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Providing high solar fractions for space and water heating in cold climates through seasonal storage

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Heating, cooling, and ventilating the places we live in, and providing the hot water, lighting, and appliance services we need, consumes tremendous amounts of energy; this contributes significantly to environmental and energy security issues. For example, housing accounts for 30% of all electricity and 26% of all natural gas consumed in Canada, and produces 13.5% of the country's greenhouse gas emissions. In most cool and cold climates, space and water heating account for the majority of the energy demand in housing, and therefore offer the greatest potential for savings. If locally available solar energy could be exploited then the majority of these energy demands could be met in an environmentally benign manner. However, this is complicated by the strong seasonal mismatch between solar availability and space-heating needs---approximately 70% of the solar energy resource is available outside the principle space-heating period. This talk will introduce the concept of the seasonal storage of solar energy at the single-house scale and will present ongoing research at Carleton University aimed at devising and evaluating methods for providing the majority of space and water heating needs (>90%) through solar energy. It will first provide some context by explaining the Canadian energy situation and current housing construction practices. A simulation-based analysis of a solar thermal system employing seasonal storage will then be presented, followed by a description of the design, construction, and commissioning of a full-scale research house. Finally, results from the first annual experiment conducted at the facility on the seasonal storage of solar thermal energy will be provided.



Ian Beausoleil-Morrison is a Professor in the Faculty of Engineering and Design at Carleton University in Ottawa, where he heads the Sustainable Building Energy Systems laboratory. He is co-founder and has been Co-Editor of the Journal of Building Performance Simulation since its establishment in 2008. He has been a Director of the International Building Performance Simulation Association (IBPSA) since 2004, and was Vice-President of that organization from 2006 to 2010, and President from 2010 to 2015. In 2015 he was awarded the grade of Fellow of IBPSA. He has been an Operating Agent for the International Energy Agency's Energy Conservation in Buildings Implementing Agreement. He is past Vice-Chair of ASHRAE's Technical Committee 4.7 on Energy Calculations, has been a Theme Leader of NSERC research networks on solar buildings, and is a member of the UK's Engineering and Physical Sciences Research Council Peer Review College. Prior to joining Carleton University in 2007, Professor Beausoleil-Morrison worked for 16 years at CanmetENERGY where he led a team of researchers who developed models for innovative energy systems such as micro-cogeneration and developed simulation tools for industry. His research interests include solar housing, seasonal thermal storage, micro-cogeneration, and understanding and controlling for occupant behaviour. Currently he is the Lead Investigator of the Urbandale Centre for Home Energy Research, a research house situated on the Carleton University campus that is dedicated to the long-term study of solar-thermal and other innovative energy systems for radically reducing the dependence of housing on fossil fuels and the electrical grid.

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