Sustainable Technologies
EVALUATION PROGRAM

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Energy Projects Overview

The Sustainable Technologies Evaluation Program (STEP) is a multi-agency program, led by the Toronto and Region Conservation (TRCA). The program was developed to provide the data and analytical tools necessary to support broader implementation of sustainable technologies and practices within a Canadian context.

The main program objectives are to:

- Monitor and evaluate clean water and low carbon technologies
- Assess implementation barriers and opportunities
- Promote broader use of effective technologies through research, education and advocacy

The energy component of STEP is focused on reducing energy use, improving air quality and developing solutions that will help improve our resilience to the effects of climate change.

STEP provides unique opportunities for collaboration with universities and colleges at through its Living Labs at the TRCA's Kortright Centre for Conservation. Since the construction of the Archetype Sustainable House in 2008, over 20 college and university graduate students have, or are currently working on energy-related projects as part of their academic curriculum.

Increasing technological advancements in clean energy production have the potential to replace existing nuclear and coal energy sources. Sustainable energy generation could play a major economic role as governing bodies better grasp the implications brought on by climate change.

STEP evaluates technologies that help reduce energy related emissions of greenhouse gases and pollutants, and prevent smog-related heat build-up in urban areas. In collaboration with industry and academia, our key areas of research are focused on energy efficiency, alternative heating and cooling technologies, renewable energy, and smart grid integration.

HEATING & COOLING SYSTEMS

Air Source Heat Pumps

Air source heat pumps draw heat from the outside air to heat homes in the winter, and reject heat to the outside air to cool homes in the summer. They have been used for decades to heat and cool homes, but recent advances have helped to significantly boost performance and reduce costs, especially for cold climate applications. In this study, completed in 2012 with researchers from Ryerson University, the year round performance of a high efficiency, variable capacity air source heat pump was assessed in a well-insulated semi-detached house at the TRCA's Kortright Centre for Conservation. Performance monitoring was conducted on the system both as a stand-alone technology and as installed with the indoor heat and cooling distribution system.

Geoexchange Systems

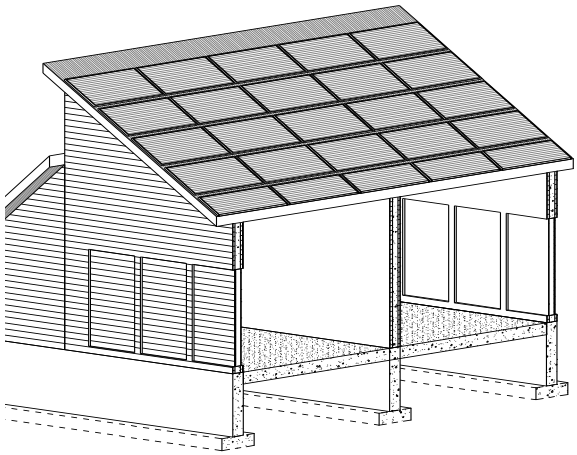
A geoexchange system uses a ground source heat pump to deliver or remove heat from the ground to the indoor or outdoor environment via a fluid circulating through buried pipes, referred to as a ground loop. A geoexchange system is able to deliver as much as four or five units of heat energy for every unit of electrical energy consumed. STEP, in partnership with the Toronto Atmospheric Fund (TAF), is helping to address knowledge gaps and document best practices by monitoring system performance and compiling data from system owners and operators on project procurement, design, installation, costs and maintenance requirements. The data and information will be used to identify further information needs and provide recommendations on best practices as needed to optimize performance and maximize return on investment.

ClimateWell System

The ClimateWell technology uses a salt-based triple state absorption process to transform heat into cooling without using electricity. This project tests and evaluates the technical and economic feasibility of combining a micro co-generation system with the cooling/thermal storage Climatewell technology to provide year round heat and cooling in residential housing. The project will include a pre-feasibility and modelling study to find optimal operating conditions under different scenarios, followed by a detailed design and performance analysis, and the development of an integrated Climatewell based Tri-generation system product designed specifically for adoption within target North American markets. The research is being conducted with researchers from Ryerson University and support from industry partners.

BIPV-T Collector with Variable Capacity Air Source Heat Pump

Building Integrated Photovoltaic/Thermal systems are arrays of PV panels integrated into the building structure, such as facades and roofs, which can produce electricity and recover useful thermal energy by circulating air or fluid behind the array of PV panels. This energy can be used for space heating, domestic water heating and air conditioning. To allow for continuous and sufficient space heating, BIPV/T systems can be coupled with air source heat pumps (ASHPs). By providing space heating, domestic water heating, summertime cooling and electricity production, the coupling of BIPV/T with ASHP will bring new and existing residential and small commercial buildings closer to the goal of net zero energy status in a cost effective and climate friendly manner. The research, led by Ryerson University and George Brown College, will be conducted in a custom enclosure designed for monitoring and research at the Kortright Centre for Conservation.



RENEWABLE ENERGY

Photovoltaic Research Program

The use of photovoltaic (PV) technologies in Ontario to generate electricity has increased substantially since the introduction of the Ontario Power Authority's Feed in Tariff (FIT) program. This program offers clean energy producers guaranteed rates per kilowatt hour (kWh) of solar and wind energy sold back to the grid. Despite growth of the industry, questions remain about the performance and return on investment that may be achieved through PV technologies in an Ontario climate. To help address these questions and demonstrate the range of available technologies, TRCA constructed a solar PV field test site in 2011 at the Kortright Centre for Conservation in Vaughan. Since its establishment, the test site has become a center for research collaborations with public agencies, universities, colleges and industry professionals from across Ontario and North America.

Solar City Technology Assessment Partnership

The SolarCity Technology Assessment Partnership (STAP) works with municipal and industry partners to develop the tools and resources required to support excellence in site selection, installation and monitoring of solar equipment on GTA solar facilities. Approximately 20 solar applications have been monitored and evaluated, including photovoltaic arrays, solar domestic hot water systems, solar air heating and solar pools. Monitoring of additional systems is currently underway. Learning outcomes from these evaluations are disseminated through case study reports and synthesis documents. Capturing and transferring the knowledge gained from evaluation of the various solar installations will help improve the effectiveness of existing systems and facilitate broader use of solar technologies in urban settings.

Micro-wind Turbines

When wind turbines in populated areas are directly connected to the grid, they offset the owners' utility bills and reduce greenhouse gas emissions. Presently, the Small Wind Turbine industry does not have systematic standards for approving or rating products, which has led to inconsistent and inflated performance claims from some manufacturers, creating uncertainty in the marketplace. This study, conducted in partnership with York University researchers, helps address these uncertainties by assessing the feasibility and performance of three small wind turbines installed at different heights at the Kortright Centre for Conservation wind field test site, and comparing monitored performance to manufacturer rated power outputs. The site includes a 30 m tower instrumented with eight anemometers and two wind vanes to characterize wind conditions at this southern Ontario location.

ENERGY CONSERVATON & EFFICIENCY

Heating and Energy Recovery Ventilators

As requirements for insulation in new buildings improves, heat recovery ventilator systems are becoming increasingly common. A Heat Recovery Ventilator (HRV) brings fresh air into the building and recovers the sensible heat from the exhaust air. Energy Recovery Ventilators (ERVs) recover both sensible and latent heat from exhaust air. These systems are often set up to run continuously, regardless of the need for fresh air. This evaluation, conducted in the TRCA's Archetype Sustainable House, uses the existing data acquisition system to evaluate different functional scenarios for HRVs and ERVs in order to provide practical recommendations on how these systems can be optimized both from a cost and energy efficiency perspective.

ENERGY CONSERVATON & EFFICIENCY - CON'T

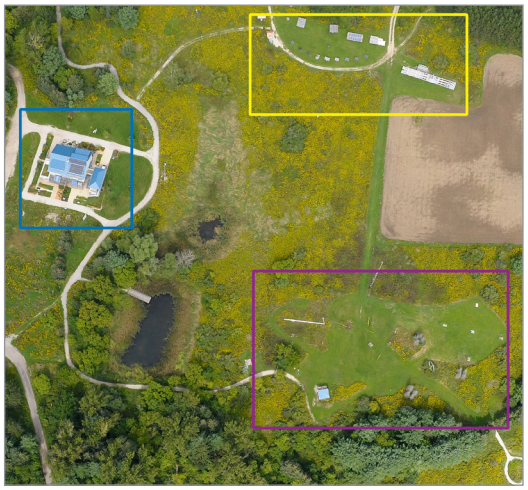
Drain Water Heat Recovery

A drain water heat recovery (DWHR) system consists of a copper coil delivering municipal cold water, which wraps around a main copper pipe that drains warm grey water from showers, sinks and/or dishwashers. DWHR units are often installed to replace existing piping sections without major retrofitting and are cost-effective options for residential energy conservation. In collaboration with Ryerson University, the performance of two DWHR systems at the Archetype Sustainable House at the Kortright Centre for Conservation were evaluated. The project assesses how the units respond to different incoming potable water temperatures and the resultant change in effectiveness and total heat recovered.

SMART ENERGY GRID

Integration of Renewable Energy into Smart Micro-grid and Off-grid Systems

Climate change is affecting our weather patterns resulting in more frequent extreme weather events. These weather events can result in the extended loss of essential services such as electrical power. STEP is undertaking research at the Kortright Centre for Conservation in Vaughan to address this issue by enhancing the resiliency of our electric power system. In this project, research is being conducted on the integration of renewable energy technologies into smart micro-grid and smart off-grid systems, which will allow our communities to remain serviced during extreme weather events and extended service outages. The research will build upon previous work done by STEP and will engage utilities, industry, educational institutions and our regional municipal partners to provide valuable recommendations and research to stakeholders.



Effects of DC Transients and Inverter AC Power Quality on the Electrical Grid

The Local Distribution Company (LDC) Tomorrow Fund has invested in STEP's solar research at the Kortright Centre for Conservation. The Fund is supporting a study investigating observed spikes in incoming solar irradiance and the potential impact of these irregularities on utility grid stability and power quality. This two year study is investigating the impact that high levels of solar irradiance will have on the power electronics, which track and convert DC electricity from the solar modules to AC electricity, and any power quality issues for the grid. As the fraction of power generated by solar modules continues to rise, the results of this study will help to inform LDC decisions and allow them to effectively protect the local distribution grid. Monitoring efforts, to be undertaken by TRCA in partnership with Mohawk College and York University, will initially focus on evaluating the impacts on the photovoltaic systems at the Campus. A second phase of the program will assess effects on large rooftop systems monitored as part of the SolarCity Partnership.

The energy component of STEP is supported by: Region of Peel, York Region, and the City of Toronto, with individual project support from Natural Resources Canada, Toronto Atmospheric Fund, the LDC Tomorrow Fund and various private sector partners.

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The website provides information about STEP projects and highlights the great work that our partners and others are doing in related areas. Full reports, technical briefs and case studies on all STEP water and energy projects are available for download through the online resource library. For more information about the program email us at STEP@trca.on.ca

Toronto and Region Conservation *for* The Living City®