NSERC **S**mart **N**et-zero **E**nergy **B**uildings Strategic **R**esearch **N**etwork (SNEBRN)

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Executive Summary

Approximately one third of Canada's GHG emissions are attributed to building energy consumption. Buildings also account for about 53% of Canada's electricity consumption. They are largely responsible for the peaks in electricity demand associated with space heating, cooling, lighting and appliances. These peaks, if not reduced and shifted in time, will impose additional requirements to build new power plants. Without a major transformation in the way we design, build, and operate buildings, Canada cannot expect to meet its goals for reductions in greenhouse gas (GHG) emissions and for clean air in its cities. Mechanisms that allow the building to act as a net energy generating system and also shift peak demand can provide the basis for this transformation. At the same time, a comparison of the Canadian construction industry with that in other industrialized nations, points out the urgent need for Canadian innovations. This convergence of the need for innovation and the requirement for drastic reductions in energy use and GHG emissions provides a unique opportunity to transform the way we conceive buildings and their energy systems. The new collaborative research network will be a vital step along the way to achieving these goals. It links researchers from academia, industry and government in a united effort to develop the technologically advanced smart net-zero energy buildings (NZEBs) of the future. *A net-zero energy building is defined as one that, in an average year, produces as much energy (electrical plus thermal) from renewable energy sources as it consumes*.

The NSERC Smart Net-zero Energy Buildings strategic Research Network (SNEBRN), funded for 2011-2016 under the strategic research networks program of NSERC, will be based on a previous network: the NSERC Solar Buildings Research Network (SBRN), which completed its program at the end of 2010. Joining 18 researchers from SBRN will be 11 new researchers in the new Network's university team, making a total of 29 researchers from 15 Canadian universities taking part in the effort. In addition there are partners from government and industry. Major partners include the CanmetENERGY laboratory of Natural Resources Canada, Hydro-Québec (Laboratoire des technologies de l'énergie) and Canada Mortgage and Housing Corporation. A broad range of industry partners is planned, including Philips (lighting and appliances, energy management), Alouette Homes and Kott Group (prefabricated home manufacturers), Régulvar (automation), Unicel (curtain walls) and Canadian Solar (PV manufacturer). SNEBRN will develop a strategy to effectively transfer the knowledge gained to designers, manufacturers, builders, and utilities. Estimated cash support from partners is about $1.7 M and in-kind support exceeds $2 M. The amount from NSERC is $5 M.

The **vision** of SNEBRN is to perform the research that will facilitate widespread adoption in key regions of Canada, by 2030, of optimized NZEB energy design and operation concepts suited to Canadian climatic conditions and construction practices. We aim to influence long-term national policy on the design of net-zero energy buildings and communities in association with our partners. We will train over 100 highly qualified personnel, thereby providing the leaders who will go on to join universities, industry and government and provide further innovations and work to overcome the barriers to our vision. The **main network goal** is to develop optimal pathways for achieving zero average annual energy consumption at both the building and neighbourhood levels. This will be achieved through combinations of dynamic building methods that integrate a number of technologies: building-integrated solar systems, high performance windows with active control of solar gains, short-term and seasonal thermal energy storage, heat pumps, combined heat and power technologies, and smart controls. We will aim for simultaneous reduction of energy demands and shifting of peak loads through techniques such as predictive control at the building and neighbourhood scales. The Network is organized into the following five Themes, each Theme having two internationally-recognized researchers as co-leaders:

1. Integrated solar and HVAC systems for buildings (Steve Harrison / Ian Beausoleil Morrison).
2. Active building envelope systems and passive solar concepts (David Naylor / Paul Fazio).
3. Mid-to long-term thermal storage for buildings and communities. (Marc Rosen / Michel Bernier).
4. Smart building operating strategies (Andreas Athienitis / Radu Zmeureanu).
5. Technology transfer, design tools and input to national policy (Alan Fung / Sophie Hosatte).

SNEBRN Researchers

Researcher	University and department/program	Relevant Expertise
Athienitis, Andreas *Scientific Director and Theme 4 co-leader*	Concordia, *Building Eng.*	Building operation dynamics and control, building-integrated photovoltaic/thermal systems, daylighting, passive solar design, design of NZEBs
Beausoleil-Morrison, Ian, *Theme 1 co-leader*	Carleton, *Mechanical Eng.*	Building performance simulation, building energy systems, micro-cogeneration, combined heat and power
Bernier, Michel, *Theme 3 co-leader*	Ecole Polytechnique *Mechanical Eng.*	HVAC systems, geothermal systems, solar thermal systems, heat pumps, building simulation, NZEB design
Chang, Liuchen	UNB *Electrical Eng.*	Load management in buildings, power electronics, electrical machines, motors, power system control
Collins, Michael	Waterloo *Mechanical Eng.*	Fenestration systems, photovoltaic/thermal systems, solar thermal systems, radiation heat transfer
Fung, Alan	Ryerson *Mechanical Eng.*	Energy modeling, HVAC system and control, energy efficiency, cogeneration systems, design of NZEBs
Harrison, Steve, *Theme 1 co-leader*	Queen's *Mech. & Mat'l Eng.*	Solar thermal systems, heat pumps, thermal storage, solar cooling, technology transfer
Kherani, Nazir	Toronto *Electrical Eng.*	Photovoltaic/thermal systems, thin films, amorphous silicon, crystalline silicon
Lightstone, Marilyn	McMaster *Mechanical Eng.*	Computational fluid dynamics, turbulence, thermal storage modeling
Love, Jim	Calgary, *Architecture*	Daylighting, architecture, building simulation, building design
Naylor, David *Theme 2 co-leader*	Ryerson *Mechanical Eng.*	Fenestration systems, laser interferometry, convection, CFD, experimental methods in heat transfer & fluids
Oosthuizen, Pat	Queen's, *Mechanical*	Convection, fuel cell systems, CFD applications
Rowlands, Ian	Waterloo, *Environment and Resource Studies*	Sustainability, environment and business, international political economy, electricity policy, climate change
Stathopoulos, Ted	Concordia, *Building Eng.*	Building envelope, wind effects on buildings, hybrid ventilation
Ugursal, Ismet	Dalhousie, *Mech. Eng.*	GHG emissions, community scale simulations
White, Mary Anne	Dalhousie, *Chemistry*	Materials science, thermodynamics, thermal conductivity, phase-change materials
Wright, John	Waterloo, *Mech. Eng.*	Solar Optics, fenestration, shading, convection, building simulation
Zmeureanu, Radu *Theme 4 co-leader*	Concordia, *Building Eng.*	Building simulation, energy efficiency, HVAC systems, building operation, continuous commissioning, comfort

New Researchers

Researcher	University and department/program	Relevant Expertise
Cotton, James	McMaster, *Mech. Eng.*	Thermal storage, CHP, heat transfer
Cruickshank, Cynthia	Carleton, *Mech. Eng.*	Solar thermal systems, thermal storage
Fazio, Paul *Theme 2 co-leader*	Concordia *Building Eng.*	Building envelope technologies, building physics, moisture transfer, curtain wall technology, policy
Flynn, Morris	Alberta, *Mech. Eng.*	Convection, hybrid ventilation
Gosselin, Louis	Laval, *Mech. Eng.*	Thermal systems modeling, optimization, thermal storage
Kennedy, Chris	Toronto, *Civil Eng.*	Sustainable communities, GHG emissions, quantitative urban planning
Kummert, Michael	Ecole Polytech. *Mech. Eng.*	Building simulation and operation dynamics, HVAC
Pearce, Joshua	Queen's *Mech.& Mat'l Eng.*	Applied sustainability, energy efficiency, photovoltaics
Rosen, Marc *Theme 3 co-leader*	OIT, *Mech. Eng.*	Thermal storage, thermodynamics, cogeneration, HVAC systems
Simonson, Carey	Saskatchewan *Mech. Eng.*	Building physics, HVAC systems, air-to-air energy recovery devices
Williamson, Sheldon	Concordia, *Elec. Eng.*	Electric vehicles (control), charging strategies

SNEBRN Partners

Network Partners	Location	Type of industry
Hydro Québec	Shawinigan, QC	Electric utility
Philips (Canlyte Inc)	Lachine, QC	Lighting, control systems
Alouette Homes	Alphonse-de-Granby, QC	Prefabricated home manufacturer
Régulvar	Laval, QC	Controls company
Kott Group	Ottawa, ON	Pre-engineered housing
Canadian Solar Solutions Inc.	Kitchener, ON	PV modules manufacturer
Gaz Métro	Montréal, QC	Gas utility
Unicel Architectural	Longueuil, QC	Window manufacturer
Arise Technologies	Waterloo, ON	PV modules manufacturer
Thermal Electronics Corp.	Aurora, ON	Thermoelectric Power Devices
Halsall Associates	Toronto, ON	Engineering Consultants
Venmar CES	Saskatoon, SK	HVAC manufacturer
Pageau-Morel Inc.	Montreal, QC	Building Engineering Consultants
Martin Roy et Associés	Deux-Montagnes QC	Building Engineering
SaskEnergy	Regina, SK	Natural Gas
Pivotry Consulting	Waterloo, Ontario	Engineering Consultants
Government sector		
NRCan CanmetENERGY	Varennes (QC) Ottawa (ON)	R&D on energy efficiency, buildings, renewable energy
Canada Mortgage and Housing Corporation	Ottawa, ON	National housing agency
City of Saskatoon	Saskatoon, SK	Environmental science branch
Saskatchewan Research Council	Saskatoon, SK	Provincial Research Laboratory
Toronto and Region Conservation Authority	Downsview, ON	Community engagement and environmental management

Non-governmental organizations/associations and Municipalities

Canadian Gas Association	Ottawa, ON	National industry association
Ontario Centre for Engineering and Public Policy	Toronto, ON	Energy, environment, health regulation, engineering talent
Net-zero Energy Home Coalition	Ottawa, ON	Industry association
Agence de l'efficacité énergetique (AEE)	Québec, QC	Provincial energy agency