NSERC Smart Net-Zero Energy Buildings Strategic Research Network

NSERC CRSNG

VISIT

www.solarbuildings.ca

Completion of the Network
By A. K. Athienitis, Scientific Director

This extensive issue of the newsletter reports on some of the Network achievements and activities and recent events. The Network completed its research activities on December 29, 2016. Technology transfer and policy-related activities continued until July 2017. We would like to thank the researchers, students, industry partners, our staff and our Board of Directors who made this Canada-wide collaboration so effective and productive.

Through NSERC strategic networks such as SNEBRN, we build partnerships across Canada that last much longer than the 5-year program and have both a direct and an indirect positive impact on Canadian society, its economic, social and technological progress. While the emphasis of the work was on applied research, significant advances were also made to the knowledge base on high performance buildings which aim to achieve net-zero annual energy consumption through energy efficient technologies such as geothermal heat pumps, solar source heat pumps, advanced windows, building-integrated photovoltaic/thermal systems and smart proactive controls. We also had significant impact on national policies.

Our final (5th) Annual General Meeting in Hamilton at McMaster University in May 2016 was a well-attended and productive 2-day event with an extensive range of activities, including an Industry Day with much participation from industry partners. The nearly 120 participants included researchers, students and partners. Canada's Building Simulation Conference eSim 2016, where much of the work of the Network was presented, took place right after our AGM, also at McMaster. The scope of eSim was expanded to include modelling, simulation and related experimental work. In addition, several building simulation workshops were organized where our students participated and most of the lecturers were from SNEBRN. Over 150 participants benefited from the four days of presentations and workshops at eSim.

Network researchers and students received several national and international awards and distinctions from organizations such as NSERC, ASHRAE, CAE and IBPSA, which are overviewed in this issue. The Network graduated/trained nearly 140 HQP. Our graduates are in high demand, with several joining government labs, universities as professors and industry partners. SNEBRN led international research initiatives such as IEA SHC Task 40/ EBC Annex 52 – Net-zero Energy Solar Buildings (NZEBs) and developed extensive international collaborations and partnerships. About 200 journal papers and over 300 conference papers were published from the research, one IEA book (Task 40) and several other books / book chapters. Several papers received best paper awards (e.g. ASHRAE). Several inventions are in the process of commercialization.

The Network contributed to the development of advanced labs and research facilities at several universities, including a large scale solar simulator and environmental chamber at Concordia, a geothermal borehole test facility at Polytechnique and CFI facilities and buildings at McMaster and Carleton.

The Network played a key role in the design of Canada's first institutional solar NZEB, the Varennes Library, in the Montreal area, officially inaugurated in May 2016. A team from Concordia is studying the performance of the building in collaboration with partners from Hydro Quebec, Regulvar and CanmetENERGY lab (Varennes). See this issue for more information.

The final activity of the Network was a two-day meeting and workshop Dec. 2-3, 2016 in Montreal at Concordia, attended by over 100 researchers, students and partners. A building envelope workshop was jointly organized with NRCan on Dec. 2nd, while panel discussions were held on Dec. 3rd to provide input to identification of research needs. The website of the Network will remain active and serve as a means of continuing technology transfer and dissemination. We look forward to continued discussion on future collaborations and initiatives.

Several senior SNEBRN researchers received important recognitions for their work, partly under the Network, with several becoming Fellows of the Canadian Academy of Engineering, Fellow of ASHRAE and Fellow of IBPSA

Final SNEBRN Annual General Meeting

Gerald Parnis*

The 5th and final SNEBRN AGM was held at McMaster University, Hamilton, Ontario on May 2, 2016. The one day meeting covered much ground and was well integrated with the 2016 eSim Conference held at McMaster University May 3-6, 2016 (see the story in this issue) with the majority of students attending the AGM presenting papers at the conference. Of the 80 eSim conference papers, 60 included at least one SNEBRN Researcher and/or HQP in the author list.

The proceedings opened with a welcome from Network Researcher and McMaster Professor Marilyn Lightstone, followed by a brief message from Network Board Chairman Terry Hollands and a presentation given by Network P.I. Andreas Athienitis.

McMaster Professor Marilyn Lightsone (left) opening the AGM. Network PI & Theme 2 presenter Andreas Athienitis (right)

***** *with input from Concordia University HQPs: Jennifer Date and Harry Vallianos*

Final AGM...continued

Network Theme Leaders then presented the cumulative achievements of each Theme to June 30, 2016, the original end date of the Network. The presentations also outlined the activities planned for the six month extension period ending Dec 30, 2016.

Theme Presentations (L to R): Ian Beausoleil-Morrison (T1), Marc Rosen (T3), Radu Zmeureanu (T4), Alan Fung (T5)

The Theme Leader presentations were followed by brief presentations by each of the 14 Project leaders who provided further details of the activities of each Project.

Project Presentations (L to R): H. Ge (P2.1), D. Naylor (P2.2), T. Stathopoulos (P2.3), M. Bernier (P3.1), L. Swan (P5.1)

Network Researchers Stephen Harrison and Michel Bernier chaired a panel discussion titled *Research Needs and Idea*s comprised of short presentations given by 6 Network Researchers. Liam O'Brien outlined the main shortcomings of Building Engineering practice and research in Canada. These shortcomings included a lack of research into occupant comfort, limited research in acoustics, lack of understanding of occupant behaviour and how building design should take this into account and finally the failure of buildings to achieve expected performance levels. Liam presented possible solutions including: an increase in demonstration projects that push technological limits, using university campuses as living labs to study areas such as occupant behaviour impacts and developing building/architectural engineering education to be more hands-on and incorporate/share "open data".

Research Needs & Ideas presentations, clockwise from top-left: (i) Liam O'Brien presenting, Stephen Harrison, Caroline Hachem-Vermette; (ii) Morris Flynn; (iii) Nazir Kherani; (iv) Jim Cotton

Caroline Hachem-Vermette presented building research topic suggestions relevant to communities. These included developing models/tools using existing communities for validation, integrating transportation and neighborhood spatial design into models/tools, exploring building retrofits at the community scale and developing methods for evaluating the climate change resilience of communities.

Jim Cotton presented various thematic research areas in the general category of Integrated Community Energy and Harvesting Systems, to be pursued at the Thermal Management Research Laboratory of the McMaster Institute of Energy Studies. These areas include: Community Integrated Sustainable Energy Systems; (Waste) Energy Harvesting and Storage; Community Energy Optimization; and Energy Policy Input and Impact on Economic Development.

Nazir Kherani presented a summary of his research in the area of *Energy Coatings* and their building applications. These coatings have been used in building glazing, greenhouses, orchards and PV/T systems, but do not have widespread uptake due to the cost. Nazir described the nano-technology-based coatings (Diamond-like Carbon, 3E Nano) developed by his research group at University of Toronto that have a higher performance and significantly lower manufacturing cost compared to current coatings (e.g. VLT, TSER). In his view, widespread adoption of these coatings on glazing surfaces of existing and new buildings would have a significant impact on building envelope thermal performance.

Morris Flynn explained his future research plans at University of Calgary including stratification studies in the built environment and investigating the integration of Phase Change Materials with storage tanks including stratification properties and their impacts on system optimization.

The afternoon session was dedicated to an Industry and Partner Panel Discussion chaired by Wayne Chang, (Director of Pivotry Consulting Inc.; SNEBRN Board Member) and Andreas Athienitis (SNEBRN Scientific Director; Concordia University Professor). Wayne Chang introduced the session and described the Masters programme at University of Waterloo, focusing on new technology commercialization strategies, in particular, the collaboration with Concordia University on the commercialization of BIPV/T solar facades.

**AGM Industry and Partner Panel Discussion: Chaired and Introduced by Wayne Chang (left).
Network Researcher Cynthia Cruckshank (right) reports on CHBA innovation initiatives.**

Cynthia Cruickshank reported on how the Canadian Home Builders' Association (CHBA) is supporting innovation in the Canadian residential construction sector. Following a brief introduction to the CHBA, she provided the results of a 2015 home buyer preference survey suggesting significant consumer interest in energy efficiency measures applied to home construction. The CHBA promotes Net-Zero Energy (NZE) housing through educational, financial and marketing initiatives as well as a labelling program. In terms of occupant behaviour, the CHBA has found that the average Canadian NZE-ready (80% designed NZE) annual energy consumption is 33-44% of the average Canadian home.
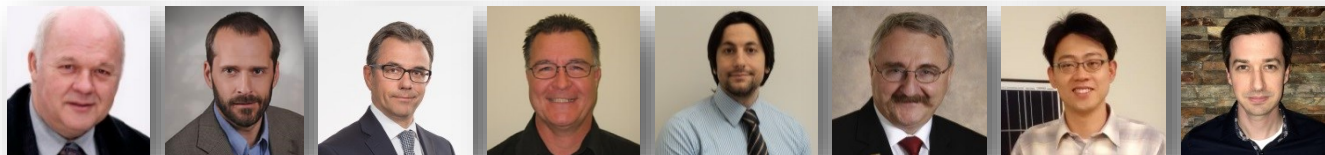
**AGM Industry and Partner Panel Discussion Participants (L to R): Gilles Jean, Jocelyn Millette,
Marc Dugre, Bernie McIntyre, Livio Nichilo, Roland Charneux, Wenda Zheng, Adam Neal**

Gilles Jean (NRCan; SNEBRN Board Member) described 3 barriers to the uptake of new energy-related building technologies. Firstly, lowest initial cost criteria place new technologies at a disadvantage. Secondly, conservative building managers expect short term paybacks resulting in very short term decision making. Thirdly, the architectural and engineering design process is being constrained by commercial demands. Gilles pointed out the importance of developing efficient and intelligent design tools; the need for predictive controls as the means towards grid responsive buildings; and the role that storage, heat pumps and non-vapour compression HVAC will play in renewable energy meeting 80% of building heating/cooling loads.

Jocelyn Millette (Hydro Québec; SNEBRN Board Member) discussed barriers (and possible solutions) to building engineering innovation from an energy utility and building owner perspective. Although there is a significant energy generation surplus at Hydro Québec, power constraints are growing (morning peak is currently 10% of the morning power demand) and Jocelyn indicated that Demand Response (DR) is a possible means to peak power reduction. Hydro Québec currently has a pilot project involving 35 of their buildings implementing DR that collectively contribute about a 20 MW power demand reduction. This pilot will soon be extended to commercial buildings. Although building controls are fundamental to good building performance, there are barriers to mass adoption namely, inherent complexity, lack of integration at the design stage and lack of standardization and open access to control algorithms.

Continuing the theme of building controls, Marc Dugre (Regulvar Inc.; SNEBRN Board Member) put forward the following issues as barriers to innovative applications of building controls: outmoded building codes; the perceived risk of adopting controls; and control technology design not informed by market knowledge while development/implementation is being guided by profit instead of providing useful functionality to building owners and occupants. Controls and associated devices (e.g. lighting technology) often lack open source access, limiting ease of integration into a cohesive building control scheme. Marc enumerated the technical skill and knowledge areas required for the building control development/deployment: telecom technologies, fuzzy logic algorithms, general computer programming skills, big data analysis techniques and building mechanical/electrical systems.

Final SNEBRN AGM ...continued

After a brief introduction to the Toronto and Region Conservation Authority (TRCA), Bernie McIntyre presented various general strategies the TRCA has adopted in response to climate change. These strategies include managing regional water resources, contributing to community development that integrates nature with the built environment, compiling and disseminating urban sustainability knowledge and fostering new partnerships and business models that are based on sustainability. Bernie outlined general areas that require investigation for building sector market transformation to occur including the identification of target markets and associated interests and the identification of technologies/practices that can meet these interests including how the technologies support low carbon communities and carbon risk management.

Livio Nichilo (Internat Energy Solutions Canada) discussed barriers to innovation for technology companies. He emphasized that dealing with technology patents is difficult and costly, product development schedules do not align with the academic calendar and early adopters of new technology are difficult to enlist. Reasons for the latter difficulty include: risk aversion, the building cycle is long (years) making timing difficult to coordinate and a general intolerance to "mistakes". Livio suggested that public programs such as Build Canada Innovation can help to enlist early adopters of new building technologies in projects they fund such as social housing.

Roland Charneux (Pageau Morel) brought a Building Engineering Consultant perspective to the topic of barriers to building innovation and solutions. Building systems are complex and there is a need for better/simpler system design. Building systems require better integration and this needs to be specified and incorporated as integrated building design. There is a lack of post-occupancy building performance data and this needs to be publicly available, for example, from a web location. The risk of early adoption of new technology can be mitigated by the development of demonstration projects (buildings) that are highly visible. Schools and colleges are good candidates because they expose a new generation to new building technologies. Building operations and management staff need training that provides information and know-how about new building technologies, while architectural students need training in building envelope topics and building systems.

The perspective of a large Photovoltaic (PV) manufacturer was given by Wenda Zheng (Canadian Solar) who discussed the barriers to BIPV uptake in the residential building sector. The business model of a BIPV project is not a traditional Engineering, Procurement and Construction (EPC) project based on power purchase agreement (PPA) with a third party (e.g. local gov't) thereby reducing risk by promising to purchase an amount of electricity. The issue of cost is central to the homeowner and this is especially relevant due to the lack of large scaled production of BIPV modules and resulting economies of scale. For some, a 5 year payback may be too long. In addition, a homeowner may be charged a financing or insurance penalty for deploying a new/unknown building element. The building industry has not sufficiently endorsed BIPV technology (e.g. building code enhancements for BIPV) and PV manufacturers and building engineering academics need to work actively together to promote BIPV. Wenda suggested that the PV industry partner with major architectural firms to standardize BIPV building elements, partner with the banking industry to perform due diligence studies, perform and publish safety and reliability studies and follow recent PV building codes in BIPV demonstration projects.

The final speaker of the afternoon session was Adam Neal from the Natural Gas Technologies Centre (NGTC) who discussed the role that natural gas can play in facilitating the transition to a low-carbon economy. Renewable natural gas is a promising technology that can be produced using excess electricity, providing an energy storage function. Biomethanisation (Anearobic digestion) and Syngas (Biomass gasification) are examples of other promising gas technologies.

Following a Q & A session, the AGM adjourned with the Network dinner held later in the evening. All speaker presentation files can be accessed from the SNEBRN fileshare.

Most HQPs attending the AGM presented papers at the eSim Conference (left).
AGM Network Dinner at McMaster University.

SNEBRN at eSim 2016
Gerald Parnis

The 9th biennial eSim building simulation conference, organized by IBPSA-Canada (the Canadian chapter of the International Building Performance Simulation Association), was held from May 2-5, 2016 directly after the 5th SNEBRN AGM; both events were held at McMaster University, Hamilton. One hundred and forty-six delegates from 5 countries (predominantly Canada) attended the conference with SNEBRN strongly represented. Of the 80 conference papers presented, 60 included at least one author who is a SNEBRN Researcher or HQP; this is a significant increase in SNEBRN research participation compared with the 2014 eSim Conference.

Network Researchers Drs. Marilyn Lightstone and Jim Cotton respectively chaired and co-chaired the conference. Following Dr. Lightstone's opening address, SNEBRN Scientific Director Dr. Andreas Athienitis gave a keynote address entitled "*Integration of Solar and Energy Efficiency Technologies: Towards Smart Net Zero Energy Buildings and Communities*".

Dr. Andreas Athienitis delivers the Day 1 keynote address at the eSim 2016 Conference

Over the two days of the conference, 80 conference papers were presented on topics from 8 different themes of building simulation including *Occupant Behaviour & Comfort*, *Simulation Tool Use*, *Modelling Physical Processes* and *Algorithms & Validation*. This paper count is an 11% increase compared with eSim 2014.

As part of IBPSA-Canada's support for building simulation research and in recognition of the expense of attending conferences, 3 *IBPSA-Canada Student Travel Awards* were presented at the conference. The selection criteria for these awards includes overall conference paper quality; relevance of the contribution to the field of and/or furthering the effective application of building simulation; and a direct relationship of the student thesis to building simulation. This year's 3 recipients are SNEBRN HQPs/PhD students from Carleton University: Zixiao Shi, Christopher Baldwin and Sebastien Brideau.

Network Researcher Liam O'Brien, PhD, President, IBPSA-Canada (left) and Simon Sansregret, former IBPSA-Canada board member (right) present IBPSA-Canada Student Travel Awards to (L to R): Zixiao Shi, Christopher Baldwin and Sebastien Brideau.

eSim Workshops

Six workshops on a diverse range of building simulation topics were co-organized by SNEBRN and IBPSA-Canada and given by SNEBRN Researchers and Collaborators. Thirty-three SNEBRN HQPs attended one or more workshops with the majority attending 2 or more, while 7 other conference delegates also attended workshops. Drs. Michaël Kummert and Michel Bernier from École Polytechnique de Montréal each gave practical TRNSYS-based workshops that were well attended: *Building Performance Optimization using TRNSYS* and *Modelling Ground-Source Heat Pump Systems using TRNSYS* respectively. The first workshop dealt with topics including building envelope optimization and HVAC system optimization, while the second centred on the modeling of borehole and heat pump systems. The workshop *Fundamentals of Building Occupant Modelling and Simulation* was given by Dr. Liam O'Brien and HQP Burak Gunay from Carleton University. This workshop covered associated research and practice as well as building occupant modeling techniques and design influences, using EnergyPlus-based exercises. Dr. Costa Kapsis from Concordia University led the workshop *Performance Simulations of Advanced Building Skins* which included the analysis of new building skin materials and responsive/adaptive skin designs through performance simulations using EnergyPlus. Dr. Leon Wang (Concordia University) ran the workshop *Modelling CFD: Fundamentals, Tools & Applications*, providing students with an overview and historical perspective of CFD as well as practical insights and the opportunity to practise using CDF simulation software in the context of buildings. Finally, Dr. Bruno Lee (Concordia University) organized and designed a co-simulation workshop, *Introduction to BCVTB - an environment for co-simulation*, run by himself and HQP Navid Pourmousavian. The workshop introduced students to the motivation, applications and limitations of co-simulation through an involved exercise using Building Controls Virtual Test Bed (BCVTB), in conjunction with EnergyPlus and Modelica.

SNEBRN collaborator Dr. Costa Kapsis (left) presenting the "Performance Simulations of Advanced Building Skins" workshop and SNEBRN HQP Navid Pourmousavian (right) clarifies co-simulation functionality at the "Introduction to BCVTB - an environment for co-simulation" workshop.

In addition to these SNEBRN-led workshops, 3 other industry-led workshops were given centring on tools for meeting the Canadian National Energy Code for Buildings (IES), Daylight Harvesting (IES) and CFD analysis (Cradle). Thank you to all of the above workshop instructors for giving up their time and sharing their expertise in this important component of the conference.

Thanks also to the organisers, sponsors and volunteers of eSim 2016, as well as those who attended the conference. This broad support helps to ensure that IBPSA-Canada will be able to hold future conferences and other events promoting building simulation research in Canada.

VARENNES LIBRARY
Vasken Dermardiros & Andreas Athienitis

Varennes Library Exterior

Varennes Library Interior

Varennes Library Inauguration
L-R: C. Kapsis, A. Athienitis, M. Damphousse (mayor),
V. Dermardiros, R. Dumoulin

Dr. G. Jean, Director General, CanmetENERGY Varennes
giving a speech at the Inauguration

Inauguration

On May 16, 2016, SNEBRN researchers and students (A. Athienitis, C. Kapsis, V. Dermardiros and R. Dumoulin) and about 150 other guests, were invited by the mayor of Varennes Martin Damphousse and the municipal council to participate in the inauguration of the Varennes Library. This library is unlike others. It is designed to be the first Canadian institutional Net-Zero Energy Building. It has still not been a year since the building is in operation, but having high efficiency HVAC systems, an advantageous shape and a 110 kW photovoltaic array on its roof, it will most favourably achieve the Net-Zero energy target over a period of 5 years. The event was hosted by the author and speaker Marcia Pilote. Throughout the evening, mayors of other cities, representatives and counsellors spoke about the importance of forward thinking and environmental proaction. Dr. Gilles Jean, Director General of CanmetENERGY Varennes and representative of the Green Municipal Fund, gave a speech on the importance of energy reduction and its impact on the environment.

Research

The Varennes Library integrates many advanced technologies to reach net-zero energy: it uses heat recovered from part of its building integrated photovoltaic system (BIPV) to heat its ventilation air in winter (building-integrated photovoltaic/thermal system – BIPV/T) in addition to generating electricity; it also integrates a geothermal heat pump system, floor heating and cooling, motorized windows for natural ventilation and advanced daylighting design for its south façade. It has two EV charging stations. SNEBRN researchers played a key role in generating the energy concept for the building and guiding the design team. Design variations of the building could supply excess energy to surrounding buildings.

Dr. Andreas Athienitis and Dr. Costa Kapsis from Concordia and Dr. Jose Candanedo participated in the design charrettes and early design phase at CanmetENERGY and have suggested several design considerations that are now the main features of the library. The orientation, which is angled compared to the street, the roof slope, the building integrated PV thermal (BIPVT) system, the use of concrete to increase the building's thermal mass and the use of daylighting controls. SNEBRN partner Martin Roy also contributed with extensive simulations of the different energy efficiency measures.

The library features 8 boreholes for its ground source heat pump, radiant hydronic slabs used for heating and cooling, advanced lighting and daylighting controls using the DALI system, fan coils for closed rooms on the north orientation, ventilation heat recovery, and cross natural ventilation with automated window openings.

Now, the research has shifted from the design stage to the operational stage. Our goal is to analyze the performance of the building and to aid in attaining the net-zero target. We are interested in solutions that will have a broader application to other small commercial or institutional buildings. The south orientation of the roof is covered with PV panels. Half of the roof is naturally vented whereas the other half is mechanically vented. Around half of the mechanically vented section's air is used as a preheated fresh air intake (BIPV/T system). With the ongoing collaboration of the city of Varennes and our NSERC-Hydro-Quebec Research Chair partner, Regulvar, we are monitoring the performance of the BIPV/T system and all other points.

The library, with all its features and with the strong interest expressed by the City of Varennes, is a valuable case study for SNEBRN and related continuing research. Vasken Dermardiros who started his PhD with Dr. Andreas Athienitis and Dr. Scott Bucking in September 2015, is studying the controls of the radiant slab and its interaction with the other systems. He is interested in determining ways to reduce the mismatch between electricity generation and consumption through optimizing the operation. Remi Dumoulin, an MASc student under Dr. Athienitis' supervision, is studying the BIPV/T and geothermal systems to propose improvements in the operation and develop recommendations for similar NZEBs.

The Varennes Net-Zero Library received an award of excellence from the Canadian Association of Consulting Engineers in 2016 , noting that "Demonstrating the small community that could ... and did, this municipal library is proof that net-zero buildings can be achieved at any scale while making no compromise in the design. Visits to the library have doubled since it opened, and it serves as a model and inspiration for the citizens and the engineering profession." (see http://www.canadianconsultingengineer.com/features/varennes-net-zero-library-award-excellence/

AWARDS

Dr. Nazir Kherani inducted as Fellow in The Canadian Academy of Engineering (CAE)
June 27, 2016 in Winnipeg, Manitoba

R: Dr. Nazir Kherani

The Canadian Academy of Engineering (CAE) is the national institution through which Canada's most distinguished and experienced engineers provide strategic advice on matters of critical importance to Canada. The CAE is an independent, self-governing and non-profit organization established in 1987. Members of the CAE are nominated and elected by their peers to honorary Fellowships, in view of their distinguished achievements and career-long service to the engineering profession. Fellows of the Canadian Academy of Engineering are committed to ensuring that Canada's engineering expertise is applied to the benefit of all Canadians.

Nazir Kherani, Professor at the University of Toronto jointly appointed in the Department of Electrical & Computer Engineering and the Department of Materials Science & Engineering, has made sustained contributions in the fields of tritium science and technology, silicon solar photovoltaics, and photonic crystal device integrations. Specifically, these include innovative tritiated semiconductor materials and devices, record setting heterojunction silicon materials and solar cells, and photonic crystal studies.

Dr. Kherani's achievements have been recognized through numerous awards including the Early Researcher Award, the Ontario Research Foundation - Research Excellence Award, and the Professional Engineers' Engineering Medal in Research and Development.

ASHRAE FELLOWS

Dr. M. Bernier

Dr. C. Simonson

Dr. Michel Bernier and Dr. Carey Simonson became ASHRAE Fellows. Less than 1% (0.85%) of ASHRAE members are Fellows.

The presentations were be made at ASHRAE's 2017 Winter Conference in Las Vegas, Nevada.

Awards.. continued

MEDALS

Dr. Burak Gunay presenting his Senate Medal and Governor General's Medal at Carleton's Fall Convocation

L-R: Dr. I. Beausoleil-Morrison, Dr. B. Gunay, Dr. L. O'Brien

At Fall Convocation, network student Burak Gunay was awarded the Governor General's Medal and the University Medal for his doctoral research. Under the supervision of Professors Liam O'Brien and Ian Beausoleil-Morrison, Gunay developed algorithms that recursively learn from occupants' comfort, behaviour, and presence. In addition, he developed inverse models that recursively learn from the thermophysical characteristics of each office space inside commercial zone controllers by using a small number of sensors.

To develop these algorithms, Gunay conducted analyses upon the archived data from Carleton's automation and controls networks. Partnering with Vancouver-based automation company Delta Controls, he implemented these algorithms on a floor of one of the campus buildings, with the floor above as a control. These year-long field trials pointed out that reductions up to 60% in the heating, cooling, and lighting demand can be achieved with these algorithms. He also employed building performance simulation as a tool to investigate alternative test scenarios. He has extensively published these and related findings on modelling occupant behaviour. Burak is an active researcher of IEA EBC Annex 66 on Definition and Simulation of Occupant Behaviour and is also a board member of IBPSA-Canada. His thesis and related publications are available at his ResearchGate account: https://www.researchgate.net/profile/Burak_Gunay

Gunay is now working as a research associate at the National Research Council in Ottawa on projects related to building fault-detection and diagnostics for the federal buildings in Ottawa. In January, he will return to his home department of Civil and Environmental Engineering as an assistant professor. His research program will examine methodologies to optimize the operation of commercial buildings for comfort and energy use.

Dr. A. Brunger

Obituary

Alfred Brunger passed away tragically following an accident, doing what he loved, on September 24, 2016 at the age of 63 years.

Alfred was a world renowned solar energy and technical standards expert He started the Midnight Sun solar car program at the University of Waterloo.

In the words of Mike Collins from the U of Waterloo: "Alfred will be well known to most of the Network participants. He worked with Terry Hollands in the Solar Thermal Research Lab at UW from 1986 to 1997 before going to work at the National Solar Test Facility in Mississauga (part of Bodycote Intl, and then Exova). He started UWs solar car team (Midnight Sun), and was a co-organizer of SESCI's conference at UW in 2004. Alfred retired about 2 years ago, but remained active in the solar community on a national and international level. Alfred was an outstanding individual, and it was a pleasure to be counted among his friends. He will be missed dearly."

In 2011, Alfred won the CSA Award of Merit in recognition of tireless leadership, pioneering work and passionate commitment to developing and advancing standards related to solar energy.

Dr. A. Athienitis opens the SNEBRN Technology Transfer and Research Planning Workshop, December 2016

Participants at the Building Envelope Workshop held at Concordia University, December 2016

NSERC SMART **N**ET**-Z**ERO **E**NERGY
BUILDINGS **S**TRATEGIC **R**ESEARCH **N**ETWORK

RÉSEAU DE RECHERCHE STRATÉGIQUE DU **CRSNG**
SUR LES BÂTIMENTS INTELLIGENTS À CONSOMMATION
ÉNERGÉTIQUE NETTE ZÉRO

For more information about the Network, please contact:

Andreas Athienitis
Scientific Director
Professor
Concordia Research Chair Tier 1
Email: aathieni@encs.concordia.ca
Tel: (514) 848-2424 Ext. 8791
Fax: (514) 848-7965

Lyne Dee
Project Administrative Coordinator
Email: lynedee@solarbuildings.ca
Tel: (514) 848-2424 Ext. 7029
Fax: (514) 848-7965

www.solarbuildings.ca