QUANTIFYING GREENHOUSE GAS REDUCTIONS
PROJECT PROFILE
SOLAR THERMAL (HOT WATER) RETROFITS

The new Local Government Climate Action Program (LGCAP) provides local governments and Modern Treaty Nations with predictable and stable funding to support reducing greenhouse gas emissions and preparing for the impacts of a changing climate. LGCAP is built on the foundations of CleanBC, the Climate Preparedness and Adaptation Strategy and the BC Climate Action Charter (the Charter). Carbon neutrality is not a component of LGCAP, but the carbon neutral framework remains available as a resource to local governments to quantify community mitigation projects and account the reductions in a credible manner against corporate emissions. The carbon neutral framework can also support climate lens assessments and meeting commitments under the Charter. This decision was a result of engagements with local governments who indicated concerns that a focus on carbon neutrality could detract from funding other, local and more climate-effective initiatives. Additionally, with an increasing number of B.C. local governments adopting net-zero targets, carbon neutrality has been seen as less of a priority pathway. Establishing net-zero targets illustrates leadership in climate action and aligns with provincial commitments on net-zero by 2050 legislation. Please view all requirements in the project profiles as recommendations for establishing credible reductions.

Project Profile Overview

This project profile provides guidance on estimating the amount of greenhouse gas (GHG) emissions that can be avoided by using solar thermal (hot water) systems to pre-heat the hot water supply.

Rooftop solar hot water is a mature technology that has been successfully used in a variety of climate zones for decades. Around the world and in British Columbia, the number of solar hot water installations is increasing rapidly. By 2020, approximately 50 local governments jurisdictions in BC had incorporated bylaws that accommodated the potential installation of domestic solar hot water systems, and hundreds of solar hot water systems have been installed across British Columbia, mostly on residential buildings, but also on schools and municipal buildings.

Calculating Emission Reductions

Annual Net Emission Reductions = Annual Baseline Emissions – Annual Project Emissions

Solar hot water projects achieve GHG emission reduction through a zero carbon and renewable resource in place of conventional energy used to heat water. This profile includes projects where the installed solar hot water system partially or completely replaces the use of natural gas, propane, electricity or fuel oil for hot water heating.

To establish the emission reductions that result from installations, the amount of energy collected by the solar equipment is determined. This total is then used to calculate baseline avoided natural gas, propane, electricity or fuel oil emissions.

$$\text{Emission Reduction} = \frac{\text{Energy collected (Solar water heater)}}{\text{Seasonal Average Efficiency (Displaced Equipment)}} \times \text{GHG emission factor (Displaced Energy)}$$

Spreadsheet Directions

The embedded spreadsheet calculates the avoided GHG emissions from multiple solar water heater installations. Recognizing that the performance of installations can vary due to hot water usage, geographical location, and system installation and operating parameters, the spreadsheet includes room to calculate five distinct aggregations of project types. For example, a group of residential homes that have a similar type of solar hot water system installed can be calculated under project type #1, and then the next group with the similar type of solar hot water system installations can be calculated under project type #2 and so on. The directions below lay out the steps for calculating multiple project types.

Step 1: Project name and capacity	
Project Name. The spreadsheet includes a series of separate project types to allow for variations in usage, performance, and equipment.	Choose a name common to the project type.
Total Installed Capacity. Calculate the total area of solar collectors for the project type.	Total Installed Capacity (m^2) = Total of installed systems * Average area of solar collector (m^2)
Step 2: Calculate seasonal average performance	
Seasonal average performance of the project type will depend on hot water usage, geographic location, aspect of the system, and system installation and operating parameters. It is recommended that the estimated performance of each installation be provided by the building owner. Otherwise software such as RETScreen can be utilized to calculate a general project average.	In the absence of a project specific average, the spreadsheet contains default performance averages for typical building types ($GJ/m^2/yr$)
Total Water Heating Provided (GJ/yr)	Total Water Heating Provided (GJ/yr) = Seasonal Average Performance ($GJ/m^2/yr$) * Total Area Installed Capacity (m^2)
Step 3: Calculate baseline and emission reductions	
Displaced Water Heater Average Efficiency.	Calculate the average efficiency of displaced water heaters for each energy type - natural gas, propane, electricity or light fuel oil (%).
Proportion of Energy Sources Displaced. This identifies the proportion of energy types that have been displaced.	100% = (natural gas systems displaced/total systems) % + (light fuel oil systems displaced/total systems) % + (propane systems displaced/total systems)% + (electricity systems displaced/total systems)%
Calculate Baseline Energy Displaced.	For each energy source calculate: Energy displaced (GJ/yr) = Total Water Heating Provided (GJ/yr) * proportion energy displaced (%)/Displaced Water Heater average efficiency (%)
GHG emission reduction	GHG avoided (tonnes CO_2e/yr) = (natural gas energy displaced * 0.050 tonnes CO_2e/yr) + (light fuel oil energy displaced * 0.069 tonnes CO_2e/yr) + (electricity energy displaced * 0.003 tonnes CO_2e/yr) + (propane energy displaced * 0.060 tonnes CO_2e/yr)
Step 4: Repeat Steps 1 through 3 for Remaining Project Types	
Step 5: Calculate Total Avoided GHG Emissions	
Avoided Emissions = Sum of Project Type #1, #2, #3, #4, and #5 emission reductions	Spreadsheet output

Baseline and Project Calculation Guidance

Information Requirements & Sources	Energy type Water temperature Hot water demand volume or Size and energy rating of hot water heater Number of building occupants Number of showers and sinks ♦ Source: Building owner/manager/tenant Emission factor for each energy type ♦ Source: BC Best Practices Methodology for Quantifying Greenhouse Gas Emissions, https://www2.gov.bc.ca/assets/download/2282FF46047E44DEBA3CCF16590638A8
Calculations	Except in rare cases where a building has a meter that monitors energy use from its hot water heater, it will be necessary to use energy modeling software to estimate total energy use over the course of a year. A few software options include: ♦ Retscreen – Free to register and download. Allows for energy and economic analysis. www.retscreen.net ♦ Polysun Solarthermal Simulation – Design tool for solar installation professionals. https://www.velasolaris.com/?lang=en ♦ Transol 3 – Based on the widely used TRNSYS modeling platform. Detailed analysis for system designers and engineers. https://aiguasol.coop/design-of-solar-thermal-systems-with-transol/ ; http://sel.me.wisc.edu/trnsys/features/ After annual energy use is estimated, annual GHG emissions can be calculated: CO_2e = Total annual energy use x emission factor
Notes	Total baseline emissions should be calculated based on one calendar year of activity
	Total project emissions should be calculated based on one calendar year of activity Documenting the assumptions used in calculating energy use and GHG emissions for this project will be important, because of the large number of variables involved. The calculation tools listed above provide summary tables of the inputs and outputs that can be used for the purpose of documentation.

Best Practices

The following checklist includes best practices for quantifying greenhouse gas emissions from local government GHG mitigation projects.

Checklist:

1. Emission reductions have occurred before they are counted
2. Emission reductions are credibly measured
3. Emissions reductions are beyond business as usual
4. Accounting of emission reductions is transparent
5. Emission reductions are only counted once
6. Project proponents have clear ownership of all emission reductions

Local Applicability and Cost Factors

- **Local Government Role as Project Facilitator:** The applicability of this project is dependent on the local government having the capacity to play a facilitation role. Each local government will need to determine an appropriate role to play in the promotion of solar hot water heaters. If a local government owns social housing, then it could directly install or fund the installation of solar thermal systems. Alternatively, the local government could potentially create development permit area guidelines, provide technical assistance, or find other means of helping residents and businesses install solar systems.

- **Energy Source Used in Conventional Hot Water Heaters:** In some jurisdictions, the norm among developers over the years has been to install electric hot water heaters. Because of the low carbon content of electricity in British Columbia, replacing an electric hot water heater with a solar hot water heater will result in a very small reduction in GHG emissions.
- **Project Monitoring and Reporting Effort and Costs:** Collecting and reporting data on baseline and project energy use and GHG emissions could present logistical challenges when the buildings are not owned or operated by the local government. This will be the situation in all cases except for government owned social housing projects. The local government will need to identify a mechanism to obtain data necessary to complete the GHG emission reduction calculations (details of the specific data needs are covered in the GHG Accounting Summary section). This may necessitate email, web, telephone or mail-based outreach in combination with social marketing tools to secure the participation of community members / groups and to provide a convenient mechanism for reporting data. For example, an estimate of annual average performance for each installation is required to accurately estimate emission reductions.

Precedents

For information on solar power in British Columbia, including rebates and loans, see:

- BC Hydro Power Smart: https://www.bchydro.com/powersmart/residential/building-and-renovating/switch-to-solar-energy.html

- Empower Energy: https://empowerenergysolar.ca/rebates-incentives-grants-for-installing-solar-power-in-british-columbia-bc/

Project Variations

Other projects that require some basic adjustments in the methodology include:

- Solar Thermal Space Heating – There are a variety of technologies and building designs that can be utilized to capture the energy of the sun for building space heating.
- Solar Electricity Generation – Solar photovoltaic (PV) panels can be placed on roofs and walls to generate electricity for in-building use.
- Solar Pool Heating - Glazed and unglazed solar pool systems can reduce gas, oil or propane usage for pool heating

Resources

- CanmetENERGY Performance Directory of Solar Domestic Hot Water Systems: Data analysis software and modelling tools (canada.ca)
- United Nation Clean Development Mechanism (CDM) approved methodology for thermal energy carbon credit projects: http://cdm.unfccc.int/methodologies/DB/JSEM51TG3UVKADPA25IPUHXJ85HE8A
- Canadian Solar Industries Association (CanSIA): http://www.cansia.ca/
- Award winning GIS Solar Application that the District of North Vancouver has created to help people with assessing the suitability of individual buildings for solar: http://www.geoweb.dnv.org/ (click on applications, and then solar)