Enabling Ratepayer Cost Savings by Adding Demand Response/Load Reduction Capabilities and Deep Retrofit Facility Archetypes to RETScreen Expert

CanmetENERGY

Date (2024-07-12)

Gregory J. Leng, Director - RETScreen International

Final Report to IESO

AODA compliant

ieso
Connecting Today.
Powering Tomorrow.

This project is supported by the financial contribution of the Independent Electricity System Operator (IESO), through its Grid Innovation Fund. However, the views, opinions and learnings expressed in this report are solely those of CanmetENERGY.

Table of Contents

Executive Summary

This project is enabling Ontario ratepayer cost savings through the successful development and integration, into the RETScreen Clean Energy Management Software (RETScreen Expert), demand response and load reduction analysis capabilities, as well as thirty deep retrofit facility archetypes.

The milestones achieved for each of the three phases of the project are as follows:

1. New demand response and load reduction capabilities were developed and integrated into RETScreen Expert.
2. Thirty deep retrofit archetypes were created and integrated into RETScreen Expert.
3. The new deliverables were promoted to key Ontario energy stakeholders and their capacity to use the new deliverables was built.

The outputs of this project are available within the latest public version of the RETScreen Expert Software (Version 9.1). The software can be downloaded from Natural Resources Canada's (NRCan) public website at www.retscreen.net

Introduction and Goal

Natural Resource Canada's (NRCan) RETScreen Clean Energy Management Software platform (RETScreen Expert) enables cost-effective low-carbon planning, implementation, monitoring and reporting. This world-leading software has more than 850,000 users in every country, and it is growing at 40,000+ new users each year. A brief introduction to some of the market barriers that this project addresses and the goals of the project are described below.

In Ontario, there remain numerous unrealized opportunities for greater energy efficiency and electricity affordability. The primary constraint to realizing these energy and cost savings is that energy professionals in Ontario (for example, energy managers) simply lack sufficient knowledge of cost-effective energy efficiency and electricity demand/load reduction options available to them, as well as how to properly assess and implement these potentially profitable projects and measures. To make matters worse, high transaction costs associated with the implementation of energy efficiency and demand response/load reduction projects pose a serious barrier to a significant increase in the deployment of financially viable electricity affordability measures. Pre-construction expenditures for pre-feasibility studies and energy audits (feasibility studies) represent high-risk financial investments for facility owners or energy service companies prior to any money being saved from a project's implementation. As a result of this justified reluctance to expend both time and money in the face of uncertain returns, numerous opportunities for implementing financially viable electricity cost savings projects are being missed – even though these opportunities have proven to be cost-effective and reliable in similar situations elsewhere.

Demand response, load reduction and energy efficiency technologies and measures are often more cost-effective than the construction of new power plants. In addition, the initial steps in reducing electricity costs are typically easier than subsequent steps (i.e. achieving up to 40% cost reductions are typically easier and more cost-effective than achieving 40%-80% cost reductions).

The RETScreen Expert software upgrades as part of this project will enable its Ontario users to better manage and reduce energy consumption, and thus achieve electricity bill savings. While RETScreen Expert has reached an important level of market penetration in Ontario, there are additional important ways that RETScreen can help Ontario ratepayers save on electricity costs. The project will further enhance RETScreen Expert by enabling deep retrofits of facilities that can result in 40% to 80% electricity cost savings. The project will also add comprehensive features to RETScreen Expert that will help Ontario organizations assess the demand response and load reduction potential for their facilities. It is expected that these new features will appeal to an even broader and deeper range of Ontario electricity stakeholders than currently use RETScreen Expert. The deliverables will enhance both the energy efficiency and the demand and load reduction analysis capabilities of the RETScreen Expert software, thus helping Ontarians better plan and manage their energy consumption, and ultimately leading to significant energy savings and greater electricity affordability. The ultimate outcome of this project will be to help Ontario ratepayers reduce their electricity costs.

Approach/Methodology

RETScreen Expert is a comprehensive system designed to provide intelligent decision support to professionals, decision-makers and other project stakeholders (e.g. architects, engineers, facility energy managers, financial planners, product suppliers, etc.) over the entire energy project life cycle. By providing complete and integrated decision making and verification support, RETScreen Expert enables a much larger number of project stakeholders to perform tasks previously requiring external specialists.

Virtual Energy Analyzer

A Virtual Energy Analyzer feature allows for the rapid and accurate estimation of the energy production and savings potential for any location in the world employing a five-star benchmark ranking system and without requiring a site visit. A Smart Project Identifier accurately identifies the best projects to be implemented at the facility and intelligently completes a pre-feasibility analysis or energy audit for further refinements onsite. A Financial Risk Assessor automatically assesses the financial risk of the proposed investment and systematically determines the sensitivity of key parameters on a project's viability. A Performance Tracker comprehensively measures and verifies the actual performance of implemented projects and helps find opportunities for further energy improvements at the facility.

To begin, each facility is geolocated by the user using the VEA. All climate data is loaded and graphed. The most accurate climate data for the given location is selected from among the software's 6,700+ ground and NASA weather monitoring stations around the world.

The full facility is then modelled using the software's archetypes loaded from the Virtual Energy Analyzer. The energy model includes base and proposed cases for a multitude of energy efficiency measures and technologies, including cost information. The total heating, cooling and electrical energy saved are calculated for all measures and technologies.

The software then calculates several financial viability indicators such as the Internal Rate of Return (IRR), simple payback, Net Present Value (NPV) and GHG reduction cost, among other things. Of primary importance is the total initial costs for all the energy measures and technologies.

A sensitivity analysis is also calculated for each facility to help the user estimate the sensitivity of important financial indicators in relation to key technical and financial parameters. A risk analysis section also provides information on the relationship between the key parameters and the important financial indicators, demonstrating which parameters have the greatest impact on the financial indicators, for each individual facility.

And finally, for each facility, a summary feasibility analysis report is automatically generated.

To this sophisticated platform, we have added features that will allow users to assess the financial feasibility of demand response and load reduction measures and technologies and allow users to access deep retrofit archetypes that can enable 40%-80% cost and GHG reductions. The new elements developed in this project will substantially expand the applicability, use and ultimate impact of the software. The three phases and milestones of the project are described in more detail in the sections below.

Phase 1 - Develop New Demand Response and Load Reduction Capabilities

In Phase 1, we focused on demand response (i.e. peak clipping and peak shifting) and load reduction (i.e. electricity fuel switching), where we developed new peak load and electricity time-of-use analysis capabilities in RETScreen. These will allow users to assess cost-effective demand response measures (including electricity storage) and electricity load reduction technologies wherein customers can switch away from using electricity to another fuel source, such as solar heating and cooling. The new capabilities will also help users cost-effectively reduce peak end-use electricity demand and related costs during peak use hours (i.e. peak clipping), or shift some of their demand to off-peak hours (i.e. peak shifting). The updated energy model was then integrated with RETScreen's cost and financial models, allowing users to clearly understand the prospective return on investment and plan financially attractive projects and measures. In-kind support for beta testing the new features in the software was provided by various staff from Oxford Properties, 3M Canada, District School Board of Niagara, Mohawk College, Town of Caledon, and CityHousing Hamilton.

Phase 2 - Create and Integrate Deep Retrofit Archetypes in RETScreen

In Phase 2, we focused on energy efficiency (i.e. reduced electricity consumption), where we first evaluated end-use energy efficiency measures and technologies that could enable 40% to 80% electricity cost-savings for Ontario facilities by using more energy-efficient equipment, processes and buildings. We also evaluated cost-effective demand response and load reduction measures and technologies using the new model capabilities developed in Phase 1. We then incorporated and validated the deep retrofit end-use demand response, load reduction and energy efficiency measures and technologies into 30+ existing (i.e., already achieving up to 40% cost reductions) facility archetypes in RETScreen Expert. The archetypes were then programmed and tested in RETScreen's Virtual Energy Analyzer, and then the archetypes and new software capabilities were beta-tested with key Ontario users prior to public release. As with Phase 1, in-kind support for beta testing the new features in the software was provided by various staff from Oxford Properties, 3M Canada, District School Board of Niagara, Mohawk College, Town of Caledon, and CityHousing Hamilton.

Phase 3 - Implement Ontario-focused Outreach and Capacity Building Initiative

In Phase 3, we executed an Ontario-focused outreach and capacity building initiative around the deliverables of this project. Key outreach and capacity building material was built directly within the software, including the English and French user manual, links to the bilingual e-Learning videos and links to recorded conference presentations, webinars, etc. in the RETScreen User Community section of the RETScreen e-Learning channel on YouTube.

We are cognizant of the fact that project impact is inextricably tied to the ability of people to productively use the deliverables. The RETScreen Division at the CanmetENERGY Research Centre has a dedicated outreach and capacity building program team that successfully disseminates and supports the RETScreen Software for over 850,000 users globally, including numerous energy, facility and/or sustainability management professionals Ontario. The software is disseminated via download from NRCan's public website at www.retscreen.net. This software download is the primary means of deploying the outputs of this project.

The RETScreen Division employs a systematic outreach process in both English and French. This process includes a regular e-mail newsletter going out to 150,000+ RETScreen users (including many in Ontario) as well as an active social media campaign through LinkedIn targeted at the RETScreen user community. More advanced capacity building efforts, in both official languages, include developing and integrating knowledge tools into the RETScreen software's user manual and continuing to build up a library of instructional videos on a freely accessible eLearning channel, used by thousands of energy professionals, including many in Ontario.

Outreach is only the first step of capacity building. Our years of working with RETScreen users and customers from all over the world has yielded a tried-and-true methodology for effective capacity building. This involves carefully identifying training needs and developing appropriate training materials; conducting training/capacity building activities; and, perhaps most importantly, providing individualized post-training technical support. This trifold model has been implemented extensively and successfully in Ontario and other locations by the RETScreen Capacity Building team over the past 28 years, including during the past 3 years covering this project period.

Apart from our own capacity building efforts, we also engage in ongoing collaboration with professional training organizations, such as the Canadian Institute of Energy Training (CIET). CIET delivers a three-day Certified RETScreen Expert (CRE) course on a regular basis, including regular participation by Ontario-based professionals. In fact, many Ontario-based energy, facility and sustainability managers have already completed the CRE, so there already exists significant RETScreen capacity in various Ontario-based professionals. CIET has recently introduced one-day introductory and advanced RETScreen courses and has also integrated RETScreen content into numerous other courses, including their Certified Energy Manager (CEM) and Certified Measurement & Verification Professional (CMVP) courses. As part of our normal outreach and capacity building work, we worked with CIET (and similar organizations, such as the Building Owners and Managers Association (BOMA)) to develop training courses around the new deliverables. RETScreen is also used for teaching and research at over 1,500+ universities and colleges around the world, including most Ontario higher educational institutions; this diffused use of RETScreen provides a further outlet for outreach and ongoing dissemination of the project results.

Results

Demand Response & Load Reduction Capabilities Integrated into RETScreen

There are numerous upgrades throughout the software related to this project. Some of the most salient items are described below. The new demand response and load reduction capabilities can be found in both the Performance Analysis Module and the Feasibility Analysis Module of RETScreen Expert.

New analytics capabilities for the integration of high-resolution and real-time data (hourly or sub-hourly, interval data with direct connection to databases, like SQL), including data visualization and analytics tools such as weekly and daily times series, load duration curve and heatmap graphs have been included in the in the Performance Analysis Module of the software to allow for the accurate estimation of both the time and amount of peak electrical demand for a particular facility.

Decision-makers can conduct a five-step standard analysis with RETScreen's Feasibility Analysis Module, including energy analysis, cost analysis, emission analysis, financial analysis, and sensitivity/risk analysis. The new demand response and load reduction analysis capabilities (e.g. electricity storage, ground-source heat pumps, etc.) have been integrated into RETScreen's energy model. These are described in more detail below.

Multiple Fuels Heating Systems

This new feature in RETScreen Expert allows the user to model a multiple fuel heating system for the facility. The "Multiple fuels" option conducts the analysis using multiple pieces of heating equipment, each having a different fuel type. As an example, the Multiple fuels method provides the opportunity to incorporate secondary heating equipment as a peak load system. This is a key load reduction (i.e. electricity fuel switching) feature added to the software.

Energy Storage Model – Heating storage

Heating storage is a technology or system that stores thermal energy for later use in heating applications. This involves storing excess heat generated through heat recovery or during periods of low energy demand as well as when renewable energy sources like solar or wind are producing surplus energy. The stored thermal energy can then be released and utilized to provide heat when needed. The primary goal of heating storage is to increase energy efficiency, reduce energy costs and/or peak demand charges by shifting some of the heating load from high-demand periods to low-demand or off-peak hours.

Heating storage systems can take various forms, including hot water tanks, phase-change materials, or underground heat storage, depending on the specific application and requirements. The software can now simulate a diverse range of projects in residential, commercial, and institutional buildings, as well as industrial facilities, where the incorporation of a heating storage system serves to lower heating costs and increase the overall energy efficiency of the heating system.

Energy Storage Model – Cooling storage

Cooling storage, also known as thermal energy storage for cooling, refers to a technology and system designed to store and manage thermal energy for the purpose of cooling. This technology is used

primarily in air conditioning and cooling systems for buildings and industrial processes. The primary goal of cooling storage is to increase energy efficiency, reduce energy costs and/or peak demand charges by shifting the cooling load from high-demand periods to low-demand or off-peak hours.

Cooling storage systems can take various forms, including chilled water storage, phase-change materials, or ice storage, depending on the specific application and requirements. The software can now simulate a diverse range of projects in residential, commercial, and institutional buildings, as well as industrial facilities, where the incorporation of a cooling storage system serves to lower cooling costs and increase the overall energy efficiency of the cooling system.

Energy Storage Model - Electricity storage

Electricity storage refers to the process of storing electrical energy in a device or system for later use. It allows for the capture and retention of electrical energy during periods when it is abundant or inexpensive, and then releases it when needed, typically during peak demand or when the primary energy source is unavailable. The primary goal of electricity storage system is to increase energy efficiency, reduce energy costs and/or peak demand charges by shifting some of the electricity load from high-demand periods to low-demand or off-peak hours.

Electricity storage technologies include batteries, pumped hydro storage, flywheels, compressed air energy storage, and various emerging technologies aimed at improving energy storage efficiency and capacity. These systems are crucial for enhancing the reliability, stability, and efficiency of electrical grids and for supporting the integration of intermittent renewable energy resources, like solar and wind. The software can now simulate a diverse range of projects in residential, commercial, and institutional buildings, as well as industrial facilities, where the incorporation of a electricity storage system (e.g., batteries) serves to lower electricity costs and/or increase the overall energy efficiency of the facility. This, and the other energy storage options, is a key demand response (i.e. peak clipping and peak shifting) feature added to the software.

Note that if the utilization of a storage system leads to demand charge reductions (such as savings during summer peak demand), the savings can be incorporated as $/kW in the "Other revenue (cost)" section of the Finance worksheet in RETScreen. The user can make use of the Duration curve and Heatmap tools, available within the Analytics worksheet of the Performance Analysis Module, for a more accurate estimation of the peak demand reduction potential.

Electricity Rate Calculator

The optional Electricity rate - time of use tool is used to determine the average electricity rate based on information from a time of use electricity bill and/or from electricity consumption data and the rates of the utility company.

The user has the option to click on the electricity rate calculator icon within the Electricity and fuels form, which will open the Electricity rate - calculator dialog. Subsequently, they can paste the computed value into the "Rate – annual" cell.

These, and other technologies and measures added to the Energy model in RETScreen Expert, will allow for the evaluation of cost-effective demand response (i.e. peak clipping and peak shifting) and load reduction (i.e. electricity fuel switching) options.

As a result of these efforts, new demand response and load reduction capabilities are developed and they have been integrated into RETScreen Expert.

Deep Retrofit Archetypes Created and Integrated into RETScreen

In this section we provide more detailed information summarizing the methodology of the design choices for the new features specific to Deep Energy Retrofits, a discussion on the archetypes for demand response in the RETScreen software, why they were developed and the supporting research and evidence on the design choices made.

Background – Benchmark and Feasibility Analysis Modules

The Benchmark Analysis Module in RETScreen allows the user to quickly establish reference climate conditions at a facility site for any location on earth and compare the energy performance of various types of reference (benchmark) facilities with the estimated (modelled) or measured (actual) annual energy consumption of a facility.

The Feasibility Analysis Module in RETScreen empowers cleaner energy decisions following a five-step standard process, including energy analysis, cost analysis, emission analysis, financial analysis, and sensitivity/risk analysis. Fully integrated into these analytical tools are climate, cost, product, and other databases.

The Benchmark and Feasibility Analysis Modules also incorporate a Virtual Energy Analyzer (VEA), which uses a database of archetypical facilities (i.e., archetypes) to rapidly determine the energy production and savings potential for any location in the world, without requiring a site visit. Built into the VEA is a Smart Project Identifier which accurately identifies the best projects to be implemented at the facility and intelligently completes a pre-feasibility analysis for further refinements onsite. Finally, the VEA incorporates a Financial Risk Assessor which automatically assesses the financial risk of the proposed investment and systematically determines the sensitivity of key parameters on a project's viability.

Virtual Energy Analyzer

As mentioned earlier, the RETScreen Software's Virtual Energy Analyzer incorporates a large database of archetypical facilities. The VEA now incorporates automated decision intelligence to enable ratepayer cost savings and it helps the user significantly reduce greenhouse gas emissions (i.e., deep retrofits) via applying various energy efficiency measures, by electrifying heating systems, while reducing peak electricity demand, and by automatically sizing both onsite and offsite renewable energy options to be considered.

New Archetypes

The thirty deep retrofit archetypes now available in the software because of this project are listed in the table below.

Table 1 | Deep Retrofit Archetypes – Commercial/Institutional and Residential Facilities

Facility Type	Type	Description
Commercial / Institutional	Education	Elementary school/Primary school
Commercial / Institutional	Education	High school / Secondary school
Commercial / Institutional	Health care	Clinic / Outpatient

Facility Type	Type	Description
Commercial / Institutional	Health care	Hospital / Inpatient
Commercial / Institutional	Lodging	Hotel - Large
Commercial / Institutional	Lodging	Nursing and residential care facilities
Commercial / Institutional	Office building	Office - Large
Commercial / Institutional	Office building	Office - Medium
Commercial / Institutional	Office building	Office - Small
Commercial / Institutional	Other	Laboratory
Commercial / Institutional	Public building	Arena - curling
Commercial / Institutional	Public building	Community centre
Commercial / Institutional	Public building	Convention centre
Commercial / Institutional	Public order and safety	Correctional facility – Direct observation unit
Commercial / Institutional	Public order and safety	Fire station
Commercial / Institutional	Public order and safety	Police detachment
Commercial / Institutional	Public order and safety	Police station
Commercial / Institutional	Religious buildings	Worship facility
Commercial / Institutional	Services	Gas station
Commercial / Institutional	Services	Wastewater treatment plant
Commercial / Institutional	Services	Water treatment plant
Commercial / Institutional	Stand-alone retail	Stand-alone retail
Commercial / Institutional	Warehouse/Storage	Warehouse - Conditioned
Industrial	Transportation – Equipment - Automobiles	Auto parts plant

Facility Type	Type	Description
Residential	Apartment building/Multi-unit housing	Apartment - High-rise
Residential	Apartment building/Multi-unit housing	Apartment - Mid-rise
Residential	Attached dwellings/Semi-detached home	Row house
Residential	Attached dwellings/Semi-detached home	Semi-detached home
Residential	Detached dwellings/Single family home	Single family home
Residential	Mobile home	Mobile home

In addition, with a separately funded but related project with the Department of National Defence (DND), we also developed an additional fifteen deep retrofit archetypes for military facilities, as listed in the table below.

Table 2 | Deep Retrofit Archetypes – Military Facilities

Facility Type	Type	Description
Military	Education	Classroom building
Military	Food services	Dining building
Military	Lodging	Barrack
Military	Lodging	Dormitory
Military	Office building	Office – Small
Military	Office building	Office – Workshop
Military	Other	Workshop – Industrial
Military	Other	Workshop – Small
Military	Public building	Sports centre – Swimming pool / Arena

Facility Type	Type	Description
Military	Public order and safety	Fire station
Military	Stand-alone retail	Retail building
Military	Warehouse / Storage	Garage – Vehicles
Military	Warehouse / Storage	Hangar – Aircraft
Military	Warehouse / Storage	Storage facility
Military	Warehouse / Storage	Warehouse – Workshop

Proposed Case Measures and Technologies

For each deep retrofit archetype, various measures and technologies are integrated into the proposed case. The deep retrofit archetypes include typical cost-effective measures and technologies aiming to reduce overall energy consumption. In each archetype, typical cost-effective measures and technologies include lighting retrofits, temperature setpoint and control systems upgrades, sealing of building envelopes, mechanical and electrical equipment upgrades, and optimization of operations through recommissioning and ongoing commissioning.

In addition to these cost-effective options, other, more expensive measures and technologies are normally required to achieve deeper reduction of GHG emissions. These include, for example, deep retrofit energy efficiency measures and technologies, such as heat recovery from ventilation systems and solar water heaters, as well as the electrification of heating systems (e.g., more efficient heat-pumps) and installing onsite renewable energy equipment, such as photovoltaics.

For each archetype, there are detailed notes about the assumptions used in the proposed case. These are available (in English and French) directly at the bottom of the Energy Model worksheet for each archetype, or via the "Notes" icon in the ribbon at the top of the software. Much more detailed information for each measure is available directly within the base case and proposed case input and output cells of the software.

Electrification of Heating

In conjunction with cleaner electricity grids, the electrification of space, domestic hot water and process heating systems are an important strategy to help organizations achieve deep GHG emission reductions. However, there are several key challenges which need to be addressed when using an electrification of heating strategy. These main challenges are:

1. the increased use of more expensive electricity, relative to typically lower cost natural gas, and the potential shifting of the time and increasing the amount of peak electricity loads, which in turn could lead to significant power demand charges from electric utilities;

2. higher equipment costs associated with heat pump technologies and their installation, particularly for ground-source heat pumps (GSHPs); and,

3. the cold climate limited performance of air-source heat pumps (ASHPs), normally requiring alternative peak load heating systems in colder locations.

Selecting and sizing the appropriate low carbon heating solutions, in conjunction with first implementing energy efficiency measures and technologies, is critical to a reasonably cost-effective decarbonization effort.

Key Assumptions for Electrification of Heating

For this electrification of heating step, the following key assumptions are made:

- Energy efficiency measures and technologies can help mitigate some of the impact of increased peak power demand resulting from the electrification of heating systems.

- Peak load heating systems are installed in conjunction with base load electric heating technologies to help mitigate increased peak power demand due to the electrification of the heating systems. This also helps minimize the costs associated with upgrades to the electric infrastructure, as well as reducing ongoing electricity consumption costs.

- Due to the increased use of electrical heating systems, retrofits to electrical infrastructure will also be required, for both centralized and decentralized facilities.

The software's Virtual Energy Analyzer automatically selects and sizes the proposed case heating and cooling equipment, to help achieve the emission reduction targets in a least-cost manner. The existing heating system is replaced with a main (base and intermediate load) electric heating system, comprised of either an electric boiler/furnace, air-source heat pump or a ground-source heat pump, as well as a peak load heating system comprised of either a fuel-fired boiler (e.g., natural gas) or an electric boiler with short-term thermal storage.

Key Assumptions for the Proposed Case Deep Retrofit Archetypes

The key assumptions for the proposed cases of each archetype are as follows:

- Electrification of heating systems, but fuel-fired boilers or electric boiler with thermal storage, peak load heating systems incorporated to help minimize potentially significant increase in peak electricity loads (kW) due to the electrification of heating.

- Electricity demand (kW) reduction technologies and measures are important to help accommodate increased electricity loads due to the electrification of the heating systems.

- Electricity consumption (kWh) in the proposed case (including electrification of heating) is minimized by the model to allow for potential electricity consumption growth (e.g., electric vehicle charging) as well as to provide sufficient electrical capacity for any new potential peak electricity loads (kW) resulting from the electrification of the heating systems.

- Only existing, commercially available technologies and measures are used.

- Target 80 to 90% greenhouse gas emission reductions at the facility, with the equivalent of the remaining 10 to 20% assumed to be procured from offsite renewable electricity sources or through other carbon offset (including removal) measures.

VEA Calculation Steps for the Deep Retrofit Archetypes

The Virtual energy analyzer incorporates several calculation steps for the deep retrofit archetypes, as follows:

1. Calculates the heating equipment capacity (kW) for the base case and proposed case.

2. Switches to electric heating for the proposed case.

3. Selects the proposed case main electric (base/intermediate load) heating equipment from the following technologies, sorted in ascending order of installed cost: electric boiler/furnace; air-source heat pump; ground-source heat pump. Adds fuel-fired boiler or electric boiler with thermal storage for peak load heating system to meet peak heating loads.

4. Sets the seasonal efficiency of the heating equipment based on the technology selected in step 3.

5. Sets the seasonal coefficient of performance (COP) of the cooling equipment.

6. Adds solar photovoltaic (PV) systems (assumed rooftop but could be ground mount) to help further reduce GHG emissions and proposed case electricity consumption. The PV system is included as an additional measure in cases where maximum targeted GHG emissions and/or electricity consumption reduction is not achieved after applying energy efficiency measures and technologies.

7. Calculates the amount of offsite renewable electricity, as well as remaining carbon offsets (including removals) required to be purchased to reach targeted GHG emissions reduction for the facility.

The Virtual energy analyzer first selects the proposed case energy efficiency measures and technologies available within each facility archetype. Then, the built-in decision-intelligence within the Virtual energy analyzer uses additional deep emission reduction algorithms, as described above, to help each facility meet the specified GHG reduction target in a least-cost manner.

The deep retrofit archetypes and the new automated decision intelligence added to the Virtual Energy Analyzer are the main deliverable for Phase 2 (Milestone 2) of the project. These upgrades include demand response and load reduction analysis capabilities to facilitate rapid and low-cost identification of cost-effective demand response (i.e. peak clipping and peak shifting), load reduction (i.e. electricity fuel switching) and energy efficiency (i.e. reduced electricity consumption) measures and technologies. These features now available in the software.

Note that via a separately funded but related project, CanmetENERGY also developed a new Net Zero Planning Tool to enable the user to prepare a portfolio-wide feasibility analysis. For real property portfolios, this includes the option to create a net zero emissions plan. This tool uses the facility-level archetypes developed as part of this project with IESO, and it now allows a top-down approach to feasibility analysis for an entire portfolio of facilities, in addition to the bottom-up approach using the Virtual Energy Analyzer for each individual facility.

As a result of these efforts, new deep retrofit archetypes have been created and they have been integrated into RETScreen Expert.

Deliverables Promoted to Key Ontario Stakeholders and Their Capacity Built

In this section we provide information about the completion of the Ontario-focused outreach and capacity building initiative, the focus of Phase 3 (Milestone 3) of this project.

Software User Manual and Translation

RETScreen Expert is available in 38 languages covering 2/3rds of the world's population. The extensive user manual built into the software is available in English, French, Spanish and Chinese.

For this project all relevant sections (i.e. for software updates) of RETScreen user manual were written, edited, reviewed and validated in English and then French translations were created, validated and finalized into the user manual (Spanish was also completed as a no charge bonus to this project).

eLearning Videos

In addition to the extensive user manual to support training, eLearning videos were also created, reviewed, validated, translated and finalized for the new electricity storage features available with the updated software. The "Power l Storage l Off-grid Feasibility Analysis with RETScreen Expert" playlist available on the RETScreen eLearning channel on YouTube can be accessed live via the following hyperlink - https://www.youtube.com/playlist?list=PLoj8AlvsTZVFZrBzoEZS1cWIGuu_jrOCO

In addition, the main RETScreen eLearning channel page on YouTube can be accessed at - https://www.youtube.com/@retscreenelearning4393

RETScreen Newsletter

Several mass e-mails were sent over the 3-year project period to the RETScreen newsletter subscribers (150,000+ professionals) informing them of the new deliverables (Versions 8.1, 9.0 and 9.1, plus RETScreen World Conference, etc.).

Social Media

An extensive social media campaign was completed, and the project deliverables were promoted to key stakeholders.

Below are some examples.

- LinkedIn articles in English by Gregory Leng (33,000+ current followers), Director – RETScreen International are available at the following hyperlink - https://www.linkedin.com/in/gregory-j-leng-retscreen-clean-energy-management-software/recent-activity/articles/

- Similarly, articles were prepared and promoted in French by Kevin Bourque (3,350 current followers), Manager – RETScreen Capacity Building Program - are available at the following hyperlink - https://www.linkedin.com/in/kevinbourque/recent-activity/articles/

In addition to these more comprehensive LinkedIn articles prepared in English and French for each major release, Gregory Leng also made project related posts on a regular basis over the 3-year project (e.g. approximately one per week). These posts focused on the specific new features released by this project – for example deep retrofit archetype for arenas (hockey & ice skating), training events, software use examples, etc.

Net Zero Planning Tool Webinar

A Net Zero Planning Tool webinar on the new deliverables was planned and delivered to key Ontario energy stakeholders and other Canadian and international users, in conjunction with project partners. An equivalent Net Zero Planning Tool webinar for the new features was also planned and delivered in French for French-speaking energy stakeholders, as well as in Spanish (at no extra charge to this project) for Spanish-speaking energy stakeholders. These 3 webinars, at 1.5 hours each, were designed to be the main launch event for the final deliverables of this project with IESO, plus with the separately funded project on portfolio-wide analysis with the Treasury Board of Canada Secretariat (TBS). On three sperate days in late January 2024 these webinars were delivered in English, French and Spanish. 1,132 people registered for the English webinar, with 230 registering for the French webinar and 164 for the webinar in Spanish. Overall, these webinars were a great success.

The Canadian Institute for Energy Training (CIET) were hired to promote and host these events, with CanmetENERGY staff delivering the training. We also used this opportunity to record all three sessions and add them to the RETScreen eLearning channel on YouTube, and with links within the RETScreen Software to these videos, to enhance the e-Learning training material available to users.

These video recordings have also provided an excellent avenue for further outreach and capacity building for this project with the IESO. For example, the English webinar recording (link below) has already had 2,700 views in less than six months.

Click here for English webinar recording - https://youtu.be/9at_7oywNj0?si=70KQyp6e0RW5s5v-

Similarly, the French webinar recording (link below) has already had 400 views in less than six months.

Click here for French webinar recording - https://youtu.be/3SRNxjCmeHA?si=AkxP2Rq4Q9kQ6kVr

RETScreen World Conference

We successfully delivered the RETScreen World Conference on January 25, 2023, in collaboration with Energy Management Canada (EMC). Presentations included overview of some of the earlier deliverables of this project. More than 800 professionals participated in this virtual event from across Ontario and Canada, and from more than 40 countries. See the conference website for recordings of the conference sessions at the following link - https://www.energy-manager.ca/virtual-events/retscreen/

The conference session recordings were added to both the EMC conference website and to the RETScreen User Community section of the RETScreen eLearning channel on YouTube. These recordings are valuable to professionals who were not able to attend the RETScreen World Conference live. They also help users to get a quick refresher on the latest updates to the RETScreen software, as well as be able to hear from some of our key users as to how they utilize and benefit from our Clean Energy Management Software platform.

Numerous other Webinars

Finally, in addition to these main webinars and conference recordings, numerous other webinars were planned and delivered in collaboration with various stakeholders. These webinars were focused on key vertical market sectors or key stakeholders. Some examples of these recorded webinars can be accessed directly at the RETScreen User Community section of our eLearning channel on YouTube

by clicking on the following link –
https://youtube.com/playlist?list=PLoj8AlvsTZVHLxvBmklEdvfewOmR-0Mb5&si=rclD0JKGU0SwNPfl

The key deliverables of this project with the IESO are all available directly or indirectly via the latest version of the RETScreen software (Version 9.1), available on NRCan's website at www.retscreen.net.

As a result of these efforts, the new deliverables were promoted to key Ontario energy stakeholders and their capacity to use the new deliverables has been built.

Conclusion

This project is enabling Ontario ratepayer cost savings through the successful development and integration, into the RETScreen Clean Energy Management Software (RETScreen Expert), demand response and load reduction analysis capabilities, as well as thirty deep retrofit facility archetypes.

The milestones achieved for each of the three phases of the project are as follows:

1. New demand response and load reduction capabilities were developed and integrated into RETScreen Expert.
2. Thirty deep retrofit archetypes were created and integrated into RETScreen Expert.
3. The new deliverables were promoted to key Ontario energy stakeholders and their capacity to use the new deliverables was built.

RETScreen Expert (Version 9.1)

RETScreen Expert (Version 9.1) now incorporates a large database of deep retrofit archetypical facilities. The software's Virtual Energy Analyzer has been upgraded to incorporate automated decision intelligence to enable ratepayer cost savings and it helps the user significantly reduce ratepayer costs greenhouse gas emissions (i.e., deep retrofits) via applying various energy efficiency measures, by electrifying heating systems, while reducing peak electricity demand, and by automatically sizing both onsite and offsite renewable energy options to be considered.

The thirty deep retrofit archetypes completed as part of this project are now available directly in the Virtual Energy Analyzer. These upgrades to the model include demand response and load reduction analysis capabilities to facilitate rapid and low-cost identification of cost-effective demand response (i.e. peak clipping and peak shifting), load reduction (i.e. electricity fuel switching) and energy efficiency (i.e. reduced electricity consumption) measures and technologies.

For each deep retrofit archetype, various measures and technologies are integrated into the proposed case. The deep retrofit archetypes include typical cost-effective measures and technologies aiming to reduce overall energy consumption. More expensive measures and technologies are usually required to obtain deep reduction of GHG emissions. These include deep retrofit energy efficiency measures and technologies, electrification of heating systems (e.g., more efficient heat-pumps) and the installation onsite renewable energy equipment, such as solar photovoltaics.

The outputs of this project are available within the latest public version of the RETScreen Expert Software (Version 9.1). The software can be downloaded from Natural Resources Canada's (NRCan) public website at www.retscreen.net

Lessons Learned

In this section we summarize three key lessons learned during the delivery the project. This information is intended to inform future work in the same area. The lessons generated will be used to inform the success of future GIF projects by identifying areas of concern / unknown barriers, inform broader industry to enhance success and avoid failure.

However, apart from minor adjustments to project deliverables during the project, there no change to the project plan required based on the lessons learned, as described below. In general, the project proceeded very well, and every stage was completed as planned in the determined time frame.

Calculating Peak Electrical Demand

One of the challenges during the first phase of the project (develop new demand response and load reduction capabilities), was to determinate the best way calculate peak electrical demand for the end-user of the software based on the typical level and quality of data and information that they would normally have access to for a facility.

In this case, we determined that the best way would be to provide high-resolution data management capabilities (e.g., 15-minute or 1-hour data resolution) and to provide analytical tools, such as load duration curves, heatmaps and time-series graphs, to help the user identify the time and amount of peak electrical loads using interval and sub-meter data. This did require much more software programming effort on our side and additional investment our own internal financial resources, to update the software from monthly and daily data, to allow hourly, 15-minute and even down to 1-minute data input. However, this additional effort and investment was worth it as the software now allows the user to calculate peak loads highly accurately within RETScreen Expert.

Electricity Cost Savings vs. Greenhouse Gas Reductions

Enabling electricity ratepayer cost savings is the primary focus of this project. However, efforts to reduce greenhouse gas (GHG) emissions are beginning to dominate multiple sectors. Although often complementary, various measures to achieve these two different objectives can also conflict with each other. For example, electrification of heating is a key GHG reduction strategy, but it can result in increased peak electrical loads and higher demand charges for end users. The challenge is to enable users to significantly reduce GHG emissions in a least-cost manner, while minimizing the impact of peak electrical loads where possible.

As part of this project, we increased the software's intelligence to help the user meet these two objectives.

The software's Virtual Energy Analyzer now incorporates automated decision intelligence to help the user significantly reduce greenhouse gas emissions (i.e., deep retrofits) via applying various energy efficiency measures and technologies, by electrifying heating systems, while reducing peak electricity demand, and by automatically sizing both onsite and offsite renewable energy options to be considered.

Project Development Costs vs. Accuracy Dilemma

Energy project proponents, investors, and financers continually grapple with questions like "How accurate are the estimates of costs and energy savings or production and what are the possibilities for cost over-runs and how does the project compare financially with other competitive options?" These are very difficult to answer with any degree of confidence, since whoever prepared the estimate would have been faced with two conflicting requirements:

- Keep the project development costs low in case funding cannot be secured, or in case the project proves to be uneconomic when compared with other energy options.
- Spend additional money and time on engineering to more clearly delineate potential project costs and to more precisely estimate the amount of energy produced or energy saved.

For both conventional and clean energy project implementation, the usual procedure for tackling this dilemma is to advance the project through several steps: pre-feasibility analysis, feasibility analysis, engineering & development, and construction & commissioning. At the completion of each step, a "go/no-go" decision is usually made by the project proponent as to whether to proceed to the next step of the development process. High quality, but low-cost, pre-feasibility and feasibility studies are critical to helping the project proponent "screen out" projects that do not make financial sense, as well as to help focus development and engineering efforts prior to construction.

It is an ongoing challenge to raise awareness of this dilemma with various industry stakeholders, as many still mistakenly jump right into time-consuming and costly detailed engineering studies without first properly considering if the project is worth pursuing via a much faster and lower cost pre-feasibly analysis study.

The new features (e.g. deep retrofit archetypes) and training material added to RETScreen Expert as part of this project can help overcome this market barrier. The new features can be used to rapidly prepare both pre-feasibility and feasibility analysis, specifically addresses this challenge by providing quick and valid results at low cost, on which "go/no-go" decisions can be made.

Next Steps

The RETScreen Clean Energy Management Software platform enables low-carbon planning, implementation, monitoring and reporting.

RETScreen International, a division of CanmetENERGY, manages the development and dissemination of the world's leading clean energy decision making software tool – including the current iteration of the software, RETScreen Expert. RETScreen Expert empowers professionals and decision-makers to rapidly identify, assess and optimize the technical and financial viability of potential energy efficiency, renewable energy and cogeneration projects. Our decision intelligence software platform also allows energy and facility managers to easily measure and verify (M&V) the actual ongoing energy performance of their facilities and helps find additional energy savings opportunities. And RETScreen allows all an organization's facilities to be aggregated, providing a bird's eye view of energy consumption, costs and greenhouse gas emissions across an entire portfolio.

RETScreen International currently has 17 full-time staff augmented by co-operative students, term and casual employees, and consultants as needed. The primary mandate of the team is to develop and disseminate the RETScreen software. Additional important activities include conducting outreach & training on RETScreen, cultivating strategic partnerships, managing our internet-based business model, and providing customer support to our global community of users. NRCan, its' collaborators and customers invest approximately $3 million per year in RETScreen software development and dissemination. This includes contributions each year by funding and task share partners and large enterprise clients (including the Greening Government Fund, NASA, Department of National Defence, etc.), as well as through a growing number of professional users who purchase an annual subscription for the Professional mode of RETScreen Expert.

Following this project with the IESO, the planned next steps are described below.

Users Download RETScreen Expert & Purchase Annual Subscription

RETScreen Expert, an advanced premium version of the software, is available in Viewer mode completely free-of-charge. Click here to download RETScreen Expert.

Our software is also available in Professional mode on an annual subscription basis. The full functionality of RETScreen Expert (including the ability to save, print & export files as well as numerous advanced features) is available in Professional mode by purchasing a renewable 12-month subscription, currently priced at $869 (Canadian dollars) per subscription (plus applicable taxes for Canadian orders).

One subscription to Professional mode entitles the subscribing organization to install the software key on up to a total of ten (10) computers at no additional charge, and for use by employees of the organization.

Educational institutions who purchase one annual subscription are eligible to install RETScreen Expert's Professional mode on an unlimited number of organization-owned computers (including computer laboratories), as well as on an unlimited number of student-owned computers (for currently registered students) and for teaching and research (non-commercial) use only. Click here for more information.

RETScreen Innovation Lab

We collaborate with government and multilateral organizations to co-fund and develop advanced versions of the RETScreen Clean Energy Management Software platform.

RETScreen Expert, the intelligent version of the software, incorporates benchmark, feasibility, performance and portfolio analysis for various types of facilities, including commercial, institutional, residential, industrial and power generation, all within one comprehensive platform.

The focus of our innovation lab is to ensure that the RETScreen software is always at the leading edge of the clean energy technology transition, and that we continuously improve our platform to meet the complex needs of our large and rapidly growing global user community.

The software harnesses advanced algorithms and data to simplify decision making around energy projects, including renewable energy, energy efficiency, cogeneration and transportation.

RETScreen Expert also allows professionals to measure and verify a facility's ongoing energy and sustainability performance, and to manage a portfolio of multiple facilities.

The RETScreen Division at CanmetENERGY has been awarded new funding from the Greening Government Fund (GGF) for a new 3-year $2.2 Million project - "Enabling Continuous Operational Energy & GHG Optimization for Many Federal Facilities" for the RETScreen Software.

Starting April 1, 2024, this new project will build automated greenhouse gas (GHG) management capabilities into the RETScreen Clean Energy Management Software (RETScreen Expert), thus enhancing the software's annual and monthly reporting capabilities, which will in turn allow for the proactive optimization of operational GHG emissions and energy performance of federal facilities on a continuous daily, hourly or 15-minute basis.

This new effort builds on some of the deliverables originally completed as part of Milestone 1 and 2 of this project with the IESO.

And, as per other software development activities, these new features will also be made available to the RETScreen Software's 850,000+ users in both the public and private sectors around the world, including many users throughout Ontario.

The new GGF funding is provided by the Treasury Board of Canada Secretariat (TBS). The Department of National Defence (DND) and Natural Resources Canada (NRCan) will also be contributing financially to this project.

If you are a government or multilateral organization interested in exploring an investment in further improvements to the RETScreen software to help facilitate your program needs, please contact us at the following email address: RETScreen@nrcan-rncan.gc.ca

RETScreen Data Onboarding

We provide data onboarding services on a cost-recovery basis for our public sector enterprise customers to help them with their portfolio-wide deployment of the RETScreen Clean Energy Management Software platform.

There has been a rapid uptake by energy, facility and sustainability managers at public and private sector enterprises, who are using RETScreen Expert for portfolio-wide energy management and greenhouse gas (GHG) reporting.

The focus of our data onboarding service is to assist public sector owners and/or operators who have many facilities in their portfolio to integrate various data for their facilities into the RETScreen platform as quickly, as accurately and as automated as possible.

For example, we provide ongoing data management and technical support to the Treasury Board of Canada Secretariat (TBS) – Centre for Greening Government (CGG) and federal departments, who use the RETScreen software to prepare the Government of Canada's Greenhouse Gas Emissions Inventory that tracks GHG emissions from federal operations each year.

Professionals also use the software for more detailed energy management activities and may benefit from this data onboarding service. Some public sector customer examples include the Canadian Space Agency (CSA), Correctional Service of Canada (CSC), the Council of Ontario Universities (COU), the Department of National Defence (DND), Global Affairs Canada (GAC), Natural Resources Canada (NRCan), and York University.

If you are an owner and/or operator of a public sector portfolio of facilities and you would like us to help you with the integration of your data into the RETScreen platform, please contact us at the following email address: RETScreen@nrcan-rncan.gc.ca

RETScreen Capacity Building

We help improve the knowledge, skills and capabilities of the 850,000+ energy, facility and sustainability professionals located around the world who use the RETScreen Clean Energy Management Software platform.

RETScreen is the world's leading clean energy management software, growing at 40,000+ new users each year and available in 38 languages, covering 2/3rds of the world's population.

The focus of our capacity building program is to ensure that both our new and existing users are able to maximize the benefit and impact of using our software platform in their day-to-day work.

We help achieve this by:

- continuing to widely disseminate RETScreen Expert, the advanced version of the software, via our website to users in Viewer mode completely free-of-charge.

- providing an ever-improving premium version of RETScreen Expert on a cost-recovery basis. The full functionality of RETScreen Expert (including the ability to save, print and export files) is available in Professional mode by purchasing a renewable 12-month subscription, currently priced at $869 (CAD) per subscription (plus applicable taxes). Each paid subscription entitles the subscribing organization to install the software key on up to a total of ten (10) computers at no additional charge, for use by employees of the organization.
- offering the 1,500+ universities and colleges worldwide who use RETScreen to purchase one annual subscription and install RETScreen Expert's Professional mode for teaching and research (non-commercial) use only on an unlimited number of organization-owned computers (including computer laboratories), as well as on an unlimited number of student-owned computers (for currently registered students).
- developing and disseminating knowledge content, such as the RETScreen User-Manual, the RETScreen Engineering e-Textbook and the RETScreen Case Studies and Templates.
- creating and publishing new instructional videos for our RETScreen eLearning Channel and helping to raise awareness of online RETScreen training resources created by other organizations.
- coordinating with private and public sector organizations who provide independent RETScreen training, such as the popular Certified RETScreen Expert (CRE) course, to help raise awareness of upcoming courses offered by this network of trainers who focus on professional development and continuing education.
- providing direct technical support to our RETScreen customers who subscribe to the Professional mode of the software.

If you are interested in purchasing an annual subscription for the Professional mode of the RETScreen software or if you are already a subscriber and you require technical support, please contact us at the following email address: RETScreen@nrcan-rncan.gc.ca

Independent Electricity System Operator
1600-120 Adelaide Street West
Toronto, Ontario M5H 1T1

Phone: 905.403.6900
Toll-free: 1.888.448.7777
E-mail: customer.relations@ieso.ca

ieso.ca

@IESO_Tweets
linkedin.com/company/IESO

Connecting Today.
Powering Tomorrow.