of a Near Net Zero Energy Solar House*.


Scott Bucking (left) and Radu Zmeureanu (right) receiving the 2014 Technical Paper Award at the ASHRAE Conference, June, 2015

Radu Zmeureanu was also recently inducted as an International Building Performance Simulation Association (IBPSA) Fellow. This award is given to “individuals who have attained distinction in the field of building performance simulation, through education, research, practice, and/or simulation tool development”.

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Awards..continued

## Carey Simonson and Robert Besant receive an NSERC Synergy Award for GHG and Cost Cutting HVAC Equipment Development

SNEBRN researcher and University of Saskatoon Professor Carey Simonson and colleague Professor Emeritus Robert Besant have been awarded a Synergy Award for Innovation from the Natural Sciences and Engineering Research Council (NSERC) for their collaboration with Venmar CES, Inc. Venmar CES is a Saskatoon-based manufacturer of energy-efficient solutions for the commercial ventilation market.

Simonson, Besant and their mechanical engineering students worked closely with Venmar CES to test and develop a new energy exchanger for the company's HVAC system. The system has the potential to improve indoor air quality and significantly reduce both the cost and greenhouse gas emissions of heating and cooling systems in buildings by up to 50%.

The award, presented during a ceremony on February 19, 2015 at Rideau Hall, the official residence and workplace of the Governor General in Ottawa, recognizes examples of collaboration that stand as a model of effective partnership between universities and industry. The two researchers will receive a $200,000 research grant from NSERC and Venmar CES will receive a $30,000 credit toward a future NSERC Collaborative Research Development (CRD) grant.

Carey Simonson (left) and Robert Besant (right) receive a Synergy Award from His Excellency the Right Honourable David Johnston, Governor General of Canada, Feb 2015. *Photo credit: Sgt Ronald Duchesne, Rideau Hall ©OSGG-BSGG, 2015.*

Robert Besant gave a well-received luncheon speech at the 4th SNEBRN AGM in Saskatoon, May 20, 2015.

## Cynthia Cruickshank given the 2014 CMHC Excellence in Education Award

SNEBRN Researcher and Carleton University Associate Professor Cynthia Cruickshank has won the 2014 Canada Mortgage and Housing Corporation (CMHC) – Excellence in Education Award, honouring outstanding educational contributions to sustainable practices. The award recognizes educators who have integrated sustainable concepts related to housing and community development into the academic curriculum.

# SNEBRN Board Chair Dr. Terry Hollands Receives Honorary Doctorate from Concordia University

On June 10, 2015, Dr. Terry Hollands, Board Chair of SNEBRN and University of Waterloo Researcher, was awarded an Honorary Doctorate from Concordia University during the university spring convocation held at Place des Arts in Montreal.

The following Citation was read by Dr. Andreas Athienitis at the 2015 Spring Convocation for Faculty of Engineering and Computer Science, Concordia University. A video recording of the reading of the citation, Honorary Doctorate presentation and acceptance speech by Terry Hollands can be viewed here: https://www.youtube.com/watch?v=fZUi43iu8HE

*Mr. Chancellor, it is my honour to present to you K.G. Terry Hollands, distinguished Professor Emeritus in the Department of Mechanical and Mechatronics Engineering at the University of Waterloo.*

*Few Canadians have contributed more to the art and science of solar energy than Dr. Hollands. A pioneer in his field, Dr. Hollands has both refined the technology surrounding solar energy and advocated for its feasibility and adoption both in Canada and abroad.*

*After obtaining degrees in Engineering Physics and Chemical Engineering from the University of Toronto and McGill, Dr. Hollands began his career working for the Australian Government in thermal energy research during the 1960s. From 1969 to 2001, he inspired generations of students as a professor at the University of Waterloo. He excelled in training graduate students; many of his former students went on to make important contributions to solar energy utilization and energy efficiency. His lasting influence is felt among students today thanks to his efforts to transform the university curriculum to include sustainability, energy efficiency consumption, energy security, greenhouse gases and numerous other environmental issues.*


Dr. Terry Hollands, Board Chair of SNEBRN receives an Honorary Doctorate Award from Concordia University, June 2015

*Dr. Hollands' scholarly work has been prolific. He has authored or co-authored 120 journal articles, 100 articles in conference proceedings and several books. He also served as the Editor-in-Chief of the influential international journal Solar Energy.*

*Dr. Hollands' research has had a direct and practical impact on Canadian industry and the design of solar products. Among his innovations, Dr. Hollands pioneered new technologies for windows that help reduce greenhouse gas emissions. They have been widely adopted by the building industry.*

*Dr. Hollands served as Chair of the Board of Directors of the NSERC Solar Buildings Research Network. He is currently Chair of the Board of the Smart Net-Zero Energy Buildings Strategic Research Network. Headquartered at Concordia, the network is a pan-Canadian, multi-university group that specializes in eco-friendly building research and solar energy.*

*A Fellow of both the American and Canadian Societies of Mechanical Engineering, Dr. Hollands has received numerous accolades during his career. His many awards include the Weeks Achievement through Action Award, the Special Service Award of the International Solar Energy Society, and the Chandrashekar Lifetime Service Award of the Solar Energy Society of Canada.*

*Mr. Chancellor, on behalf of the Senate and the Board of Governors, it is my great privilege and honour to present to you K.G. Terry Hollands, so that you may confer upon him the degree of Doctor of Science, honoris causa.*

# Recent SNEBRN Graduate Students Given Academic Appointments

Four Network graduate students were given academic appointments in Canada and the US during 2014-2015. YuXiang Chen, Scott Bucking and Caroline Hachem-Vermette are recent PhD graduates of the Building Engineering Program at Concordia University and Getu Hailu is a recent PhD graduate from the Department of Mechanical and Industrial Engineering at Ryerson University.

**Scott Bucking**
Scott is an Assistant Professor in the Department of Civil and Environmental Engineering and the Azrieli School of Architecture and Urbanism at Carleton University. As part of the further development of the multidisciplinary collaboration between Civil Engineering and Architecture Departments at Carleton, the purpose of this position is to improve digital modelling capabilities at Carleton University with a research focus on the design of net-zero energy communities. In particular, improving the interoperability between building information models and energy modelling tools is of immediate focus. Scott is currently teaching the Architecture Technology I course at Carleton.

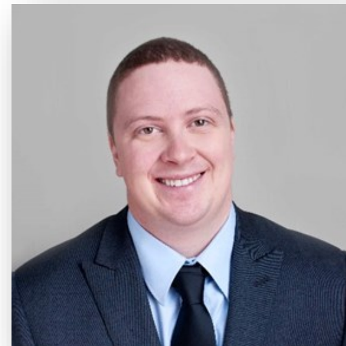
**YuXiang Chen**
YuXiang is an Assistant Professor in the Nasseri School of Building Science & Engineering, Department of Civil & Environmental Engineering, Faculty of Engineering at University of Alberta. His research interests include the modeling, design and operation of building-integrated thermal energy storage; integrated design and operation for room thermal conditioning, daylighting, and electric lighting; and high-performance buildings for remote areas in cold climate; and energy flexible buildings, from grid/occupant perspectives. He is currently teaching Engineering Mechanics (Statics) and Fundamentals of Building Science .

**Caroline Hachem-Vermette**
Caroline is an Assistant Professor in the Faculty of Environmental Design at the University of Calgary. Her research interests are: high performance building envelopes, energy enhancement in mixed-use multi-story buildings, energy efficiency, adaptable pre-engineered architectural structures, resilient design and solar optimized communities. Her teaching roster includes Sustainability in the Built Environment, Architectural Lighting Design, Environmental Control Systems and Advanced Special Topics in Environmental Design (Solar Envelope Design). Caroline is a SNEBRN Researcher and leader of Project 5.2, Design of New Solar Communities.

**Getu Hailu**
Getu is an Assistant Professor in the Department of Mechanical Engineering and the director of Thermal Systems Design Laboratory at the University of Alaska, Anchorage. His research interests include CFD analysis of Building Integrated Photovoltaic/Thermal (BIPV/T) systems, energy efficient buildings, renewable energy/solar energy and energy modeling. He teaches Thermal Systems Design, HVAC optimization and Turbomachinery.

# Recent SNEBRN Graduate Students Working in Government and Industry

**Eric McDonald**



As part of the SNEBRN network I had the opportunity, as part of my Master of Science (MASc) research project, to work on contributing and developing new ongoing commissioning models and software tools directed to reduce the net energy consumption of commercial and institutional buildings. I was able to develop and grow my skills in building energy simulation and modelling from my work, and also from network supported conferences and workshops.

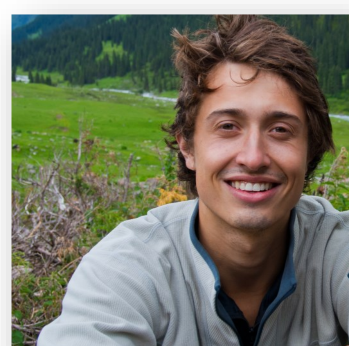
Currently I am a Research Engineer at CanmetENERGY-Varennes, where I am using the skills I developed from my participation in the SNEBRN network to work on projects directed to reduce the net energy consumption of houses, buildings and communities, reduce emissions of greenhouse gases and other pollutants in a Canadian context. Currently I am focusing on developing and adapting technologies to reach high performance, and developing and adapting technologies and practices to reduce diesel dependency in remote and northern communities in Canada.

**Andreea Mihai**

I have had the wonderful opportunity to pursue my graduate studies at Concordia University, supervised by Dr. Radu Zmeureanu. The topic of my research was "Calibration of building energy modeling tools using measured data from the building automation system". The unique building engineering program provided me with vast knowledge about building energy simulation, the uses of BEM in optimizing the energy performance of buildings, understanding the different models and assumptions used in the software, and the limitations still existent in the domain. Being part of the SNEBRN, has presented me with numerous opportunities to develop my communicating, technical writing and presenting skills. I have presented and wrote three articles for the International Building Performance Simulation Associates (IBPSA) Conference in Chambery, France (August 2013) and the International Conference of Enhanced Building Operation (ICEBO) in Montreal, Quebec (October 2013) and eSim Conference in Ottawa, Ontario (May 2014).

In August 2014 I started working at CanmetENERGY in Varennes, as a junior engineer. I am presently involved in the Low Carbon Initiative, which was launched in 2010, in response to the Federal Sustainable Development Strategy. The main goal of the program is to help Natural Resources Canada to attain and maintain its 17% reduction of departmental greenhouse gas emissions by 2020, compared to the reference year 2005-2006. In addition, along with the rest of the LoC working Group team, I am providing technical support during the design and implementation of high energy impact projects, as identified by the Federal Infrastructure Initiative and the Federal Building Initiative. Both energy and GHG emissions are tracked and reported, along with continuous optimization of building operations, in order to ensure continuation of savings from previous energy efficiency projects. It has been a very enriching working experience and I am continuously learning the ins and outs of the domain.

**Nicholas Zibin**



During my time at SNEBRN I conducted research related to ongoing commissioning and calibrated building energy simulation. One of my main research contributions was the development and testing of a new method to calibrate building energy models using building automation system (BAS) trend data. Another contribution was the creation of a new prototype software tool that automatically analyzed BAS trend data for use in ongoing commissioning.

I currently work at WSP Canada Inc. (Formerly Halsall Associates Ltd.) in Vancouver with the Sustainability Team. We help clients increase the sustainability of their buildings through services such as energy modelling, retro-commissioning, energy audits, and LEED management.

**NSERC Smart Net-Zero Energy Buildings Strategic Research Network**

**Réseau de recherche stratégique du CRSNG sur les bâtiments intelligents à consommation énergétique nette zéro**

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