



Developing solar-optimized buildings as integrated advanced technological systems that will approach net-zero annual energy consumption and be cost-effective

EXECUTIVE SUMMARY

The NSERC Solar Buildings Research Network (SBRN) was launched in 2006 by the Natural Sciences and Engineering Research Council (NSERC) through its Research Network (now Strategic Network) Grant Program. For the first time, in a unique effort, 24 top Canadian researchers in solar energy and buildings from 11 Canadian universities have joined forces to develop the solar-optimized homes and commercial buildings of the future. SBRN also includes experts from Natural Resources Canada (NRCan), the Canada Mortgage and Housing Corporation (CMHC) and Hydro-Québec. The core budget of the Network is about \$6 million, with 80% from NSERC and 20% from NRCan, CMHC, Hydro-Québec and others. Expected in-kind support will exceed \$1,000,000 from at least 20 industries that are generally members of two major SBRN partners – the Net-Zero Energy Home Coalition (NZEHC) and the Canadian Solar Industries Association. In addition, a \$2.3 million SBRN demonstration program of building-integrated photovoltaic/thermal systems is currently funded by a consortium of SBRN partners under the NRCan Technology Early Action Measures (TEAM) program.

Buildings account for about 30% of Canada's energy consumption, about 53% of its electricity consumption and roughly one third of its greenhouse gas (GHG)

emissions. These energy flows and GHG emissions, which are associated with heating, cooling and lighting buildings, have the potential to be substantially reduced if the incident solar energy on the façades or roofs of buildings is utilized. A suitably-orientated façade or roof on a typical Canadian building receives up to about 6.4 kilowatt-hours per square metre per day and, over a year, the solar energy incident on a home in Canada far exceeds its total energy consumption. Photovoltaic (PV) panels mounted on the roof and façade can typically convert 6-18% of the sun's energy into electricity, and 50-70% of the rest can be extracted as useful heat from the PV panels while 10-30% can be utilized for daylighting. Combined solar energy utilization efficiencies of the order of 80% can be achieved if proper *integration strategies* are implemented. Indeed, there is the potential for a building to achieve, *on average, zero energy consumption*.

This effort requires optimization of the performance of a building as a *system*. The effective *integration* of solar technologies – electric, thermal and those associated with daylighting – is a hallmark of the approach followed by SBRN.

Integration is based on an innovative approach to building design in which building envelope components perform several controlled functions such as generating solar heat and electricity in photovoltaic-thermal (PV/T) systems, or transmitting daylight and producing electricity in semitransparent PV systems. For both of these examples, there is a need for efficient design and control techniques to utilize effectively the energy produced or the transmitted daylight. The design of the building envelope as a solar energy conversion device will have profound implications on how heating systems are designed and controlled since the building itself will be part of the heating-cooling system. Integration reduces the cost of solar systems and makes them more affordable.

The long term goal of SBRN research is development of the solar-optimized building as an integrated advanced technological system that approaches net-zero annual total energy consumption while being both cost effective and comfortable. Both houses and commercial buildings are included in this vision. An added benefit of optimal solar energy usage is improved light quality due to enhanced daylighting levels that improve the well-being and productivity of the occupants. Moreover, solar technologies are being integrated in an optimal manner with energy efficiency measures, so that the potential

energy savings are even higher than separately applying the two approaches.

The Network research is organized into the following four themes with internationally recognized Canadian researchers as theme leaders:

Theme 1: Integration of solar energy systems into buildings; Andreas Athienitis (Concordia University) – Principal Investigator.

Theme 2: Solar thermal systems for heating and cooling; Stephen Harrison (Queen's University).

Theme 3: Solar electricity generation in buildings; Liuchen Chang (University of New Brunswick).

Theme 4: Simulation tools for solar building design; Ian Beausoleil-Morrison (Carleton University).

The Network is developing innovative solar utilization building systems, load management techniques and software tools that support solar-optimized building design. It is playing a key role in a solar home demonstration program along with our partners at CMHC and NZEHC. Finally, it provides input to the development of relevant government policies and standards while training over 100 graduate students, post-doctoral fellows and undergraduate research assistants who will contribute to making its vision a reality.

Network web site: www.solarbuildings.ca

Contact:

Andreas Athienitis

Scientific Director

Professor and Concordia Research Chair Tier 1

athiena@alcor.concordia.ca

Tel. (514) 848-2424 Ext. 8791

Fax. (514) 848-7965

Lyne Dee

Project Coordinator

lynedee@solarbuildings.ca

Tel. (514) 848-2424 Ext. 7029

Fax. (514) 848-7965