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OSEA CanSIA Solar Thermal Community Action Manual

2008 – Second Edition





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Final Notes / Disclaimer

There are a variety of tax-related and legal implications resulting from many of the options outlined in this manual. The manual is intended to provide introductory information only, and advice should be sought from trusted legal or financial counsel before signing any contract or agreement.

Financing structures discussed in this manual with have varied results for various individuals and businesses. Individuals and organizations interested in investing in a system should consult a financial advisor about accompanying loans, subsidies or newly acquired assets.

No section of this manual should be considered tax, financial, or legal advice, and OSEA and CanSIA are not liable for any resulting actions taken based on information in this manual. Furthermore, all examples in this Guidebook are intended as examples and conceptual illustrations only.

Use of RETScreen should be done only in conjunction with its manual to avoid errors that may significantly alter the financial outcome of a project.

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1 Introduction

1.1 Solar Thermal Community Action Manual: Purpose and Audience

The Solar Thermal Community Action Manual is designed for residents of Canada who would like information on residential-scale, or small-scale commercial Solar Thermal installations, and information on initializing a community based organization situated in their neighbourhood.

Solar Thermal is a form of energy generation that converts solar radiation into useable heat energy that is used on site. Community Power is a type of project ownership whereby various residents of a community pool their investment into a single or multiple renewable energy generation project. Of several types of ownership structures that exist, there are two models that have emerged; the structure that provides for individual residential-scale systems through individual purchase or neighbourhood bulk-purchase, and remotely sited large installations for use by small communities or businesses, funded by local investment. Though the guide examines all ownership options, it focuses primarily on community ownership.

This manual includes information about Solar Thermal technologies that are currently available, and which technologies are best suited for various applications. Factors that affect the viability of a Solar Thermal project, such as site feasibility and regulatory issues are discussed. Ownership options are outlined, and a primer on financing Solar Thermal projects is provided. The guide also walks the reader through the process of choosing a supplier and installer. Final chapters address possible developments that will affect the future of Solar Thermal technology in Canada.

Throughout this guidebook will be references to other resources and useful information regarding Solar Thermal. The most extensive and useful sources of information can be found at CanSIA and CanREN (Appendix A0).

1.2 OSEA and CanSIA

The guide was created by the Ontario Sustainable Energy Association (OSEA) in conjunction with the Canadian Solar Industries Association (CanSIA).

OSEA (Ontario Sustainable Energy Association) is a not-for-profit member-based association of renewable energy organizations in the Province of Ontario. The mandate of OSEA is to initiate, facilitate and support the work of community-based sustainable energy projects and organizations across Ontario. OSEA's member services are designed to support members as they develop their projects and to host and facilitate discussions surrounding a supportive policy framework for community power projects.

To date, OSEA has focused on community wind power projects by supporting co-operatively-owned projects, and initiation of Provincial policy in the form of Advanced Renewable Tariffs, to promote renew-

OSEA; CanSIA

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Funding provided by Natural Resources Canada

able energy development. OSEA is expanding its services to provide support for community- based biomass, small hydro, Solar PV and Solar Thermal projects. For more information on the support services OSEA provides, please visit their website at www.ontario-sea.org.

OSEA's work in policy development has centered on the Standard Offer Program (Section 7.1), which includes provisions for community wind, biomass, small hydro and solar PV. Solar Thermal energy generation is not yet included in this policy, however Solar Thermal is rapidly gaining recognition as a technology with benefits largely associated to larger-scale, community-based systems.

CanSIA (Canadian Solar Industries Association) is a federally registered not-for-profit association with a membership comprised of individuals, organizations and companies who share an interest in solar technology. CanSIA is working to strengthen the Canadian solar industry and to promote the use of renewable energies. (www.cansia.ca)

1.3 The Benefits of Community-Owned Solar Thermal

Solar is a clean and reliable source of energy. It reduces pollution while producing a dependable source of energy that is not affected by international fuel supplies or events. It directly replaces energy consumption from non-renewable energy sources, including:

- Heating predominantly from natural gas, oil, propane and wood
- Electricity from coal, nuclear, natural gas, and oil

Energy created by non-renewable resources creates:

- Greenhouse gas (GHG) emissions associated with climate change
- Smog-related emissions that effect air quality and health
- Long-term radioactive waste issues from nuclear

Solar energy generation is a decentralized approach to energy production. It generates energy where it is needed, reducing the need for energy to travel long distances, and will save money. As solar technologies grow, the industry will expand; new high-trained jobs will be created and local wealth will increase.

Community Solar Thermal Power has benefits over and above those realized by individual ownership. By pooling the skills and resources of communities, larger-scales can be achieved, reducing the average cost for each member. Even though the overall cost of the larger system will be greater, the average cost per member will be less for an equal amount of heat generating capacity, since each individual has only the obligation to cover a portion of a single installation instead of many individual installations. This will be explained further in section 5.2.

Community ownership also has other benefits, including increasing public knowledge and recognition of Solar Power, reducing many of the risks associated with having an individual system, and many other advantages explained in section 4.4.3.

1.4 Appendices / Resource Centre

The face of Solar Thermal technology is changing rapidly in Canada. To stay up-to-date in this changing environment, please consult the CanSIA website regularly.

2. Overview of Solar Thermal Technology in Canada

2.1 Introduction to Solar Energy

Solar Energy is a form of renewable energy generation. Renewable energy is generated such that it does not depend on a resource or fuel that will eventually be exhausted. A nuclear reaction in the sun generates radiant energy that travels to earth, and is in turn converted into energy by solar energy technologies.

The most well known form of electricity generation from solar energy is Solar PhotoVoltaic (PV) cells, or solar panels. PV cells or panels convert solar radiation into electricity using a crystalline semiconductor of Silicon. OSEA will be producing a Solar PV community action manual expected in July, 2007. For information on PV solar installations please refer to the Canadian Renewable Energy Network, or the Canadian Solar Industries Association (Appendix A0).

Another well-known form of energy generation from solar applications is Solar Thermal.

Solar Heat Generation Facility in Sweden

ARCON / ESTIF

2.2 Introduction to Solar Thermal

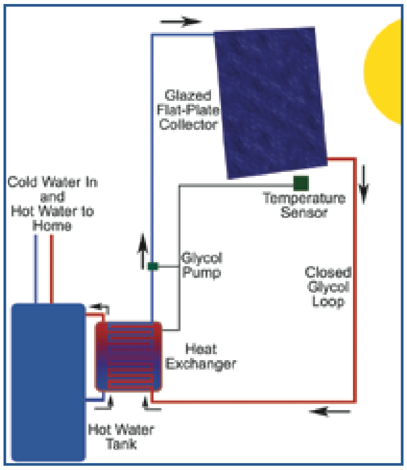
Solar Thermal energy collection is defined as using a technology to convert sunlight into energy in the form of heat. Applications of Solar Thermal include domestic hot water (DHW) heating, commercial hot water (CHW) heating, heating your home or building (ventilation air heating, or VAH), heating an indoor swimming pool (ISP) or outdoor swimming pool (OSP), and agricultural uses such as water heating and crop drying. By far, the most prominent residential applications of Solar Thermal are for domestic hot water (DHW) and outdoor swimming pool (OSP), and commercially for commercial hot water (CHW) and ventilation air heating (VAH).

There are various forms of Solar Thermal energy technologies on the market, technologies that convert energy from the sun into heat via solar collectors. The type of solar collector selected depends upon the nature of the end use of the heat energy.

Solar Thermal technology is divided into two types: 'Active', denoting actively moving solar heat energy to where it is required, and 'Passive', which functions as a stationary system that uses heat 'in situ', or at the source. This guidebook is designed as an introductory 'how-to' guide for Active Solar Thermal.

2.3 Passive Solar Thermal

Passive solar is the term given to the use of sunlight for heat energy without the use of collectors. It is passive in nature since no pumps or fans are used to move the energy from where it is



A diagram of a typical glycol-based domestic hot water heating system; the most common residential aplication

generated to where it is used. Please consult the Appendix for further reading on passive Solar Thermal (Appendix E1), as well as alternate applications (Appendix E2).

2.4 Active Solar Thermal

Active Solar Thermal is the technology directly addressed by this guidebook. The term 'active' denotes using a specifically designed solar collector that converts solar radiation into heat energy and, using a pump or fan, transfers that heat energy to where it is needed. Active solar collectors typically consist of a panel or container that has either air or a liquid passing through it to collect the heat energy. Most forms of Solar Thermal collectors available for purchase are active solar collectors.

Air based collectors are typically defined by a loop of air that is forced into a Solar Collector using a pump to acquire energy, into the area that is to be heated, and then back into the collector again to gain energy.

Liquid-based collectors circulate a liquid through the heating system to act as a heat transfer solution, or heat energy host. Propylene Glycol, typically used as a coolant or antifreeze due to its low freezing point, is the liquid found in most liquid-based solar collector panels. The boiling point of a 50/50 mixture of Glycol and water has a boiling point that rises sharply as the closed loop is pressurized. Another common type of collector is the drain back system, which utilizes water as the solution. In Canada, liquid-based collectors are the industry standard, representing 99% of installed solar thermal capacity.

An array of Vacuum Tube collectors used for commercial hot water heating

Thermomax / ESTIF

2.5 Solar Collectors

There are a variety of different types of solar collectors available in Canada. For a full list and description of these collectors please refer to Appendix E3.

In Canada, the most prominent residential applications of Solar Thermal are for domestic hot water (DHW) and outdoor swimming pool (OSP), and commercial applications are for commercial hot water (CHW) and ventilation air heating (VAH). This section will discuss the different applications for Solar Thermal and the kind of equipment used for each type of application.

Applications of Various Solar Thermal Collectors

Collector	DHW	CHW	VAH	ISP	OSP
Air-Based					
Back-Pass or Single-Pass Open			✔		
Unglazed Perforated Flat-Plate			✔		
Glazed Flat-Plate			✔		
Liquid-Based					
Unglazed Flat-Plate					✔
Batch, Bread-Box or Integral	✔				
Evacuated or Vacuum Tube	✔	✔		✔	(✔)
Glazed Flat-Plate	✔	✔		✔	(✔)

2.6 Outdoor Solar Pool Systems

In Canada, outdoor solar pool heaters (OSP) are the most commonly adopted type of system.[1] The simple payback for OSPs is the most attractive of all renewable energy generation technologies available to homeowners. A solar pool heater can provide 100% of the pool heating needs and typically pays for itself within 1 to 5 years[2], as pool heating costs can reach over $1,000 per year.

Unglazed seasonal panels are the most commonly used type of panel for this application, but glazed flat plate or evacuated tube panels can be used to heat the pool as well (see section 2.11 for more information on combination systems). Since pools lose the majority of their heat from the surface, the typical panel sizing for an unglazed system is equal to 50% of the square footage of the pool if southern roof exposure is available. If the pool is significantly shaded or if a west or east roof is used, more panels may be required to maintain the desired temperature.

Seasonal solar pool heaters integrate easily with existing pool equipment. The pool pump circulates the pool cold water to the roof, through the solar collectors, and back into the pool. Other than the solar pool controller and the actuator, additional pumps or equipment are not needed.

Solar pool systems can be operated manually, but it is recommended to use a controller which activates/deactivates an actuator that will pump water through the panels only when the temperature of the roof is higher than that of the pool temperature. This kind of system can usually be installed in a single day, and the typical cost for an average pool (16' by 32') would be in the range of $3,500 to $4,000 installed.

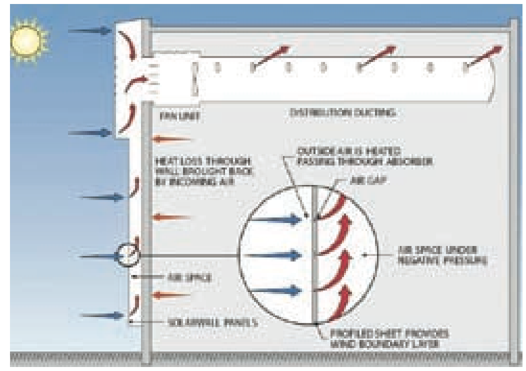
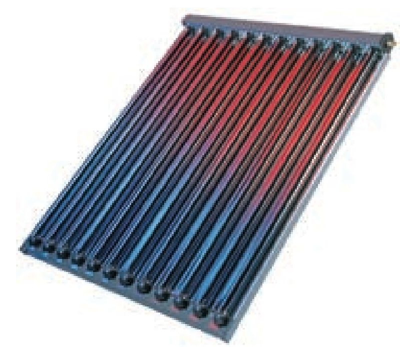


Diagram of an Unglazed Perforated Flat-Plate and vacuum tube collectors can be used for space heating when combined with hydronic furnaces, radiant infloor heating, or radiators.

Solarwall



Vacuum or Evacuated tube collector

Ritter Solar / ESTIF

Solar Pool Heater

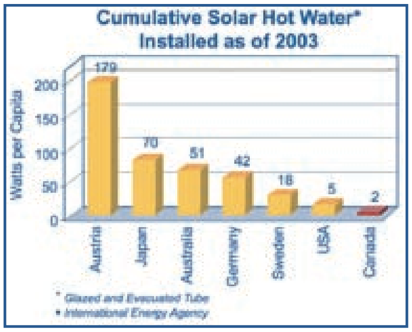
Aaron Goldwater

Glazed Flat-Plate collector panel

Wagner & Co, Cölbe / ESTIF

1 Office of Energy Research and Development. Renewable Energy in Canada – Status Report 2002. www2.nrcan.gc.ca/ES/OERD/English/view.asp?x=1571&all=true#540

2 RETScreen International. Solar Water Heating Project Analysis. Clean Energy Project Analysis Course. Slide 12.



Solar thermal installed capacity for the purpose of domestic hot water measured in Watts per capita

International Energy Agency / CanSIA

2.7 Solar Domestic Hot Water Systems (SDHW)

SDHW systems work year round to provide preheating for domestic hot water consumption. The most common type of system is a two-tank system, in which the solar collectors heat a heat transfer fluid in a closed-loop. The heat transfer fluid (either glycol/water or just water in the case of a drainback system) is pumped to the solar collectors (typically located on the roof), gains heat from the sun, and travels back down to the heat exchanger. The heat exchanger (commonly located inside of the solar storage tank), allows the heat transfer fluid to transfer the heat into potable cold water, which travels first through the solar storage tank where it is preheated and then flows into the conventional hot water tank or a tankless water heater where it is distributed throughout the home.

SDHW systems should be sized to provide 100% of domestic hot water needs on an ideal summer day. The sizing of the system depends on the household hot water consumption, the slope and orientation of the solar collectors (south facing is best), and the performance of the solar collectors. A typical family of 4 will use approximately 240L (60L per person) of hot water per day[3]. The year round average production of a system is usually sized to provide 50 - 60% of a household's hot water consumption.

Flat-plate panels are often 4' x 8' in size each and a typical family will require 2 panels to meet their needs. Evacuated tube collectors come in different sizes and are available in 10 to 30 tube arrangements per collector. The panel arrangements should have 10-12 evacuated tubes per person (in the case of a south facing roof). More information about the types of SDHW systems available can be found in the following sections.

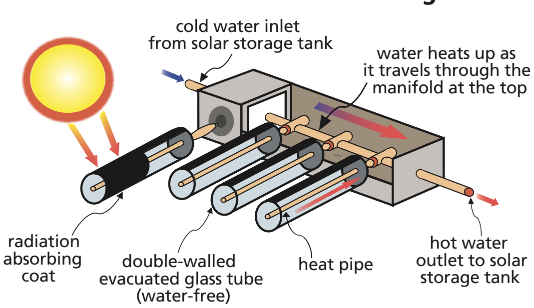
Flat-Plate Collector Installation

Blair Beesley

2.7.1 Flat-plate Collectors

In Canada, the most common type of SDHW collector is the Flat-Plate Collector (FPC)[4]. The Flat-Plate Collector typically consists of a network of copper piping attached to a black absorber material inside of a glass-covered frame. Performance can vary widely depending on the materials used and the design. The appearance of an FPC is similar to a skylight and can be integrated easily into the building design.

Solar evacuated tube collector diagram



Heat Pipe Evacuated Tube Design

Aaron Goldwater

2.7.2 Evacuated Tube Collectors (ETC)

There are different designs in Evacuated Tube Collectors. Some have glass tubes with a single wall of glass where the vacuum is contained in the same area as the absorber material. Others, and probably the most common design, consist of a number double walled glass tubes that have a vacuum within the two walls of glass. Some have the heat transfer fluid

[3] 60L is the recommended load per person in the RETScreen International model for Solar Water Heating. The average household uses approximately 220L of hot water per day (average household is actually less than 4 people).

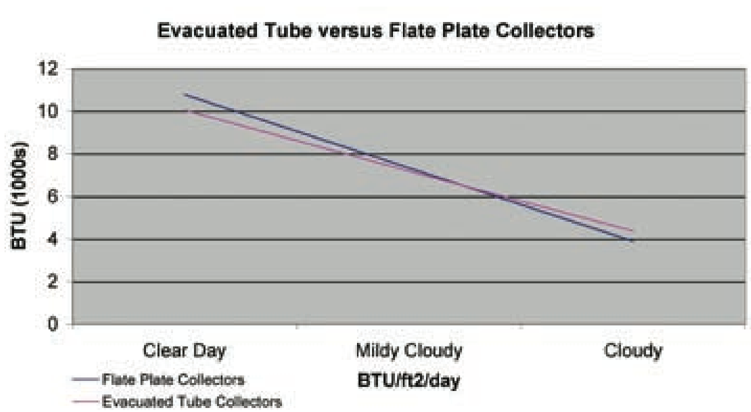
[4] CanSIA. *STT 100: Solar Domestic Hot Water Installation – Fundamentals.* Page 22.

traveling into each glass tube whereas others have a heat conductor that runs the length of the tube and exchanges heat in the manifold. Evacuated tube collectors can reach very high temperatures and are very effective at trapping heat due to the vacuum between the two layers of glass. Heat pipes contain a non-toxic liquid that undergoes an evaporation and condensation cycle in order to concentrate the heat at the tip of the heat pipe.

Some installers and designers prefer to use only either FPCs or ETCs. The table below illustrates some of the advantages of both types of collectors.

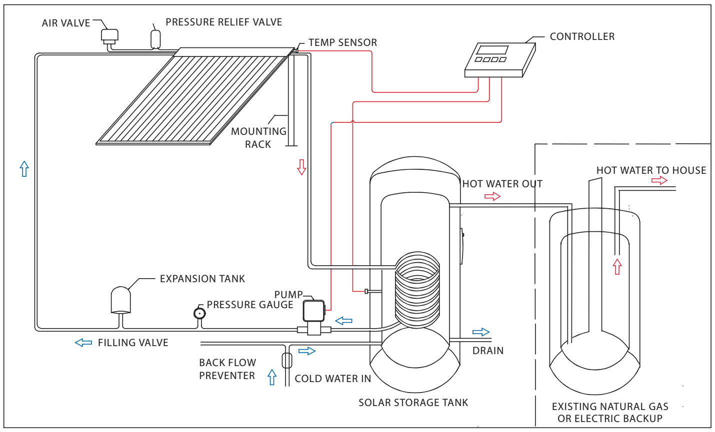
Type of panel	Flat-Plate Collectors (FPCs)	Evacuated Tube Collectors (ETCs)
Performance	FPCs tend to have better performance than ETCs on ideal solar days. However, their efficiency drops off significantly during the colder months.	ETCs can reach extremely high temperatures and are especially good for systems requiring high grade heat in commercial or industrial settings. They also tend to perform better than FPCs in the winter months due to the superior insulating properties of a vacuum.
Cost	FPCs are typically less expensive.	Typically more expensive than FPCs. However, due to a large number of manufacturers producing ETCs in China, some ETCs can be relatively inexpensive.
Size/Weight	FPCs are typically 4' x 8', however, some manufacturers provide them in a variety of sizes. A typical collector will weigh between 100 to 130lbs.	ETCs come in various tube sizes and collectors with a wide range of number of tubes. Once assembled, ETCs can weigh anywhere from 100lbs to 240lbs depending on the number of tubes in the collector.
Maintenance	The FPC cover is typically made of low-iron tempered glass which is strong and resistant to breakage. However, in the event it were to break or condensation were to get inside the collector and damage it, it is likely that the entire collector would need to be replaced.	Although evacuated tubes are made of hail-safe tempered glass, they can break from time to time. If broken, each individual tube can be replaced easily and at relatively little cost without having to shut down the system as each tube is isolated from the rest of the collector.

The performance of FPCs and ETCs is similar regardless of the amount of solar radiation. FPCs tend to perform better on days in which the ambient temperature is similar to the collector temperature, whereas, ETCs tend to outperform FPCs on days when there is a larger difference in temperature. The following chart was created using performance data obtained from the Solar Rating and Certification Corporation (SRCC) data available at **www.solar-rating.org**.



2.7.3 Glycol Systems

In a glycol system, the heat transfer fluid (usually 50% glycol, 50% water) circulates through a closed-loop via a circulating pump from the solar storage tank to the collectors and back



through a heat exchanger commonly inside of the solar storage tank. The closed-loop of the glycol system is typically kept under low pressure (between 15 – 30 PSI) and can protect the system pipes and components from bursting down to approximately -50 degrees Celsius. Food-grade propylene glycol is typically used in the event that the heat transfer fluid comes into contact with the potable water especially in the event that the glycol degrades, becomes acidic, and creates a hole in a heat exchanger located within the solar storage tank. According to the CSA standards on solar water heating, food grade propylene glycol is required for solar storage tanks with single walled internal heat exchangers[5].

One of the drawbacks of a Glycol system is that glycol should be tested and changed every 2–5 years in order to ensure that it has maintained it's pH level and freeze protection characteristics. Experienced installers of SDHW systems have the appropriate testing equipment to diagnose the condition of glycol. A typical service call for purging the solar loop and replacing the glycol can cost between $100 to $200[6].

2.7.4 Drainback Systems

Similar to a glycol system, the drainback system also operates under a closed-loop from the solar storage tank to the collectors. However, the main difference from a glycol system is that the heat transfer medium is usually water and that the closed-loop is not kept under pressure. The drainback system requires a reservoir above the pump and the solar storage tank. The reservoir (drainback tank) allows air to travel upwards in the solar loop and water to drainback into the heated area of the house when the pump is not circulating. It is this function that prevents the system from freezing during the colder months.

When installing a drainback system, it is important that all piping (including the solar collectors) be sloped downwards in order to allow the water to drain into the drainback tank. In addition, all piping should be at least ¾" to prevent airlocks from occurring and stopping the water from draining.

The drainback system's main advantage is that it prevents overheating in the collector because all of heat transfer fluid (water) drains back when the solar tank reaches its set maximum temperature. Water also has better heat transfer characteristics than glycol, and as a result, all things kept equal, drainback systems should perform better than glycol systems[7]. In addition, drainback systems require

5 Canadian Standards Association. CAN/CSA-F379.1-88 *Solar Domestic Hot Water Systems (Liquid to Liquid Heat Transfer)*. Section 7.4.3. Pages 28 – 30.

6 This value is estimated based on a limited Ontario industry survey December 2007.

7 CanSIA. STT 200: Solar Domestic Hot Water Installation – Design, Installation & Maintenance. Pages 20-23.

less maintenance than glycol systems, since there is often no need to change the heat transfer fluid over time.

Comparison of Glycol vs. Drainback Systems

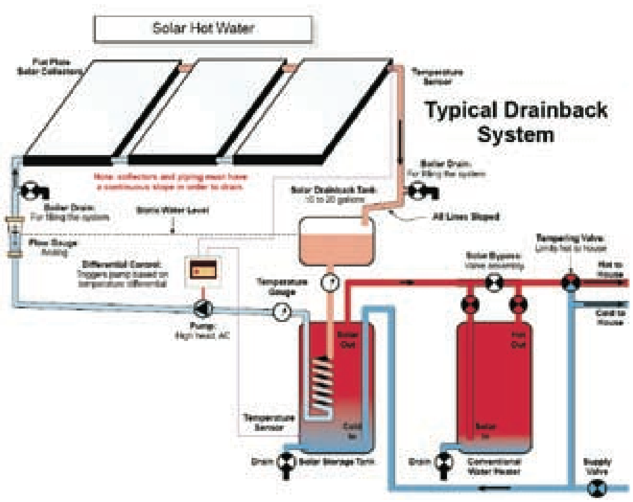
Type of System	Drainback System	Glycol System
Performance	Water transfers heat better than glycol.	Glycol doesn't transfer heat as well as water, degrades with time, and can become acidic over time if it overheats.
Safety	If the solar tank reaches it's set maximum temperature the pump ceases to circulate and the water drains back into the reservoir. Therefore overheating is not a concern. The same is true in the event of a blackout or controller/pump failure.	The solar loop can overheat in the event of a electricity blackout (not in the case of a solar pump), controller failure, or the solar storage tank reaching its maximum set temperature. Typically a pressure relief valve will expel the glycol onto the roof and therefore need to be recharged. In some cases, solar collectors have the ability to expel excess heat.
Cost	Drainback systems are typically more expensive due to the need for a drainback tank, the need for stronger pumps, and the cost of specialized mounting hardware in some cases.	Glycol systems are typically less expensive, but require changing the glycol periodically.
Maintenance	Virtually none	Glycol needs to be replaced every 2–5 years.

2.7.5 Integrated Thermosyphon Systems

Although not commonly used in cold weather climates, some installers have chosen thermosyphon systems due to their relatively low cost design. A thermosyphon system works without the use of a pump and integrates the collector with the solar storage tank on the roof. The cold water first circulates to the storage tank on the roof and then back inside the building to the conventional water heater. Since the storage tank is housed on the roof, it is undetermined at this point whether these types of systems are suitable for the cold Canadian climate.

2.8 Solar Storage Tanks

Whether it's a large scale or domestic solar hot water system, solar storage tanks are required in order to store the solar thermal energy until it is required. The solar storage tank heats up during daylight hours and holds the thermal heat until it is ready to be used. Well insulated solar storage tanks should only lose a couple of degrees over night. Most solar storage tanks contain internal heat exchangers in order to exchange the heat from the closed-loop solar side to the potable water in the tank. However, some designers and



Drainback System Design[8]

[8] Lane, T & K. Olson. Solar Hot Water for Cold Climates. Part II – Drainback Systems. Home Power #86. December 2001/January 2002. Pages 62 – 70.

manufacturers use a conventional water tank with external heat exchangers to reduce the cost of the system.

Solar storage tanks can come in all sizes, from 100L to several thousand litres and with varying materials and designs. The size of a solar storage tank will affect the number of solar collectors and their performance. A tank should be sized according to the desired temperature during the peak summer months.

2.9 Solar Controllers

A properly functioning SDHW system usually requires a temperature differential controller. The controller acts to regulate the flow of the heat transfer fluid through the solar collectors. Typically it reads the temperature in the collector and the solar storage tank and triggers the pump to circulate when the collectors are warmer than the storage tank.

Temperature Differential Controller
Aaron Goldwater

There are a variety of controllers available. Most have a digital display that allows the user to view the temperatures and diagnose when problems may occur. A properly functioning controller is key to the performance of the system and allows the user to define certain parameters of the system including the solar storage tank's maximum temperature, the temperature differences for activating the pump, and in some cases safety features.

2.10 Circulating Pumps

A variety of circulating pumps are available that can be easily integrated with a solar water heating system. Depending on the application and project, low-wattage or DC solar powered pumps can be used on some systems with low roofs. Drainback systems usually require higher head AC circulating pumps because they need to overcome the static head in the solar loop.

Centrifugal circulating pumps are most commonly used in solar hot water systems and hydronic heating systems. These are appropriate because of their efficiency, reliability, low maintenance, and low energy consumption. They also permit backflow of fluid when not operating. This is a critical aspect of their function in a drainback system[9].

2.11 Combination Systems

Solar water heating systems can be designed for a combination of purposes. Some companies provide options to combine solar water heating systems for domestic hot water, swimming pools, and space heating. These systems require a larger number of solar collectors due to the higher demand for hot water.

[9] Lane, T & K. Olson. *Solar Hot Water for Cold Climates.* Part II – Drainback Systems. Home Power #86. December 2001/January 2002. Pages 62 – 70.

The system provides hot water during the swimming season for the pool and domestic hot water and in winter months for domestic hot water and space heating. Combo systems should be carefully designed and sized to provide the appropriate amount of heat at different times of the year.

The summer is the best period for solar heat production. As a result, a system that is designed strictly for solar domestic hot water and solar space heating should have a method for dumping excess heat in the summer. Often combining this kind of system with pool or spa heating is the most economical way of putting the summer heating to use. It is usually best to size the SWH system to heat the DHW and pool heating in the summer and use the excess heat in the winter for space heating.

2.11.1 Solar Space Heating

Space heating accounts for over 60% of household energy[10]. A carefully planned solar thermal system can provide enough energy to provide a portion of the space heating requirements for a building. Hydronic systems are typically the easiest to integrate with solar thermal. Radiant infloor heating and hydronic furnaces or air handlers are effective ways to use the captured solar thermal energy during colder months. These systems tend to operate at lower temperatures and can take advantage of the lower grade of heat that solar thermal systems generate during the winter months. Boiler/radiator systems tend to operate at much higher temperatures (in the range of 165 – 185 degrees Fahrenheit) and therefore it can be cost-prohibitive to use solar thermal for preheating in this kind of system.

Picture of Solar Water Heater with a Tankless water heater and Air Handler

Aaron Goldwater and Frank Mongillo

Air handlers or hydronic furnaces can be installed in place of a conventional furnace, and using existing ducting can distribute solar thermal energy in the same way as a conventional furnace.

Geothermal or ground source heating systems can also be combined with solar thermal systems to provide space heating and domestic hot water. More detailed information on Solar Thermal's use in space heating can be found in Appendix E.

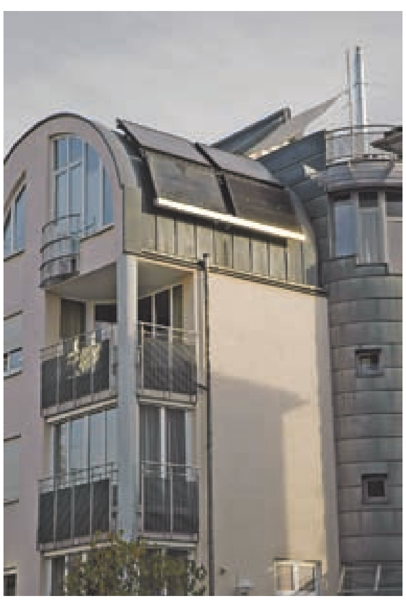
[10] Ontario Power Authority, Conservation Bureau Website. Energy Usage in Ontario Households. Accessed on November 12, 2007, from: www.conservationbureau.on.ca/Page.asp?PageID=122&ContentID=1535&SiteNodeID=168

3. Site Resource Assessment

3.1 Site Feasibility Considerations

There are several important considerations when determining the proper location for a Solar Thermal system. An accredited Solar Thermal installer should make the final determination of site feasibility, as they will have the tools and knowledge necessary to make an informed and comprehensive decision. The considerations listed below are the main criteria for their site inspection.

- **Direction to the Sun:** In Canada, solar collectors must be mounted facing South with a certain degree of accuracy. A south-facing rooftop is optimal.
- **Load Factor:** The structure(s) upon which the collectors will be mounted must be able to support a full system. Factors taken into account include the age and type of construction of the building.
- **Age of the Roof:** An appropriate site should not need roof replacement or major maintenance within 25 years. Long term warranties on a roof are difficult to protect from being voided unless the roofers perform the flashing around the mounts themselves. If a warranty is desired, this is an important consideration.
- **Angle:** The angle of the array mounting will vary depending upon the season and the latitude of the site. Your installer will consult an atlas or map to determine your latitude.
    - **Adjustable Mounts:** Collectors should be mounted at an angle approximately equal to the site's latitude in the spring and fall, 15° more in the winter and 15° less in the summer.
    - **Fixed Mounts:** Collectors should be mounted at an angle slightly higher than the site's latitude up to a maximum of approximately 50°, to keep snow from collecting in winter. This will differ slightly based on the type of collector.
- **Potential Solar Radiation Blocking:** Mounting arrays where there are shadows cast on the site at certain times of the day can severely cut efficiency. Two important factors to consider:
    - **Future obstructions:** Solar projects are designed to last 25 years or more. Small trees in your neighbour's yard can grow to block sunlight over time; and new buildings or additions can cast shadows in the future.
    - **Time of year:** Although there may be no obstructions in the summer, the sun follows a lower path during winter months and neighbouring trees or roofs can cause unforeseen blocks. A qualified installer will have the knowledge and tools necessary to calculate possible obstructions while the sun follows a lower arc.



Shadows cast on potential sites can drastically reduce overall system efficiency.

Paul Gipe

- **Radiation Supply:** Radiation potential data obtained by using solar resource maps (Section 2.3) can be used to assess the yearly supply of radiation.
- **Plumbing and Electrical Requirements:** Existing on-site plumbing and hot water systems and electrical systems must be assessed for suitability to Solar Thermal system installation.

3.2 Home Conservation and Efficiency

Solar Thermal is an excellent way to reduce reliance on the energy grid and thus reduce associated environmental and economic costs. There are, however, a number of actions the reader can take, prior to installing a Solar Thermal project, which would significantly increase the potential benefits from a Solar Thermal system. Home energy efficiency will drastically improve the ability to use the heat energy efficiently and to realize the highest economic benefit.

Natural Resource Canada's Energuide Program (Appendix A1) recommends three types of actions and associated investments, described in Appendix E4.

3.3 Regulatory Considerations

As for any construction project, zoning and permitting must be considered when assessing a Solar Thermal installation. Homeowners and businesses considering Solar Thermal should consult local zoning by-laws (which control land use in the community) and municipal building codes (which are regulations regarding construction of, additions to, or renovation of a building). Refer to your provincial Ministry of Municipal Housing and Affairs for more details and updates. In the case of DHW and CHW, there are additional plumbing concerns, as installations must meet Provincial plumbing code. CanSIA recognized installers will be able to identify and address these issues. As the use of Solar Thermal technology grows, regulations may eventually be put in place.

A homeowner has chosen a dual system of PV panels and Glazed Flat-Plate collectors
Wagner & Co, Cölbe / ESTIF

4. Ownership: Options for Organizational Structure

A number of criteria should be assessed when considering the type of organizational structure that would work best for specific situations and Solar Thermal needs. Ownership options, organizational structures and suggested applications listed in this chapter are by no means exhaustive, however some of the following considerations should be kept in mind when considering the different options for organizational structure. These include:

- Capital Investment Needs: Each option presents different requirements for initial (capital) investment
- Risk: Financial and legal risks are specific to each organizational structure.
- Long-Term Financial Implications: Future revenue or cost savings from Solar Thermal installations will last for decades, involving long-term implications such as property ownership or lease agreements, and who will benefit from energy savings in future years.
- Maintenance: Future maintenance costs and contractual implications vary with different organizational structures.

4.1 Exclusive Ownership (Individual or Institutional)

Exclusive ownership is considered an initiative by an individual or institution to adopt the use of Solar Thermal technology on a small or individual scale. Likely, the person or organization chooses to install a solar collector or group of collectors on their residence or place of business.

4.1.1 Best-Suited Applications

Individual ownership structure is best suited for circumstances where that individual would benefit more from adopting Solar Thermal technology instead of other energy options. A good example is a cottager on an island purchasing solar water heating collectors to install hot water on the island rather then paying for underwater utility cables to be extended from the shore. In this case, the system should be limited to a drain-back water-based system as opposed to glycol. Another example is a new office building employing solar thermal collectors on their roof for ventilation air heating, which given a 20+ year cost analysis is more economical then the long-term cost of electric or natural gas heating.

4.1.2 Advantages and Disadvantages

Advantages	Disadvantages
Exclusively Internal Benefits: Since the investment is in assets that will remain internal (ie. not shared), all possible benefits of cost savings remain with the individual owner.	**Risk:** Exclusive ownership places full financial and legal responsibility on the individual. Individuals are held accountable for any loans used to purchase the technology, and potential financial losses arising from the project will not be shared. This risk can be mitigated by sufficient research into the most appropriate solar thermal technology for a project, and by realistic financial and viability studies.
Social Positioning Benefits: Reflective of growing public concern over climate change and international efforts to reduce energy use, an individual or business may benefit from the environmental implications and subsequent social positioning of their investment. For an individual, this may be an affirmation of personal conviction; for a business, it may create 'green market value' or environmental brand power.	**Lack of Expertise:** Individual project owners must either have knowledge of all issues relating to the project and undertake all aspects of the project, or outsource parts of the project at potentially significant cost (see Section 5.2: Financial Analysis for details of potential costs).
Increased Cost Certainty / Decreased Risk: Reducing reliance on non-renewable fuels reduces future, unknown market price fluctuations of these fuels.	**Cost Prohibitive:** Solar Thermal technology is a long-term, capital intensive project with large upfront costs and gradual returns, which may be a barrier to a single person or business. Other options, outlined below, include joint development, bulk purchase or forming a co-operative.
	Economy of Scale: Since the installation is individual, the cost (per unit of energy) of the system components, design, and installation will be much greater than a large-scale community power project.

4.1.3 Case Example: Exclusive Ownership of a Solar Thermal System: Mike Brigham

Background:

Toronto resident Mike Brigham embarked on the building of a custom-built home in 2002. The home was to be built to R2000 standards, but Mike wished to enhance the energy conservation aspects of the house in many ways, including a grey water heat recovery system, and a Solar Thermal system working to reduce the energy demand for heating his domestic hot water (DHW).

Mike felt confident in choosing the components himself, and focused on three objectives: efficiency, dependability and ongoing low maintenance. Since the house was being designed and constructed from scratch, there were essentially no design or installation limitations.

Selection Process

The first objective of efficiency was directly related to type of collectors to be used. Those considered were the rooftop (external) storage tank, evacuated tube collectors, and traditional glazed flat-plate panels. Traditional glazed flat plate collectors were chosen due to their reasonable price, availability, and since they were intended to be used in northern climates.

The objectives dependability and ongoing low maintenance often go hand in hand. Problems may arise in some closed loop thermal systems, in the situation where the water in the DHW tank has been heated to its limit so that the Solar Thermal system shuts down, yet the collectors continue to collect the sun's heat in the sunny parts of the day. The result is that the panels overheat the fluid, possibly even boiling it and creating a large pressure build-up in the closed loop portion of the system.

There are a number of ways to deal with this issue. The standard methodology in Europe, and the solution accepted most by industry professions, is to size the solar system for summertime peak load, utilizing properly sized glycol collection reservoirs able to hold the complete volume of the liquid. To further address these concerns, refilling or re-pressurizing pumps, and control switches are used to keep pressure at a manageable level.

After some research, Mike decided to select a system that tackled this issue by way of heat-activated air vents on the collectors that are usually closed, but open when the panels get close to the point of overheating, allowing air to pass through the panel, thereby cooling it to a safe level. Mike determined that being a simpler system with no pressure-release valves or switches, it would logically result in increased system dependability and reduced maintenance. The following 25 years will show whether this choice will result in a higher or lower maintenance cost, and whether the industry sees more than one manufacturer adopt this type of cooling technology.

Challenges

Obtaining, and running the 3/8" copper tubing from the panel location on the roof to the basement mechanical room was easy, as was obtaining a well insulated electric hot water tank. A scissor lift was used to boost workers and panels to the roof just below where the panels were bolted in place then connected to the copper tubing and electric sensor wires which are required by the system to send panel temperature readings back to the pump controller.

Mike selected an enclosed assembly that was fitted near the hot water tank. This assembly contained the pump, pump controller, heat exchanger, pressure tank and reservoir, connected together already in a single package by the manufacturer.

In all, the professional installers did not run into any major issues. A piece of equipment that might hold back a do-it-yourselfer form performing such an installation, is the pump necessary to fill the closed loop part of the system with fluid and burp it to eliminate any remaining air.

Results and Performance

The system has operated completely trouble-free and maintenance free after some 3 years of use, performance has been completely satisfactory, and even winter days generate hot water when the sun is reasonably strong, even on the coldest of days. After the fifth year, the glycol solution may need replacing if it is becoming slightly acidic and corrosive. In the warmest 5 months of the year, the home's natural gas consumption for hot water heating averaged under $6.00 per month for two people, with two showers per day, dishwashing and laundry for two adults.

Case Information courtesy of Mike Brigham, Toronto.

4.2 Joint Development or Joint Venture

A Joint Venture (JV), or partnership, involves the cooperation of two or more separate groups or individuals on a single Solar Thermal project. All parties contribute funding to the project, co-own the project and share in project-related revenues and expenses in proportion to the party's funding of the project.

4.2.1 Best-Suited Applications

Forming a JV between community-based parties (for example, community groups or co-operatives) and private firms or companies interested in renewable energy has many advantages. These include the combination of market knowledge and expertise with the distribution of the capital load of the project. There are many possible JV configurations.

Thermal collectors line a complex of attached homes for domestic hot water heating

Paul Gipe

4.2.2 Potential Partner Organizations

JV's and/or partnerships can be arranged between the following groups:

- Interested Individuals
- Sole Proprietorships
- Privately-owned Businesses and Limited Liability Corporations
- Existing Partnered or JV Organizations
- Non-Governmental Organizations
- Not-For-Profit Organizations
- For-Profit Community Organizations
- Municipalities
- Cities
- Government-Owned Businesses Including
  - Utilities
  - School Boards
  - Community Centres
- Co-operatives
- Publicly-owned Businesses

JV Example 1: JV between Two Businesses

Two businesses sharing an office building combine capital investment to install a solar ventilation air heating project in their building. Each business shares the economic benefits in proportion to the space they inhabit in the building and their portion of capital investment, eliminating the need to meter or invoice for the amount of energy produced, since they share the solar-heated air circulating in the building.

JV Example 2: JV between a Co-operative and a Municipal Business

One appropriate neighbourhood-based joint venture may involve a member-owned Solar Thermal co-operative and a community center operated by the local municipality. Capital investment pooled by the co-operative members can fund a large-scale Solar Thermal CWH or ISP system for the community centre, and subsequently the community centre would pay the co-operative an amount equal to the cost savings achieved as a result of the Solar Thermal technology. Revenues received by the co-op would be paid to members in the form of dividends.

4.2.3 Advantages and Disadvantages

Advantages	Disadvantages
Lower Initial Investment: JV's spread initial capital costs of a Solar Thermal system purchase between multiple partners, providing all parties with desired Solar Thermal results at a portion of the cost.	**Conflicting views:** Solar Thermal projects are long-term projects, and it is crucial to ensure that all potential JV partners share similar values, have similar long-term goals, and agree on the specifics of the project prior to forming the JV. A long-term JV contract that articulates goals and views of the JV members can mitigate this risk and avoid future disagreement on project-related issues.
Lower Risk: JV's diversify associated risk by sharing financial and legal responsibility among partners, particularly in cases where the Solar Thermal system underperforms for a limited amount of time.	
Expertise Sharing: JV's can combine important skills and attributes of all partners, allowing each different type of partner organization to contribute their particular strengths (for example, communications, funding etc.)	**Liability:** Each JV partner organization remains partially legally liable for actions of the JV.
Limited Gain from Economies of Scale: JV's may be able to take advantage of economies of scale if the partnership increases membership and the size of the project grows. Please refer to the "Bulk Purchase" section below for more information regarding economies of scale.	

A bulk purchase of identical systems in one neighbourhood drastically reduces installations costs for each homeowner

Zensolar / ESTIF

4.3 Organized Bulk-Purchase

A bulk-purchase involves a group of local participants or volunteers interested in individual solar systems, combining their purchasing power by pursuing quantity discounts to achieve the best price per unit from a single supplier/installer. This is achieved by pooling the interest of multiple residents of a neighborhood in purchasing similar systems.

4.3.1 Best-Suited Applications;

To date, bulk-purchase has usually involved a small group of volunteers from a specific community that gathers a list of interested homeowners who would like to purchase Solar Thermal collectors for their homes. The group issues a Request For Proposal or Request for Quote (RFP and RFQ; further described in Section 6.4, Appendix D) to various Solar Thermal manufacturers and installation companies to find the most competitive price per unit. Once the price is determined, each homeowner enters into a contract individually with the respective manufacturer and installer.

4.3.2 Advantages and Disadvantages

Advantages	Disadvantages
Economies of Scale: The major advantage of choosing to purchase a Solar Thermal system through an organized bulk purchase organization is to take advantage of Economies of Scale. Also termed *Quantity Discounting* or *Bulk Purchase Discounting*, purchasers achieve a lower cost per unit as quantities increase. In Bulk Purchasing organizations, individuals who purchase collectors as part of a large group have historically paid approximately 4%-14% less per system than an individual would for his or her own project.	**Volunteer Inexperience:** In new Bulk Purchase organizations, there is likely little industry expertise on the action committee. Organizers are volunteers who have an interest in the technology, but often no working experience.
Cost Efficiency: Bulk Purchasers lower the cost of operation; the process of bulk purchasing is meant to achieve the lowest price possible, and the organizers are usually volunteers, keeping costs down.	**Low Transfer of Expertise:** Given the voluntary nature of the action committee, there may be high participant turnover, resulting in loss of their experience and knowledge. The ongoing creation of organizational and operational manuals by the action committee may mitigate this loss and ensure the transfer of knowledge.
"Hands Off": Bulk purchasing removes much of the responsibility of neighbourhood individuals to research, find and negotiate appropriate and best-cost systems. Action committee participants are exempt from this benefit.	**Price/Participation Fluctuation:** With no initial obligation to commit by homeowners, some may withdraw from the purchase at various points in the project, affecting the cost of participation for others.
Security: Responses to RFP's will likely highlight inexperienced or inappropriate manufacturers and installers, making these installers easier and less time consuming to eliminate from the selection process.	

4.3.3 Forming a Bulk Purchase Group

There is little published information currently available for communities wishing to implement organized bulk Solar Thermal purchases, however a number of groups are currently conducting cost-benefit analyses for Solar Thermal technology, developing a standard RFP and lists of more prominent and reliable installers, as well as developing standard materials and processes for groups across the country.

Information for start-ups of new Bulk-Purchase organizations can be acquired by way of accessing the resources of some of the organizations listed in Appendix A4. The organizations listed are non-profit organizations that have information on Solar Thermal technology.

The general process of initiating a neighbourhood-based Bulk-Purchase is as follows:

1. A group of interested residents form a neighbourhood solar energy action committee.

2. Members of the action committee research required materials and expertise for the project, financial modeling and RFP or RFQ parameters.
3. The action committee reaches out to the community to assess and bolster support for a neighbourhood bulk-buy, and to begin developing a database of interested homeowners and / or small business owners.
4. Based on the amount of community interest, the action committee develops and finalizes an RFP/RFQ, including a no-risk/no-obligation site assessment, and submits the RFP/RFQ to selected manufacturers and installers.
5. The action committee reviews project tenders to select the best proposal based on pre-determined criteria and parameters.
6. The action committee organizes and holds a major community meeting inviting all individuals in the database to date, as well as marketing the meeting using the media, local politicians, and other methods of advertising.
7. At the final public meeting, the selected vendor (or vendors in the case of a Solar PV / Solar Thermal RFP/RFQ) should be asked to participate and respond to questions about their system. Interested individuals will be requested to leave their contact information, to be visited by the vendors for a free no-obligation home assessment.
8. At this point the action committee's duties are complete. Each individual homeowner then has the choice to accept or reject the proposal(s) at the time of site inspection, and enter into a contract directly with the installer.
9. A final count of total systems installed will result in a quantity discount applicable to all system purchasers, as outlined in the successful vendor's bid.

The RFP/RFQ process is further explored in Section 6.4, and a sample RFQ can be found in Appendix D, and Toronto's WISE or DWSEP's RFPs can be requested from their organizing committees through OurPower.

Not listed in the disadvantages above, is a potential disadvantage for the country's local solar energy sector, arising from adoption of the bulk purchase model. The Canadian residential solar Thermal industry is still relatively small, currently comprised of a number of smaller installer companies. A Bulk-Purchase in a neighbourhood or community will essentially allocate all of the potential early adopters of solar Thermal systems to a single installer, resulting in that installer reaching and potentially far surpassing their capacity to install systems, leaving no business for other installation companies. This can potentially result in erratic or unsustainable industry growth, in that at any point in time, installation companies may have either too much business to handle, or none at all.

That being said, the Bulk-Purchase model does have a variety advantages for the industry, in that much of the education and marketing of Solar Thermal systems will be done on a volunteer basis by the community. This will almost certainly result in faster, but potentially more erratic, demand growth. There are also ways to address this concern; using an RFQ as opposed to an RFP (Section 6.4) and selecting two or more preferred vendors as opposed to one, is one way of addressing this concern.

4.3.4 Case Example: Bulk Purchase Organization: OurPower, RISE

RISE (the Riverdale Initiative for Solar Energy) began as a voluntary, community-based project that brought together a large number of Homeowners in the East-end neighborhoods of Toronto interested in clean-energy grid-tied solar electricity systems for their own homes. As an informal, volunteer-based neighbourhood buying organization, RISE participants came together as a group to negotiate a best price from a local solar energy supplier. By working as a group, the home owners benefited from quantity discounting, and secured installation contracts with trustworthy companies.

From the success of RISE, the organization OurPower developed, as a free resource center for other bulk-purchase organizations across the country. OurPower is also a volunteer-based research group that is currently developing a model that they hope will be able to be copied across the Country. Involving volunteer financial professionals, policy advisors and other solar industry experts they hope to create an online resource centre for aspiring bulk-purchase organizers across Canada.

OurPower enhances the capacity of individuals or communities to conserve by increasing awareness through the installation of multiple small-scale renewable energy systems. As these systems increasingly become part of the Ontario energy supply mix, stakeholders with sustainable energy systems become much more aware of where their energy is coming from, how it is being produced and the limits of that energy production.

OurPower will support small-scale ("behind the meter") renewable energy by actively promoting the adoption of small-scale sustainable energy in selected Ontario communities. OurPower will actively identify and target communities who have expressed interest in, or who would be receptive to, creating their own community-based renewable energy initiatives. Working with community leaders and volunteers as well as local municipal and utility company representatives, OurPower could supply the resources and information needed to bring together neighborhoods, the Ontario renewable energy industry and local Ontario power utilities as partners in stimulating the sustainable energy marketplace.

Case Information courtesy of RISE, OurPower ***www.ourpower.ca***

4.4 Co-operative Ownership

4.4.1 Applications of Co-operatives

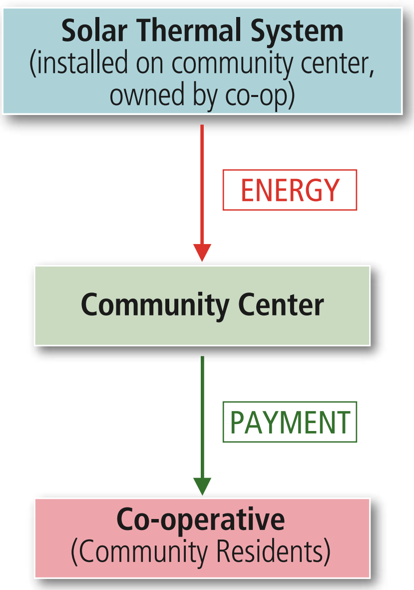
Co-operatives are either a for-profit or non-profit business owned by an association of members who wish to cooperate to satisfy common goals. The co-operative model denotes incorporating all of the investment and individual interests into a single remotely-sited, collectively-owned, large-scale project, requiring only one installation, site assessment, and set of system components. Combining capital resources allows the aggregate cost (per person) of a project to be greatly reduced, in order to achieve greater economic benefit and a shorter payback.

Co-operatively owned Solar Thermal systems are very different from those purchased through a Bulk Purchase Organization. Applications of a co-operatively-owned, large-scale Solar Thermal project are numerous. Three community applications of the co-operative model are as follows:

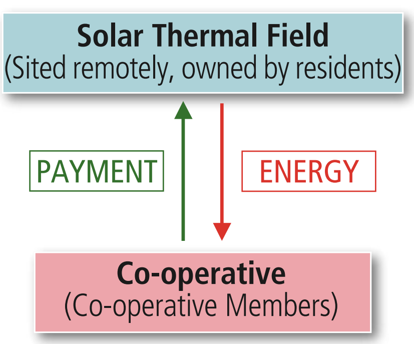
A centralized hot water heating facility for a community in Sweden; hot water is piped to each residence, metered, and used to heat the homes

ARCON / ESTIF

Application 1

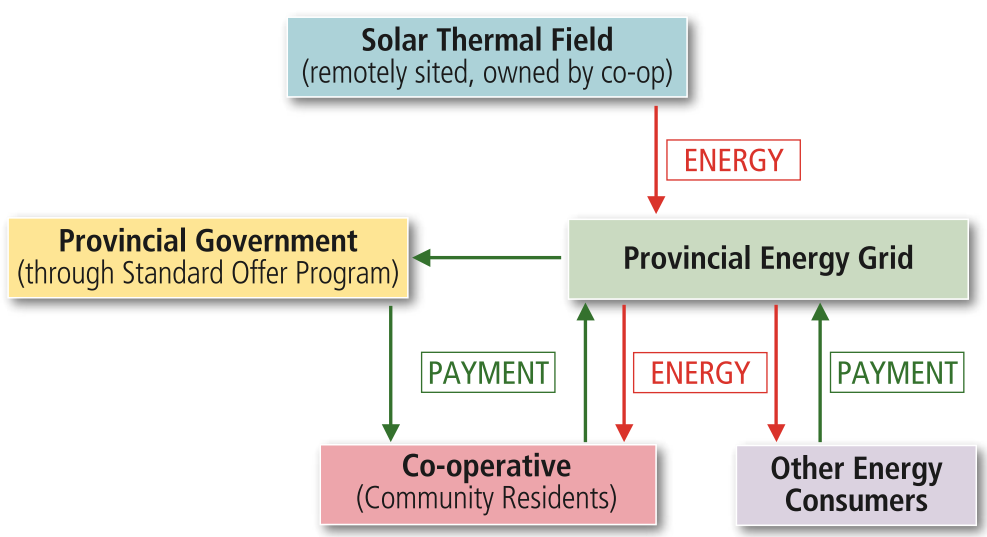


Application 2



1. Residents who use a local fitness and community centre would like to form a co-operative to see a large solar hot water system installed on the roof of the centre. The system would be funded through investment in the project, and would heat the water used for showering, laundry, and the indoor swimming pool. Once installed, the heat energy that is generated could be metered, and a predetermined price could be paid by the centre to the co-operative members on a monthly basis.
2. Residents who purchase homes in a new Solar Thermal residential subdivision of townhouses must become members of a co-operative upon purchasing the home. A remotely located field of collectors near the neighbourhood will collect solar energy and heat water. This heated water can then be pumped to, and used by, the individual homes for VAH (radiator heating) or DHW. Hot water entering the home will be metered, and each homeowner will pay for the energy they use; any profits made over and above the maintenance and on-going operation of the system by the co-operative will be returned to the homeowners. The image on the previous page shows this type of district heating system in a Swedish community.
3. The Toronto Renewable Energy Cooperative (TREC) has initiated SolarShare that intends to be structured around a larger, PV installation within a community whereby members of the community purchase shares, the PV system is connected to the grid and the green power is sold to the Province at 42cents/kWh under the Standard Offer Program (SOP), a policy for renewable energy generation projects 10 MW or under. Members receive dividends proportionate to the number of shares/kWh produced. At present, in jurisdictions like Ontario, Solar Co-operatives utilizing PV are easily initiated under this type of scenario because of the SOP (See Section 7.1). If Solar Thermal were to be incorporated into the SOP or a similar

Application 3



type of programming, a similar model to *SolarShare* would be available for Solar Thermal Co-ops. The only difference to the above scenario is that the Province, as opposed to the building/site owner, would pay for the energy savings (MegaWatts). And of course, a PV/Thermal Co-op is also possible.

Canadian Co-operatives operate under the *Canada Cooperatives* Act (1998, c.1). They are fundamentally different than other incorporated businesses. As opposed to making decisions by way of a proportional vote among shareholders, co-operatives operate democratically so each member has an equal vote in decisions made by the co-operative. Typically major decisions are made, and board members are chosen, at the annual general meeting where members cast one vote for each issue. Although members each share an equal vote, co-operative profits are dispersed based on the size of individual investment, thereby a member with twice the investment in the co-operative is entitled to twice the profit. For a detailed guide with more information on Canadian cooperatives, consult the Federal Government's *Canada Business Cooperative Info-Guide*, or visit the Canadian Co-operative Association (Appendix A4).

There are some inter-provincial differences in co-operative regulations. In Ontario and Quebec, co-operatives must conduct at least 50% of their business activity with their members, a condition with strong implications for energy co-operatives that needs consideration for large remotely-situated Solar Thermal energy co-operatives in those provinces. This will be further described in the following section.

The Canadian Co-operative Association (Appendix A4) has a contact list for all provincial associations. Consult your Provincial Co-operative Association for Province-specific considerations.

4.4.2 Forming a Renewable Energy Co-operative

The primary consideration for the development of any co-operative is finding an appropriate array of founding members who share similar visions and goals. Research regarding the start-up of a co-operative is essential, and the *Canada Business Cooperative Info-Guide* (Appendix A4) is a good place to begin as it outlines a clear process for the creation of co-operatives, and provides a number of related, helpful resources. Other co-operatives similar to a potential Solar Thermal co-operative may be able to provide insight, and can be researched in the lists of your Provincial co-operative association's members. Once a collection of founding members has been established, scheduling routine meetings where founding members are assigned tasks can accelerate the start-up. During this 'fact-finding' portion of the process, participants will investigate whether a Solar Thermal co-operative is economically feasible and socially viable in the local community. Before incorporating as a co-operative, contact your provincial co-operative association for any additional information you may need.

Once incorporated, the co-operative must solidify the exact type of project to be developed and establish all of the specifics relating to the Solar Thermal installation. Once this is known, the co-operative must develop a business plan, an offering document and a membership agreement, which will allow them to begin searching for members to invest in the project. For this, an Offering Statement is required. Provincial financial service providers will have information regarding these processes; in Ontario, the Financial Services Commission of Ontario (FSCO) has an online resource for co-operatives (Appendix A4).

Although registering an Offering Statement for a renewable energy co-op in Ontario or Quebec costs significantly less than a regular Initial Public Offering, there has previously been trouble establishing a link between the energy that is produced by the project, and the respective members (energy link theory). In these Provinces, 50% of the co-operative's business must be conducted with members. The energy created is very difficult to associate with individual members because the energy generated by a remote PV panel or saved by a Solar Thermal installation goes into the grid and gets 'mixed', members of the Co-op do not receive the electrons directly into their homes or businesses. Provisions must be made in the Offering Statement to link the energy usage with individual members. This would be relatively easily achieved with the district heating model show above (application 2, where members use the heat generated), as compared to the community centre in the previous example (where members would receive the profits from the sale of energy generated). The previously referred to Solar Energy Co-operative in Ontario, SolarShare, is currently attempting to establish this link to facilitate the creation of energy co-ops in these Provinces. Please see appendix G for the proposed methodology for addressing the business-with-members rule, developed by OSEA and the Ontario Co-op Association, for Offering Documents submitted to FSCO.

4.4.3 Advantages and Disadvantages

Advantages	Disadvantages
Lower Installed Cost: By forming a single large installation, a number of costs can be avoided and significantly reduced, decreasing the average cost per unit of energy of the project. In addition to this, co-operatives can take advantage of significantly reduced costs of approval of a share offering by the Provincial Financial Services Commission.	**Diversity of Investment:** Members with a larger financial stake financially in the co-operative may come into conflict with other members with less of a financial stake in the organization. Setting a minimum and maximum investment is one way of limiting lop-sidedness of members' financial dependence on the co-op.
Democratic: The organization is owned and controlled by its members. All decisions are made internally and democratically.	**Timeliness:** There may be long time periods required for decision-making, as most decisions must be made by the co-operative's Board of Directors, and some major decisions have to occur at the annual general meeting.

Advantages	Disadvantages
Community-Building: Co-operatives tend to foster a strong sense of community, and present the opportunity for members to associate in pursuit of shared goals.	**Low Growth:** As profits are paid out regularly to members, there may be little incentive for the co-operative to grow through reinvesting profits into new projects.
Limited Liability: Contrary to previously listed organizational structures, a co-operative has limited liability; members are not individually legally responsible for debts, contracts and other obligations or losses the co-op may endure in the future.	
Access to Profit: Co-operatives are organized so that profits are distributed to members on a regular basis, usually quarterly or annually in the form of cash or shares in the co-operative.	
RRSP Eligibility: Co-operative shares or bonds may be RRSP-eligible, likely within a self-directed RRSP account.	

5. Financing & Financial Analysis

When considering the financial aspects of installing a Solar Thermal system, there are two primary considerations that need to be addressed. Due to the capitally intensive nature of Solar projects, the primary consideration for anyone considering a new system is the manner of financing the project. The second consideration is the financial analysis of the project itself, to ensure that a reasonable payback can be expected over the project's lifetime.

5.1 Financial Assessment

There are a number of ways to evaluate which structure would create the greatest economic benefit for your specific situation.

Important considerations include:

- Overall Value of the Project
- Capital Cost Obligation
- Monthly or Annual Cash Flows

Overall Value

The financing structure that optimizes the overall value (Net Present Value, or NPV) of the project consists of maximizing the contributions of grants or subsidies, thus reducing the remaining balance to be financed through private or shared equity. The process of maximizing NPV must also avoid debt which carries the obligation to pay interest and erodes the long-term cost-savings or revenue of the installation.

Capital Cost

Reducing the capital cost obligation, or the initial payment required, of the project requires taking on debt. The nature of debt is that it charges the borrower interest for the ability to spread out the financial demands of the project over time, and decreases the capital cost obligation. Most project planners assume a certain amount of debt and account the interest as a reasonable expense for the increased ability to spread out project costs. Increasing the amount of debt directly increases the amount of interest paid over the course of the project, decreasing the NPV.

Cash Flows

A monthly or annual cash flow is the combined value of the loan repayment amount and the cost savings generated by the system during the specified time period. The term of the debt selected will affect both the NPV and the variability of monthly or annual cash flows. Maintenance and operational costs will also affect the monthly cash flow.

5.1.1 Net Present Value

Net Present Value (NPV) is an important concept when considering any project, especially projects with large capital costs and long project lifetimes such as any Solar Thermal project. The NPV calculation can be used to determine whether long-term projects are in fact profitable.

Future cash flows do not have the same value as currency today. NPV is equal to a future sum of money, after accounting for inflation, and after forecasting future interest rates that today's investment would have been expected to earn if it had been invested. The application of NPV in Solar Thermal project valuation is useful, since it may be difficult to recognize a profitable project when it is tied to significant initial cost. Though Solar Thermal technology is inherently very capital-intensive, it generates savings that are realized over a long period of time. A positive NPV indicates that regardless of large capital cost, the project is in fact profitable overall; the larger the NPV, the higher the value of the project. For those same reasons, the cost savings in energy that will be saved in future decades from the Solar Thermal installation are different than the value of those savings today. NPV will illustrate all the future energy savings to today's dollars.

5.1.2 Return on Investment (ROI)

The ROI of a project is a measurement of the cash generated by an investment. It measures the amount of cash flow or income stream from the investment to the investor. In the case of solar thermal projects, the projected ROI should be determined to attract investment or justify the debt/equity ratio of a project. If investors are able to get a better return by investing in other projects it may be difficult to attract that investment. In the case of debt, the ROI must be larger than the debt interest payments in order to justify the size of the debt, otherwise, the debt will continue to grow with time. Appendix C shows examples of a sensitivity analysis demonstrating the effect on ROI when a number of factors are affected in both a residential and large scale project.

5.2 Financing a Project or System

Several financial mechanisms are available to raise capital for Solar Thermal projects. These include:

- Private or Shared Equity
- Grants, Subsidies or other Government incentives
- Debt Financing
- Financial Intermediaries

5.2.1 Private or Shared Equity

Equity in (ownership of) a Solar Thermal project refers to funds allocated to capital costs of the project. Private Equity is money that an individual or business allocates toward a project, while Shared Equity is money from a variety of investors for the purpose of developing a Solar Thermal project, such as aggregated investment from members in a partnership or co-operative.

5.2.2 Government Grants, Subsidies & Programs

There are several federal and provincial programs designed to financially aid Solar Thermal projects. Government programs and subsidies may be discontinued at any time, and should be considered as a risk during the planning process for Solar Thermal projects.

A Vacuum Tube DHW system on a single residence

Thermomax / ESTIF

Federal Funding:

Currently, *ecoENERGY* is the only federal incentive program that supports Solar Thermal Technology. *ecoENERGY* is a federal subsidy program designed to allocate billions of dollars towards action on climate change.

The *ecoENERGY* for Renewable Heat program will provide $36 million of incentives and industry support to increase the adoption of clean renewable thermal technologies for water and space heating in buildings such as solar air and hot water heating. The *ecoENERGY* for Renewable Heat program provides up to 25% of the costs of a commercial, industrial, or institutional solar thermal project up to a maximum of $80,000 per project. In addition, projects for residential solar heating technologies will be explored with partners such as utilities and community organizations.

In the summer of 2007, NRCan issued a call for Expressions of Interest from Utilities, businesses, or non-profits that wish to install more than 200 residential solar water heaters as part of a pilot project to make solar water heating more accessible to Canadian homes. A total of $9 million dollars will be allocated to successful proponents who will receive up to 50% funding from the Federal Government to install 200 systems or more by 2010.

This program is in additional to the *ecoENERGY* Retrofit for homes which is designed to provide $500 to home owners who install solar water heating systems. This incentive was recently matched by the Ontario and Saskatchewan Provincial governments. In order to be eligible for the full $1000 rebate, a homeowner must first have a home energy audit completed by a licensed energy auditor and install a qualifying system. A list of approved solar collectors, energy auditors, and more specifics about this and other programs can be found on the *ecoENERGY* website (Appendix A5). Once the system has been installed, a verification audit must be performed. On behalf of the homeowner, the auditor completes the necessary forms to apply for the grants.

Provincial and Regional Funding

CanSIA (Appendix A0) as well as Environment Canada's Incentives and Rebates (Appendix A5) both have a continually updated list of Provincially and Regionally available subsidies and grants. Those where Solar Thermal systems currently directly apply are listed here.

Quebec:

Energy Efficiency Fund: Homeowners using natural gas heating are eligible to receive $400 in financial assistance towards the installation of a solar wall. Specifics of the program can be researched at the Energy Efficiency Fund website: www.fee.qc.ca/en/programs_res.htm

Ontario:

The Ontario Government has introduced the Ontario Home Energy Retrofit Program to match the Federal government's $500 contribution to homeowners that install solar water heaters. Homes must undergo energy audits in order to be eligible[11]. Ontario currently offers 50% of the cost of a home energy audit up to a maximum of $150.

Similarly, the Ontario government has made $14.4 million available over four years to commercial, industrial, or institutional solar water heating projects in order to match the Federal Government's commitment under the ***ecoENERGY*** for Renewable Heat program. A project can therefore receive a contribution agreement of 50% of the project costs (25% from Ontario and 25% Federal) up to a total of $160,000 per project.

Provincial Sales Tax (PST) exemption: System owners may apply for a 3% (total cost not including GST) or 3.4% (including GST) rebate off the total cost of all new residential Solar Thermal systems. The PST rebate is typically in the range of $170 - $240.

Toronto Atmospheric Fund: A municipal fund organized to provide loans and grants to new projects that contribute to cleaner air quality in the Greater Toronto Area. Specifics of the program can be researched at www.toronto.ca/taf

The Northern Ontario Heritage Fund: The Small Business Energy Conservation Program covers a wide variety of applications solar hot water for restaurants, solar air heating for small manufacturing plants and solar pool heating for hotels. Specifics of the program can be researched at www.mndm.gov.on.ca/nohfc/Default_e.asp

[11] See Federal Funding above for more details on this program or visit the Ministry of Energy's website www.energy.gov.on.ca/index.cfm?fuseaction=conservation.homeretrofit.

New Brunswick:

Once a homeowner has completed the NRCan ecoENERGY Retrofit for Homes Program, the Provincial government will provide a rebate of 20% of recommended upgrade costs up to a maximum grant of $2,000. In addition, the Provincial government also provides a $300 rebate plus a $100 coupon for the home energy audit required for receiving the rebates. If financial assistance is required, there are also interest-free loans available up to maximum loan of $10,000 to be repaid over a maximum term of 6 years. To find out more information visit www.efficiencynb.ca/Promo/indexpromo-e.asp.

Nova Scotia:

The Nova Scotia government is providing 10% (up to a maximum of $5000) on top of the 25% contribution for commercial, industrial, and institutional solar thermal projects provided by the Federal government. This program is also available for residential solar water heaters up to a rebate of $500 to match the Federal government's incentive. For more information about this program visit www.conservens.ca/consumerinfo/residential/solarhotwaterrebate

Prince Edward Island:

Provincial Sales Tax (PST) exemption: This effectively takes 10% off the final price of all new residential renewable energy applications, including solar thermal and solar PV energy collection systems. Specifics of the program can be researched at the PEI Environment, Energy and Forestry website: www.gov.pe.ca/envengfor/index.php3?number=1012183&lang=E

Saskatchewan:

The Saskatchewan government recently announced that they will be matching the $500 grant offered by the Federal ***ecoENERGY*** Retrofit program under the Saskatchewan Energuide for Houses program. For more info on this program visit www.saskenergy.com/Saving_Energy/energuide.asp

SUMA: This program offers an 8% rebate on the installation and cost of solar collectors used to heat swimming pools. Between 10 and 14 systems can qualify per year. Specifics of the program can be researched at www.suma.org/siteengine/activepage.asp?PageID=49

British Columbia:

Provincial Sales Tax (PST) exemption: This effectively takes 7.5% off the final price of all new wind-powered generating equipment, solar PV panels, solar thermal collector panels, and micro-hydro turbines and generators rated up to 150 kilowatts. Specifics of the program can be researched at the BC Ministry of Small Business and Revenue website: www.sbr.gov.bc.ca/individuals/Consumer_Taxes/Provincial_Sales_Tax/energy_conservation_exemptions.htm

5.2.3 Debt Financing

Debt financing is one way to address the upfront capital cost requirements of a Solar Thermal project, and still remain profitable in the long term. There are many types and sources for loans available. Major considerations when borrowing money include the amount and term of the loan, and interest rate. Because interest paid servicing the debt will lower the NPV, the higher the ratio of debt to equity that is used to finance a Solar Thermal project, the lower the NPV. Individuals and organizations should research what types of loans are available for their project by speaking with regional banks, credit unions and other loaning institutions.

Non-Specific Loans:

Nonspecific loans are available to most individuals and businesses. The most common non-specific loans include Lines of Credit or Secured Loans. These loans carry short terms and high interest rates; generally commanding an interest rate of prime plus 3%. By securing a loan against the property in which the installation is being done, it may be possible to get a lower interest rate.

Renewable Energy Loans:

Because of the nature of the loan, some government organizations and financial institutions may finance solar projects at a preferred rate due to the long-term nature of the investment, and an institutional commitment to promote renewable energy technologies. However, this type of loan is not widely available, and availability may fluctuate. Of those that do exist, renewable energy loans are typically at comparable rates to non-specific loans.

Case Example: PEI Loan Program

PEI Alternative Heating Loan Program provides loans with a 6% interest rate for the purchase and installation of alternative heating systems that reduce oil consumption including solar air and water heating systems.

More information regarding the above case, and regarding other provincial and type-specific can be found in the Index of Incentives and Rebates from Environment Canada (Appendix A5).

5.2.4 Financial Intermediaries

Financial Intermediaries are organizations with the funding capital necessary to install medium and large scale projects. Upon a request by a building owner to install a Solar Thermal system, the intermediary will assume all the responsibility of installing the system, including selecting an installer and maintaining the system. Through a contract with the building owner, the intermediary will install an energy meter, and bill the owner for the energy produced by the system at a pre-determined price.

Regardless of the fact that the system will be incorporated in the structure of a building, the building owner does not own the system; ownership of the system remains in the hands of the financial intermediary.

The price of energy is typically recalculated every 10 years. This finance and ownership structure is rare in North America. Also, Financial Intermediaries are not to be confused with Solar Thermal ESCO's (discussed in Section 7.3), which do not exist in Canada.

5.3 Financial Analysis & Payback

The Financial analysis of potential projects is dependent on a number of factors, and it is possible to use financial tools that are currently freely available to calculate the payback of Solar Thermal projects.

The main factors affecting the economics of any Solar Thermal project include:

- The cost of Solar Thermal Systems
- The cost of energy that the solar thermal system is offsetting.
- The rate of hot water consumption.
- The efficiency/performance of the system.
- Method of Financing Selected
- Operational costs and required maintenance.
- Trading Carbon credits or Renewable Energy Certificates.

In the following section each one of these factors will be discussed briefly.

A combination of Vacuum Tube and Glazed Flat-Plate collectors generate reasonably steady cash flows from energy savings over 25-30 years

Paul Gipe

5.3.1 Cost of Solar Thermal Systems

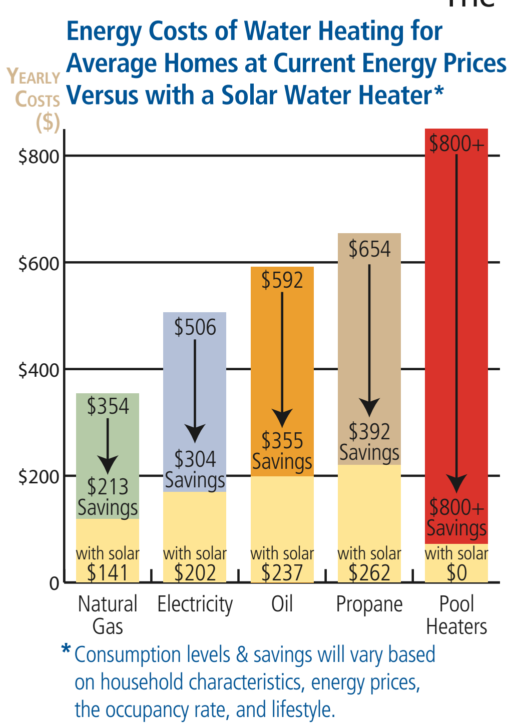
The prices of Solar Thermal systems are extremely variable. They are based on a variety of factors; type of collector, type of system, application, type of liquid used, site considerations, and scale are only some of the factors affecting cost. Included as Appendix F is a financial breakdown of the costs of three types of Solar Thermal systems, based on a number of assumed variables described below. Please note, the prices included in the Appendix are to be used as a guide only; they represent an average of a wide variety or prices, and specific project costs will differ. To provide a reference for the scale of the three described systems, the internationally recognized conversion of 0.7kW/m^2 may be used to compare with a PhotoVoltaic system. The exclusive system would then be 4.2kWth, and the Bulk Purchase and remotely sited installations would each be equivalent to 210kWth (Appendix F).

A recent survey conducted by CanSIA reported the average cost of a 2 collector, fully installed, residential DHW system to be $5,523 (Appendix A5). This amount is lower than that actual industry average however, due to one important factor. The sample size of the respondents is quite small, and is comprised of not only installers, but manufacturers/installers as well. In the opinion of several industry experts, the price quoted for the system components appears to be the manufacturer’s base cost, without taking into account the installer’s markup cost for researching, procuring, storing, transporting and providing the system. An appropriate national average is approaching $6,250.

The average price of systems only begins to near that reported in the CanSIA survey when quantity discounting is achieved through the RFP process. In addition, the quantity discount in material cost of 13%-17% can only be realized if the respondent to the RFP is the manufacturer, supplier and installer; and only if they are of a scale large enough to satisfy a request for a large quantity of systems. In Canada, this is evident in PV bulk-purchases, but is not widely evident for Solar Thermal. A reputable, CanSIA recognized installation firm can only reasonably deliver a discount of 5% on materials when responding to an RFP. The financial model included does however make the assumption that a large enough RFP could entice a manufacturer/supplier to enter into a contract to install the systems. Not addressed in the financial breakdown is the cost of a commercial system.

The Financial analysis for a community-owned, remotely-sited installation is based on the following: A collector field, sited near a neighbourhood of townhouses, feeds hot water to approximately 300 residents. The property is owned by the community (or leased, at a variable cost). The collectors heat water in an insulated 15,000L storage tank (50L/person). Once heated, the water will pass through a high-efficiency natural gas boiler to bring the water up to the desired temperature, then pumped through insulated pipes to the individual townhouses for DHW. It is metered by volume, and individual homeowners are billed for usage. The model assumes a total cost of installation of $65,000, approximately ¾ that of installing 50 separate systems.

The financial model shows that a remotely-sited, large Solar Thermal system can provide a drastically lower cost per m^2 installed.



5.3.2 Cost of Energy

One of the main factors affecting the economic feasibility of any solar thermal project is the cost of energy that the solar thermal system is reducing. Most of the time, a Solar Thermal system provides a partial contribution towards heating water or air. As a result, they reduce or eliminate the need for a conventional form of energy. For example, a solar DHW system that is preheating water for an electric water heater reduces the need for electricity, whereas a seasonal solar pool system can completely eliminate the need for a conventional pool heater and the natural gas required to operate it.

Systems using different kinds of energy sources have varying savings. The chart on the left is an estimation of the savings for a household based on fuel type and will change with time as energy prices fluctuate.[12]

5.3.3 Hot water consumption

Hot water consumption for homes is typically based on the rate of occupancy which includes the number of people in the home and

[12] Goldwater Solar estimation based on 60% solar fraction – average consumption taken from Enbridge Gas Distribution 2003 data and is based on a family of 3

how often they are there. On average, a typical person consumes 60L of hot water per day whether it is in the shower or washing dishes or clothes[13]. The larger the size of a solar thermal system, the less the average cost for solar generated energy. This is mostly due to the fact that certain components will remain the same regardless of the size of the system. As a result, the economics of a system are tied directly to the size of a system. That is why large scale commercial, industrial, or institutional projects tend to have shorter simple payback periods.

An important consideration is the occupancy rate. If the system is producing hot water and the hot water is not being consumed, then the system is not providing a reduction in conventional energy usage. This is especially true in the case of seasonal cottages. In this case, the installation of a solar water heater may only be cost-effective when a conventional energy source is not available for water heating.

In commercial or other large scale projects, there is a very large steady demand for hot water and as a result the economic feasibility of such projects is far better.

5.3.4 System Efficiency/Performance

Solar collectors, heat exchangers, and solar storage tanks all have different characteristics which can affect their ability to transfer heat or trap it. CanSIA certified solar installers will have an understanding of the capabilities of their system in order to size the system appropriately to achieve optimal performance in the summer months. However, solar collectors will have different capabilities to trap heat in the colder months. Evacuated tube collectors are especially good at preventing heat from escaping from the collector on cold winter days. One way to compare and evaluate the performance of a solar collector is to visit various websites which include the test results of a large number of manufacturers. The following websites provide a performance listing of a number of solar collectors.

Solar Rating and Certification Corporation (SRCC): www.solar-rating.org
Florida Solar Energy Centre (FSEC): www.fsec.ucf.edu
Institut für Solartechnik (SPF): www.solarenergy.ch

The European Solar Keymark program requires that in order to receive the certification, solar thermal collectors must provide at least 525kwh/m^2 related to a solar fraction of 40%[14].

5.3.5 Method of Financing

Section 5.1 describes the effect on a project's overall value as system owners select various methods of financing a project. However, if new system owners finance a project wholly or partly with debt, it is important to structure the debt for desired cash flows.

[13] 60L per person in household is the typical suggested volume used by RETScreen International

[14] Din Certco. Certification of Solar Collectors and Solar Thermal Systems. www.dincertco.de.

Solar Thermal projects have proven to generate fairly constant annual cost savings over long time periods of 25 to 30 years. Although future energy prices (primarily natural gas and electricity) are uncertain, as they rise, the economics of a Solar Thermal project improve. With long-term loans, it is much easier to balance monthly cash flows over the life of the loan.

It is important to determine the appropriate debt structure to ensure that monthly savings are greater than monthly interest payments as early as possible in the project's lifetime.

The monthly and annual cash flow generated by a Solar Thermal project consists of the cost savings generated by the system during the given time period offset by the loan repayment amount. An illustration of this concept can be found in Appendix C.

Longer-term loans are accompanied by lower annual payments. If less is spent servicing or repaying a loan on a monthly basis, it will be easier to balance that amount with the energy savings and avoid negative cash flow situations in early years of Solar Thermal projects.

Notice from the example (Appendix C) that although the long-term loan generates more positive annual cash flows during the first 10 years, the shorter-term loan generates a higher NPV. Finding an appropriate balance between interest rate and term is specific to each individual situation and project.

5.3.6 Operational and Maintenance Costs

Once a system is installed, the maintenance or operational costs can significantly impact the economics of a solar thermal project. For example, pumps used for circulating the heat transfer fluid in the solar loop consume electricity. Although the circulating pumps generally consume under 5% of the energy gained from the solar panels, it is something that should be factored into the economics of the system. Drainback systems generally require stronger pumps than glycol systems because of the need to overcome the high static head created under a non-pressurized loop.

In addition, some systems require more maintenance than others. The periodic costs involved with replacing glycol should be considered. Drainback systems typically have lower maintenance costs because of the use of water as the heat transfer fluid. In addition, components break down from time to time. Expansion tanks, pumps, controllers, even tanks can degrade with time and eventually may need to be replaced.

5.3.7 Carbon Credits & Renewable Energy Certificates

When accurate monitoring equipment is installed with the solar equipment, it may be possible to take advantage of carbon credit or Renewable Energy Certificate (REC) markets. Systems that wish to take advantage of these additional revenue streams need to show that the reductions are real and accurate and must be verifiable. It is also important to note that the system owner typically retains the rights to the environmental benefits associated with the system.

Currently a number of voluntary Carbon Credit markets exist including the Chicago Climate Exchange (www.chicagoclimatex.com), and a variety of carbon neutral programs. Renewable energy certificates can be traded through a number of brokers across North America or potentially sold to renewable energy retailers. The price of a REC or carbon credit can vary widely.

5.3.8 RETScreen Financial Analysis Software

An excellent resource for the financial modeling and analysis of renewable energy projects is the program RETScreen, on the Natural Resources website (Appendix A2). The *Solar Air Heating* Project Model and *Solar Water Heating* Project Model are both tools developed by industry professionals to aid in financial project analysis. RETScreen should only be used in conjunction with the RETScreen manual to avoid errors that may significantly alter the financial outcome of a project. For large projects, a project specific financial analysis should be developed for an appropriate level of accuracy.

5.4 Cost of Solar Thermal Systems

The prices of Solar Thermal systems are extremely variable. They are based on a variety of factors; type of collector, type of system, application, type of liquid used, site considerations, and scale are only some of the factors affecting cost. Included as Appendix F is a financial breakdown of the costs of three types of Solar Thermal systems, based on a number of assumed variables described below. Please note, the prices included in the Appendix are to be used as a guide only; they represent an average of a wide variety or prices, and specific project costs will differ. To provide a reference for the scale of the three described systems, the internationally recognized conversion of 0.7kW/m^2 may be used to compare with a PhotoVoltaic system. The exclusive system would then be 4.2kWth, and the Bulk Purchase and remotely sited installations would each be equivalent to 210kWth.

A recent survey conducted by CanSIA reported the average cost of a 2 collector, fully installed, residential DHW system to be $5,523 (Appendix A5). This amount is lower than that actual industry average however, due to one important factor. The sample size of the respondents is quite small, and is comprised of not only installers, but manufacturers/installers as well. In the opinion of several industry experts, the price quoted for the system components appears to be the manufacturer's base cost, without taking into account the installer's markup cost for researching, procuring, storing, transporting and providing the system. An appropriate national average is approaching $6,250.

The average price of systems only begins to near that reported in the CanSIA survey when quantity discounting is achieved through the RFP process. In addition, the quantity discount in material cost of 13%-17% can only be realized if the respondent to the RFP is the manufacturer, supplier and installer; and only if they are of a scale large enough to satisfy a request for a large quantity of systems. In

Canada, this is evident in PV bulk-purchases, but is not widely evident for Solar Thermal. A reputable, CanSIA recognized installation firm can only reasonably deliver a discount of 5% on materials when responding to an RFP. The financial model included does however make the assumption that a large enough RFP could entice a manufacturer/supplier to enter into a contract to install the systems.

Not addressed in the financial breakdown is the cost of a commercial system. According to industry experts, the cost, fully installed, is approximately $1000/m^2 for a drain-back water-based system, and $1300-$1500/m^2 for a glycol system. This also assumes that the supplier/manufacturer is the installer.

The Financial analysis for a community-owned, remotely-sited installation is based on the following: A collector field, sited near a neighbourhood of townhouses, feeds hot water to approximately 300 residents. The property is owned by the community (or leased, at a variable cost). The collectors heat water in an insulated 15,000L storage tank (50L/person). Once heated, the water will pass through a high-efficiency natural gas boiler to bring the water up to the desired temperature, then pumped through insulated pipes to the individual townhouses for DHW. It is metered by volume, and individual homeowners are billed for usage. The model assumes a total cost of installation of $65,000, approximately ¾ that of installing 50 separate systems.

The financial model shows that a remotely-sited, large Solar Thermal system can provide a drastically lower cost per m^2 installed.

6. Installation and Planning

A Solar thermal rooftop installation in Austria, the world leader in installed per capita capacity for DHW.

Austria Solar / ESTIF

6.1 Installation Process

The installation of Solar Thermal technology encompasses the type of installation in terms of purpose, scale, location and cost, and the process by which the project will be completed.

The Canadian solar industry is quickly moving from a fairly unregulated industry, to one with more clearly defined guidelines and procedures. CanSIA has been continually developing a code of ethics under which to govern its members, as well as providing installer training and certification. Although new solar enthusiasts should maintain a “Buyer Beware” approach, municipal governments and CanSIA are continually making the choices of individuals and organizations considering new systems easier.Most installations are performed by way of a single contract with one service provider, and an individual, business, group or organization typically enters into an agreement with a single installation company. The installers generally secure the proper collectors and other system components themselves, install the project and typically provide future maintenance. There are other means of having a system installed, for instance purchasing the collectors directly and contracting only the installation, but this is rare for small installations. Resources for finding installers can be found in Appendix A6.

There is a risk minimizing process to follow that limits the possibility of making major mistakes during the planning of a project. The following considerations highlight this process.

6.2 Considerations for a New System

There are four major considerations during the planning process, each of which are integral and co-dependent. They include:

1. Choosing the Appropriate Technology
2. Selecting a Good Quality Product
3. Hiring a Reliable and Reputable Installer
4. Securing an Appropriate Service Contract (Maintenance and Warranty)

6.2.1 Appropriate Technology

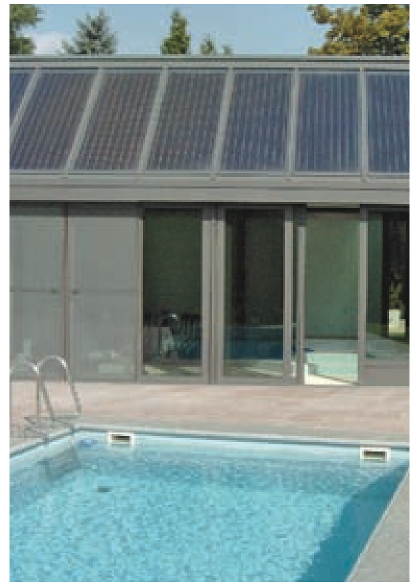
A large range of available Solar Thermal technology can make it challenging to determine the technology best suited and most economical for a particular situation. For residential applications, the best current economic choice is DHW or OSP, applications that have proven to have the shortest payback period and fastest financial returns. For residential and commercial projects, a full long-term analysis of all technological options is warranted before making any decisions.

6.2.2 Product Quality

Unlike PV modules where quality is a function of power output, efficiency, and life expectancy, Solar Thermal collectors have these, plus additional considerations, including moving parts, alternate designs, and different system applications. Typically, the only obligation on the part of the building owner in terms of selecting a product, is to select the application (for example, DHW). The Canadian industry standard is that the installer will use his or her knowledge of the industry to select the best and most appropriate system and collectors.

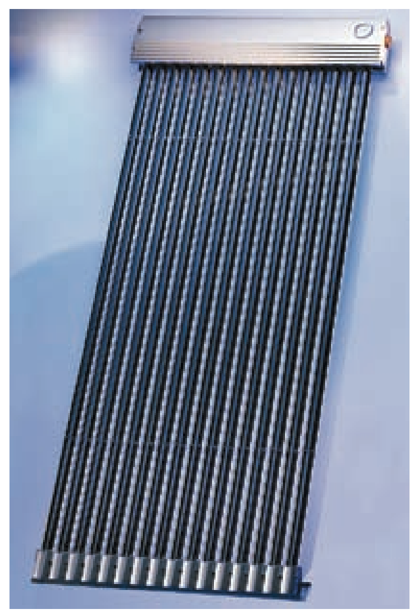
The CanSIA website (Appendix A0) has a Solar Performance Directory listing Solar Thermal systems and various product specifications including energy ratings, cost, warranty and other special features. It is an excellent resource when selecting a system.

It will be difficult to meet all of the following selection criteria, however it is recommended that you strongly favour the following suggestions. Selecting a brand of collector that is well known and accepted as one of the industry standards is recommended. Research the history of a collector, and select one with a proven track record, preferably one that is at least 4 to 5 years old. In a rapidly changing and growing industry, there will always be new but unproven technologies that promise higher efficiency, output, or any other unverified characteristic, but unexpected increases in maintenance or other unanticipated costs over a 25 year project life-cycle are generally not worth the risk. Some installation companies may indicate which collectors they prefer, and give feedback on maintenance and performance track records.



Glazed Flat-Plate collectors are chosen for DHW and OSP; in Canada typically a Thermal Blanket (Unglazed Flat-Plate) is used to heat OSPs.

Gasokol / ESTIF



Vacuum Tube collectors are excellent at retaining heat energy created, but are not the best economic choice in Canada for most applications

Schott-Rohrglas / ESTIF

An excellent resource for installers is the CanSIA members directory (www.cansia.ca/directory)

Gasokol / ESTIF

6.2.3 Reliability and Reputability of Installer

Currently there is no federal or provincial Solar Thermal certification process that is officially recognized by the Canadian Government. There is however a certification process offered by CanSIA that is designed to certify existing installers. Some classes are offered for those individuals wishing to become Solar Thermal system installers, and classes are listed on the CanSIA website (www.cansia.ca/education.asp).

The following considerations will increase the chance of selecting a reliable contractor.

- Investigate installers who are members in good standing with the Canadian Solar Industries Association. A list of their members can be found on the CanSIA website (Appendix A6)
- For individual residential homeowners, investigate whether there are any Bulk-Purchase organizations currently organizing a project in your region. If there is not, consider speaking to people in your community to investigate starting your own.
- Research installers that have already installed projects in your community. Speak to the homeowner or business clients directly and ask about their experience. For those companies that haven't installed projects in your community, ask for references, and check them.
- Select an installer who has industry experience, and has been installing Solar Thermal technology for a minimum of three years.
- Investigate companies that are larger in scale, as they can take better advantage of their scale to achieve cost savings, and will likely have more industry knowledge and experience than smaller or newer companies.
- If pursuing an individual contract, ensure that all possible details have been fully explained and consider having the document reviewed by legal council. Make sure the contract stipulates all costs associated with the installation including future guarantee or maintenance costs, warranties on the hardware, and complete and thorough descriptions of installation requirements for the collectors and system.
- Request proof of insurance. Some jurisdictions may require a plumbing contractor license for the plumbing portion, but they are typically not required. In Toronto for example, plumbing permits or certain structural permits are required for some commercial applications only.

6.2.4 Servicing: Maintenance and Warranty

Major considerations for servicing Solar Thermal installations include the guarantee associated with the installation, the manufacturer's warranty on the system components, and the long-term servicing and routine maintenance.

An installation contract should include a one-year warranty on installation at minimum, specifying on-site service for technical failures of the installation itself. This ensures the system will run properly in all weather conditions. Report any irregularities during this time to your installer to ensure they don't become bigger problems after the warranty expires.

The system parts themselves should carry a manufacturer's warranty. As recommended in the 'Product Quality' section, choose a product where the durability and the long-term maintenance requirements of the collectors are known: the manufacturer's warranty is a good indicator of parts' durability. The industry standard stipulates that an appropriate warranty would provide limited coverage for manufacturing defects on the collectors for the first 10 years. A limited manufacturer's warranty covering the remainder of the system components including the heat exchanger, tank, controller, pump, etc. should have a duration of 5 to 10 years. PhotoVoltaic panels carry substantially longer warranty periods because they are inert and have no moving parts.

Entering into a regular maintenance agreement with the original installer to inspect the system yearly after the warranty expires will ensure maintenance is conducted by someone who is familiar and comfortable with the system. As with all contracts, research other maintenance providers to ensure your service comes at market price.

RFPs/RFQs can be used to allow installers to bid on an installation contract for a number of similar systems

Paul Gipe

6.3 Suppliers and Installers

The Solar Thermal industry is new and growing quickly in North America so a list of suppliers and installers quickly becomes outdated.

The most up-to-date resource for finding local Solar Thermal installers is the CanSIA index of Member Organizations (www.cansia.ca/directory). An additional source is the Government of Canada Business Directory Strategis, which contains an extensive list of renewable energy companies in the Canadian Company Compatibilities database (Appendix A6).

6.4 Individual Contract or RFP/RFQ Process

A Request for Proposal (RFP) is a written invitation for suppliers or service providers to bid on a specific product of service. In the case of Solar Thermal, an RFP is sent to a select list of installers, and each will return a proposed bid on the system described in the RFP. These bids are legal offers, and once reviewed by a committee, one winning bid will be selected and homeowners will have a choice of entering, or not entering into the described contract with that installer.

A Request for Quote (RFQ) is a written invitation for installers to provide a quote for a proposed application based on a graded scale of quantity discount pricing. If for example a community group desires a number of DHW systems, the RFQ will invite installers to describe their proposed system, and provide a price estimate based on a reference home. Unlike an RFP, it is not a legal offer; the price of the installation may vary from the price quoted based on individual homeowner's system requirements. Also unlike an RFP, there will be no 'winning bid'; each offer will be given to homeowners to make their own choice. The quantity discount achieved from the bid will occur only if the quantity of bids accepted for a specific respondent's quote falls within a quantity-discount block, as described in the RFQ.

An RFQ provides more flexibility to each individual homeowner to choose exactly which system will be appropriate for their home. However, since multiple installers will be selected, the same level of discount pricing achieved will likely be less than selecting only one installer under an RFP.

For single or small Solar Thermal installations, a formal request is not required. In this case, the individual or business will do a preliminary search for local installers, and select the best suited for the job based on the guidelines in Section 6.3. Once the company has been selected, a thorough and very specific contract is drafted for the project, and both parties enter into an installation and warranty agreement.

For large installations (for instance, a large Solar Thermal collector array on a community center) or for Bulk-Purchases, an RFP or RFQ should be issued prior to entering into contracts. By issuing an RFP or RFQ, a larger project may achieve the best value by having a number of installation companies bid competitively on the specific project. Appendix D includes an example of an RFQ intended for use by a community bulk-purchase group. It is to be used only as a guide, and consulting legal council is recommended when designing an RFP or RFQ.

Sections of the RFP/RFQ to be developed include:

- Description of the project details and scale
- Which type of organizations the RFP targets
- Explanation of what specific deliverables are required by installation
- Request for references and past projects
- Details of the final contract(s) and parties to the contract
- Other legal terms as determined by legal council

7. The Future of Solar Thermal

Up until this point, all technologies, programs, policies and initiatives discussed in this manual are currently available in Canada. Below is an initiative that may be instituted at some point in the future, but does not currently exist in Canada.

7.1 On-Bill Financing

On-Bill financing is a new concept in Canada, and is being considered by regional utilities. It is based on the concept of a Local Improvement Charge (LIC).

LIC's are typically improvements made in a neighbourhood by the local municipality or a government-run organization, improvements that have been requested by the neighbourhood, and financed by way of a property-specific loan. For example, a neighbourhood could choose to have utility cables that need replacing buried, at a higher cost, rather than replacing the above-ground poles; the extra cost shows up as monthly loan repayments on neighbourhood utility bills, until such time as the extra costs have been recovered.

Some utilities are working with the Ontario Energy Board (OEB) to allow for an on-bill financing structure for new solar installations. In effect, the concept is a 'lease-to-own' structure, where the utility will continue charging the home owner for a term that surpasses the payback period (in place of interest on a loan), and once the system is paid for with a certain amount of interest recovered, ownership of the system is transferred to the building owner. This system could also act to facilitate the Bulk Purchase process.

Energy Service Companies (ESCO's) are the public business equivalent of a municipal LIC. They are further described in Appendix E5.

Appendix A: Additional Resources

A0

Canadian Solar Industries Association (CanSIA):
An excellent resource for Solar Thermal installers, manufacturers and organizations in Canada **www.cansia.ca**

Canadian Renewable Energy Network (CanREN):
An excellent resource for almost everything you need to know about Solar Thermal technology. **www.canren.gc.ca**

A1

ecoENERGY: Natural Resources Canada **ecoaction.gc.ca**

Energy Conservation
Ontario Ministry of Energy: Tips on Energy Conservation
www.energy.gov.on.ca/english/pdf/conservation/Conservation%20Tips%20Brochure.pdf

Energy Efficient Appliances
EnerGuide: Buying and Using Energy Efficient Appliances
oee.nrcan.gc.ca/publications/infosource/pub/home/Buying_and_Using_EE_Appliances.cfm

A2

Further Reading on Passive Solar Heating

'Passive Solar House: The Complete Guide to Heating and Cooling Your Home' by James Kachadorian; or

'Solar House: A Guide for the solar Designer' by Terry Galloway.

Atlas of Canada Solar Radiation: Natural Resources Canada
atlas.nrcan.gc.ca/site/english/maps/archives/5thedition/environment/climate/mcr4076

RETScreen International **www.retscreen.net/**

A4

List of Community Organizations That Are Involved in Solar Thermal

1. BCSEA; Vancouver BC; **www.bcsea.org**
2. CanREA; Canada; **www.canrea.ca**
3. CARE; Ottawa ON; **www.renewables.ca**
4. OSEA; Toronto ON; **www.ontario-sea.org**
5. OurPower, Toronto ON; **www.ourpower.ca**
6. Solar Buildings Research Network; Montreal QC; **www.solarbuildings.ca**
7. Solar Energy Society of Canada; Kingston ON; **www.sesci.ca**
8. SolarShare, Toronto ON
9. Vancouver Renewable Energy Co-op; Vancouver BC; **www.recov.org**

Government of Canada 'Canada Business' Website
Main: **canadabusiness.gc.ca**
Information on Co-operatives:
Search on main page "Cooperatives Info-Guide"

Canadian Co-operatives Association **www.coopscanada.coop**

Financial Services Commission of Ontario: Resources for Co-operatives **www.fsco.gov.on.ca/english/regulate/co-ops**

A5

CanSIA Report: The Price of Solar Water Heating in Canada (May 06)

www.cansia.ca/downloads/report2006/C20.pdf

ecoENERGY **www.ecoenergy-ecoenergie.gc.ca/index-eng.htm**

Environment Canada: Incentives and Rebates:
www.incentivesandrebates.ca/gc_fi_search.asp

Ministry of Natural Resources News Room
www.nrcan-rncan.gc.ca/media/index_e.php

A6

List of Solar Technology Installers

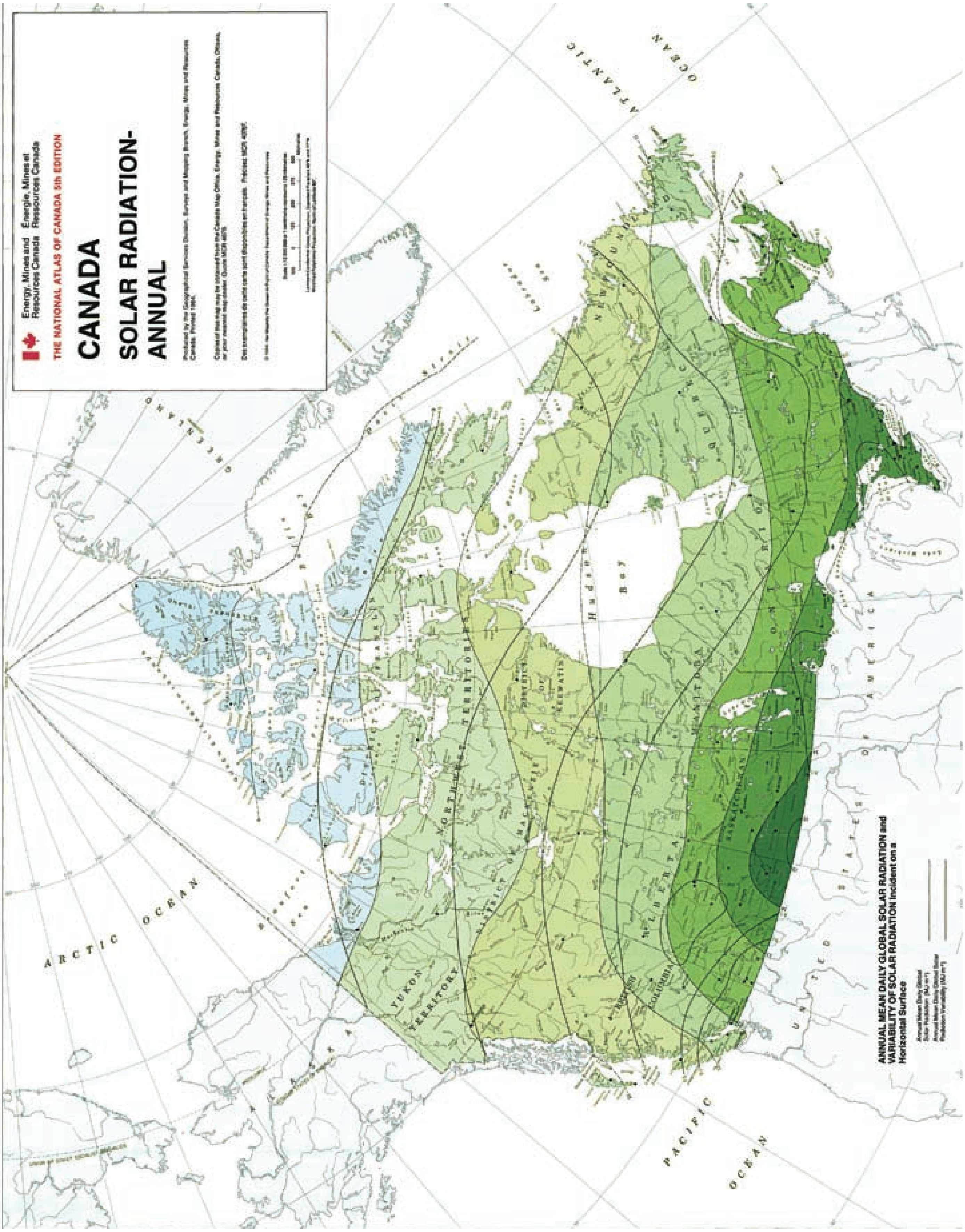
CanSIA – Member Directory; **www.cansia.ca/directory**

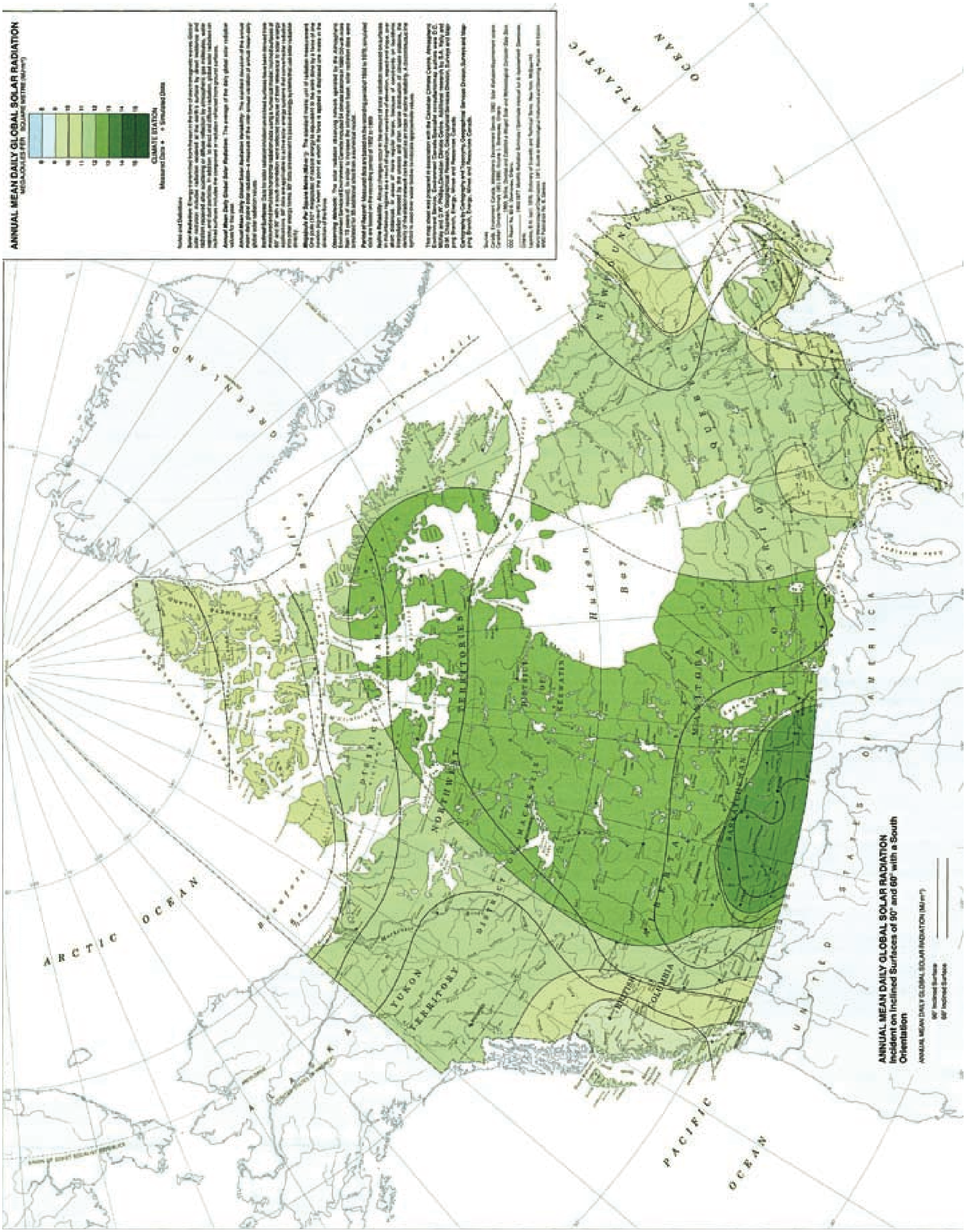
Strategis – Canada's Business & Consumer Site;
strategis.ic.gc.ca/sc_coinf/ccc/engdoc/homepage.html

A7

Standard Offer Program; the Ontario Power Authority
www.powerauthority.on.ca/sop

Appendix B: Solar Radiation Resource Map




ANNUAL MEAN DAILY GLOBAL SOLAR RADIATION
ANNUAL MEAN DAILY GLOBAL SOLAR RADIATION
Incident on Inclined Surfaces of 90° and 60° with a South Orientation
ARCTIC OCEAN
ATLANTIC OCEAN
PACIFIC OCEAN
Hudson Bay
UNITED STATES OF AMERICA
YUKON TERRITORY
NORTHWEST TERRITORIES
BRITISH COLUMBIA
ALBERTA
SASKATCHEWAN
MANITOBA
ONTARIO
QUEBEC

Appendix C: Possible Loan Structures

25 Year Loan At 7% Interest

Year	Loan Pmts.	Interest	Savings	Annual Cash Flow
1	-$200	-$350	$500.00	-$50.00
2	-$200	-$322	$495.00	-$27.00
3	-$200	-$308	$490.05	-$17.95
4	-$200	-$294	$485.15	-$8.85
5	-$200	-$280	$480.30	$0.30
6	-$200	-$266	$475.50	$9.50
7	-$200	-$252	$470.74	$18.74
8	-$200	-$238	$466.03	$28.03
9	-$200	-$224	$461.37	$37.37
10	-$200	-$210	$456.76	$46.76
11	-$200	-$196	$452.19	$56.19
12	-$200	-$182	$447.67	$65.67
13	-$200	-$168	$443.19	$75.19
14	-$200	-$154	$438.76	$84.76
15	-$200	-$140	$434.37	$94.37
16	-$200	-$126	$430.03	$104.03
17	-$200	-$112	$425.73	$113.73
18	-$200	-$98	$421.47	$123.47
19	-$200	-$84	$417.26	$133.26
20	-$200	-$70	$413.08	$143.08
21	-$200	-$56	$408.95	$152.95
22	-$200	-$42	$404.86	$162.86
23	-$200	-$28	$400.82	$172.82
24	-$200	-$14	$396.81	$182.81
25	-$200	$0	$392.84	$192.84
			NPV	$459.82

Loan	$5,000.00
Interest Rate	7%
Term	25 years
Capital Pmts.	-$200.00

10 Year Loan At 3.75% Interest

Year	Loan Pmts.	Interest	Savings	Annual Cash Flow
1	-$500	-$188	$500.00	-$187.50
2	-$500	-$150	$495.00	-$155.00
3	-$500	-$131	$490.05	-$141.20
4	-$500	-$113	$485.15	-$127.35
5	-$500	-$94	$480.30	-$113.45
6	-$500	-$75	$475.50	-$99.50
7	-$500	-$56	$470.74	-$85.51
8	-$500	-$38	$466.03	-$71.47
9	-$500	-$19	$461.37	-$57.38
10	-$500	$0	$456.76	-$43.24
11			$452.19	$452.19
12			$447.67	$447.67
13			$443.19	$443.19
14			$438.76	$438.76
15			$434.37	$434.37
16			$430.03	$430.03
17			$425.73	$425.73
18			$421.47	$421.47
19			$417.26	$417.26
20			$413.08	$413.08
21			$408.95	$408.95
22			$404.86	$404.86
23			$400.82	$400.82
24			$396.81	$396.81
25			$392.84	$392.84
			NPV	$1,027.32

Loan	$5,000.00
Interest Rate	3.75%
Term	10 years
Capital Pmts.	$500.00

Annual Savings	$500.00
Annual System Efficiency Loss	1%
Discount Rate for NPV calculation	7.5%

**** This model is to be used as an illustration only.**
Annual cash savings from actual projects will differ **

Appendix D: Sample RFQ for Bulk-Purchasing Organization

Request for Quotation (RFQ) for Bulk Purchasing of Solar Domestic Hot Water and Solar Air Heating Systems

[*Date*]

A. Background

[*Organisation*] is a local non-profit, community-based group helping residents and businesses in [location], and the surrounding region make more responsible choices in their use and supply of energy.

[*Organisation*] is staffed entirely by volunteers including professionals in the renewable energy field dedicated to reducing greenhouse gas (GHG) emissions by encouraging energy conservation and pursuing renewable energy projects in the [*location*] region.

As one of its priorities for [*year*], [*Organisation*] has launched the <u>A Residential Solar Project</u>, the goal of is to encourage residents of [location] and the surrounding region to consider a solar domestic hot water (SDHW) heater or solar air heating system for their home. The project will help to identify and overcome barriers to the adoption of SDHW and Solar Air heating systems through education and support to homeowners including product information, advice on buying and installing SDHW and Solar Air heating Systems and access to qualified professionals who can conduct a site analysis. We also will be registering up to 50 homeowners who wish to install either one or both of the systems during the project. An energy meter will be installed so that [*Organisation*] and the homeowner can record and monitor the energy output of the solar system installed.

A key element to the Solar project is to coordinate bulk purchasing arrangements with SDHW and Solar Air Heating System suppliers in order to secure the most cost-competitive price quotations. This information will be shared with the homeowner who wishes to install the unit(s).

B. Purpose and Scope of RFQ

The purpose and scope of this RFQ is to provide [*Organisation*] and the homeowners with information on local suppliers of SDHW systems who can provide “turnkey” residential solar domestic hot water and hot air systems. For the purposes of the RFQ, the term “turnkey” will include the following:

- **Final Site Assessment** ([*Organisation*], with the knowledge provided by the solar supplier, will conduct the preliminary site assessment to ensure the home has the correct orientation, roof slope and condition or South facing wall, space for the second hot water tank)
- **System Design**
- **System Purchase**
- **System Installation**
- **System Commissioning**
- **Warranties, After Sales Service and Maintenance Agreements**
- **Financing** (optional)
- **Future Upgrades** (optional)

In order to allow the [*Organisation*] and the homeowners to compare submissions on an equal basis, each supplier will submit a quote based on a reference house, the characteristics of which are provided in Annex 1.

The group recognizes that each installation is unique and actual quotes for each installation will be different, however the expectation of the group is that the “System Supplier” will be able to provide a very price competitive quote based on the fact that the “System Supplier” will have access to a large number of consumers interested in purchasing solar systems.

Companies responding to this RFQ will be considered the “System Supplier” and a principal point of contact for the group involved in the project.

Designation as a “System Supplier” does not reflect an endorsement of that company’s product or service by [*Organisation*] or the homeowners, but merely reflects the fact that said company responded to the RFQ.

C. System Submission Requirements

C.1. Site Assessment

The “System Supplier” must demonstrate the ability to conduct or provide a site assessment to determine the appropriateness of solar systems for each site. Using the reference house as a base, each quote must clearly identify costs associated to travel to the site, final site assessments and a report estimating the potential savings using the RETScreen calculator.

C.2. System Design

Using the reference house as a base, the “System Supplier” must recommend a system that will provide optimal performance for the [*location*] market. Each submission must clearly describe specifications and cost of the recommended system including:

- solar collector
- pumps
- controller
- plumbing
- mixing valve
- expansion tanks
- storage tank (if necessary)
- heat exchangers
- controls including stagnation/over-heating strategies and freeze protection strategies
- roof and/or ground anchors
- all installation materials
- all other equipment and materials recommended by the “System Supplier”
- equipment features, options or considerations regarding hard water (or other water quality issues)

To provide the group with an appreciation of the implications on system design and cost for different family configurations, system design options should be provided for a low DHW load situation (family of 2 – working couple) and a high DHW load configuration (family of 4 with young children at home). The “System Supplier” is invited to provide any information that will help the group make an informed choice on the relationship between family size/DHW load and system costs.

The “System Supplier” will provide complete specifications for individual components and for the complete system. Performance data for the system will be provided (i.e. Bodycote tests or equivalent). The “System

Supplier" may recommend more than one system design or offer system designs with different components (i.e. different collectors).

Test data from actual field installations is highly desirable, particularly for the [location] area or similar climactic regions.

A RETScreen analysis will be provided using the system specifications and the Reference House description. A RETScreen analysis should be provided for each system design option. The RETScreen analysis should provide the solar fraction and the solar energy delivered (kWh/year) and a printout of the RETScreen sheets: "Energy Model" and "Solar Resource and Heating Load Calculation". The financial, cost and greenhouse gas calculations with RETScreen are not required but if they are available, it will add benificial information.

Regulatory Approvals and Permits

The "System Supplier" shall provide a description of how the turnkey solar hot water or air system conforms to relevant standards (CSA, UL, etc).

The "System Supplier" must include a statement on whether the system conforms with CAN/CSA-F379.1 as modified in 2004 by the CSA Technical Information Letter (TIL) "Interim Certification Requirements – Packaged Solar Domestic Hot Water Systems" or Solar Air Heating Systems.

For systems proposed by the "System Supplier", the group is interested in examples of municipalities where code enforcement officers have granted installation permits based on conformance to the TIL or equivalent standards. The "System Supplier" shall provide copies, where available, of the permits granted.

C.3. System Installation

Using the reference house as a base, the "System Supplier" will provide a clear description of tasks, time and costs to install the recommended system and clearly delineating optional features. The "System Supplier" should describe any additional costs or constraints that may need to be anticipated that are not reflected in the reference house example.

The "System Supplier" will also be responsible for securing all permits for the system and inspections as required.

The "System Supplier" will provide an estimate to install the system including final site assessment, system design, ordering time for the system, approvals and installation.

C.4. System Commissioning

Using the reference house as a base, the "System Supplier" will describe how each system will be commissioned.

C.5. Warranties, After Sales Service and Maintenance Agreements

The "System Supplier" will provide a complete description of applicable labour and parts warranties for both the system and individual components.

The "System Supplier" will also provide a description of how after sales service issues will be handled both during and after the warranty periods including labour costs, availability and accessibility of spare parts and recommissioning of the system, as required.

The "System Supplier" will also provide a description of optional system maintenance agreements and capability of offering extended warranty packages.

C.6. Financing (optional)

The "System Supplier" may wish to offer solutions to access alternative or innovative financing arrangements including:

- Preferred interest rates from a local financial institution
- Access to leasing arrangements for the system
- Access to rental arrangements for the system
- Other innovative financing options

C.7. Future Upgrades (optional)

The group recognizes that solar technology is evolving rapidly and new and more efficient components and systems will inevitably arrive on the market over the next 5 years. In addition the homeowners' situation may change (e.g. increased hot water loads, addition of a pool, desire to incorporate space heating, etc) creating the need or opportunity to increase or upgrade the system. Some members of the group may want such upgrades immediately.

To this end, the "System Supplier" may also wish to offer innovative solutions in concert with innovative financing options to enable homeowners to upgrade or modify their systems in the future.

Key features of interest to the group include:

– Future expansion of system capacity
– Integration of SDHW system with Space Heating
– Pool Heating
– Jacuzzi/Hot Tub heating
– Photovoltaic powered pumps
– Capability to work in a power outage (assume a capacity of 12 hours)

The "System Supplier" is encouraged to include in their submissions descriptions of how their system can meet these additional features.

C.8. Monitoring System (optional)

The group has indicated that it may want to monitor a number of installations to increase the confidence in the appropriateness of SHDW and Solar Air systems for the [*location*] market.

To this end the "System Supplier" is invited to offer solutions and cost estimates to provide and install monitoring equipment for their system that records solar energy collected and hot water used (i.e. Btu or kWh meters, flow meters, global radiation, etc).

D. Supplier Submission Requirements

The group insists on a turnkey installation where the "System Supplier" takes full responsibility for the design, installation and after sales service of the system. The "System Supplier" may sub-contract elements of the system but will still remain the single point of contact before, during and after installation of the system. The exception to this requirement could be issues related to financing of the system.

Each submission must provide as complete a description as possible of the "System Supplier" and sub-contractors and for each must address the following:

System Supplier

- Location of company
- # years in business
- # years in business of providing SDHW and Solar Air Systems systems
- Size of Company
- Credentials of key individuals of company
- # and examples of location of SDHW and Solar Air system supplied (include examples of designs of optional system features)
- description of liability insurance
- service area

Site Assessment Professional

- Location of company
- # years in business
- # years in business of providing site assessment
- Size of Company
- Credentials of key individuals of company
- # of site assessments conducted
- Description of liability insurance

System Designer

- Location of company
- # years in business
- # years in business of designing SDHW and Solar Air systems.
- Size of Company
- Credentials of key individuals of company
- # and examples of location of SDHW and Solar Air Heating systems designed (include examples of designs of optional system features)
- Description of liability insurance

System Installer

- Location of company
- # years in business
- # years in business of installing SDHW and Solar Air Heating systems.
- Size of Company
- Credentials of key individuals of company
- # and examples locations of systems installed (include examples of installation of optional system features)
- jurisdiction where installer is qualified to install systems (i.e. Ontario, Quebec)
- description of liability insurance

Manufacturers of System and Components

- Location of company
- # years in business
- # years in business of manufacturing SDHW and Solar Air Heating System products
- Size of Company
- Credentials of key individuals of company
- # of systems/components manufactured (include examples of installation of optional system features)
- Description of liability insurance

After Sales Service and Extended Warranty Suppliers

- Location of company
- # years in business
- # years in business of providing maintenance service and warranty repairs on SDHW and Solar Air Heating systems.
- Size of Company
- Credentials of key individuals of company
- # of systems serviced/warranted (include examples of installation of optional system features)

Financial Institutions (if applicable)

- Location of company
- # years in business
- # years in business of providing financing solutions
- Size of Company
- Credentials of key individuals of company
- # of systems financed (include examples of installation of optional system features)

The "System Supplier" should include information on all sub-contractors for optional features or elements of the system (i.e. space heating sub-contractors, pool heating sub-contractors), where applicable

[*Organisation*] and the Homeowners reserve the right to verify the financial integrity of the "System Supplier" or its sub-contractors. The "System Supplier" is encouraged to provide relevant information to allow the group to verify the integrity of the supplier and principal sub-contractors (i.e. St. Partick Street#, Better Business Bureau Reports).

E. Evaluation of System Suppliers and the Role of [*Organisation*]

A steering committee of the group will review and evaluate each submission against the requirements of this document. After all submissions have been reviewed, [Organisation] will host a meeting of the homeowners where the steering committee will present each submission and the degree to which they complied with the submission requirements.

[*Organisation*] and the steering committee WILL NOT select or recommend a preferred "System Supplier". Each consumer will negotiate their own contract or estimate with one or more of "System Suppliers" who responded to the RFQ. It is anticipated that the degree to which each RFQ complies with the submission requirements will significantly influence which "System Supplier" members of the group will prefer to contact regarding actual quotes.

[*Organisation*] makes no guarantees that any member of the group will purchase a solar system from companies responding to this RFQ.

[*Organisation*] will however make the results of this RFQ process available to all current and new members of the group and other interested homeowners. [Organisation] will continue to recruit new homeowners interested in installing SDHW and Solar Air Heating Systems.

Any contracts signed will be between the homeowner and the "System Supplier". [*Organisation*] will not be part of said contract.

F. Financial Submission Requirements

All prices to be in Canadian Dollars, PST included GST extra.

The "System Supplier" will provide a firm fixed price for this project based on the reference house and aforementioned specification conditions and constraints. All equipment and subcontractor costs (i.e. "turnkey") including but not limited to permits, liability insurance appropriate provincial workers compensation and all other regulatory issues are to be included in the quotation.

The "System Supplier" will provide quotes for a single system and volume discounts for bulk orders of 5 units, 10 units and 20 units. A "Pricing Template has been provided to help the "System Supplier" communicate the implications of system size on material and labour costs, discounts or bulk ordering cost reductions the "System Supplier" is prepared to offer, as well as other fixed and variable costs associated with a typical system supply and install contract.

The "Pricing Template" also provides an opportunity for the "System Supplier" to declare any terms and conditions for pricing. All submissions must clearly state terms and conditions for pricing.

It is the intent of the Consumer Group to present the results of this RFQ no later than [*date*] with the intent that systems would be installed commencing in [*date*] through to [*date*]. The "System Supplier" MUST clearly indicate the capacity of the "System Supplier" (i.e. # of units that can be installed per month) and any limitations (if any) regarding system installation (i.e. approximate date the last collector can be installed).

F. 1. Pricing Template

I. Materials and Labour

Provide a firm fixed price per household based on the requirements described above as they relate to the reference house in Annex A. Include all equipment supply and subcontractor costs (i.e. "turnkey"). Exclude costs for Site Assessment, Warranties, Maintenance Contracts and Energy Monitoring. Where the "System Supplier" wishes to provide quotes using alternative products please complete a separate Pricing Template for each system configuration or type.

Quantity Range (Units)		Family of 2	Family of 4
1-4	Materials	$	$
	Labour	$	$
	Total	$	$

5-9	Materials	$	$
	Labour	$	$
	Total	$	$

10-19	Materials	$	$
	Labour	$	$
	Total	$	$

20 plus	Materials	$	$
	Labour	$	$
	Total	$	$

Summary of System Specifications (major components) for each system type:

Collectors	
Plumbing	
Storage (if applicable)	
Controls	
Other Features	
Other Features	
Other Features	
Other Features	

II. Provide a separate identified price per household for the following items:

a) Final Solar Site Assessment	$
b) Plumbing or electircal Costs per m of run*.	$
b) Optional Annual Maintenance Contract (in warranty)	$
c) Optional Annual Maintenance Contract (out of warranty)	$
d) Extended Warranty per year. ___________ years available	$
e) Optional Energy Monitor – installed and commissioned	$

* The purpose of this cost is to provide consumers with information to allow them to estimate plumbing costs for their own situation where plumbing distances are significantly greater or less than that of the reference house.

All of the above prices are valid until ____________________, 200__

Quote qualifiers

Travel Cost Policy:

____

____

____

Labour Overtime Policy:

____

____

____

Authorization

Company Name: ____________________________________

Authorized By: ____________________________________

(Print)

____

(Signature)

Date: ____________________________________

G. Deadline for Submission

Five (5) hard copies of each submission and one electronic copy will be provided no later than [*date*] to:

[*Organisation*]

[*Mailing Address*]

[*Phone/Fax*]

H. Questions Regarding the RFQ

All questions regarding this RFQ must be submitted by E-mail. Phone calls or direct communications with any member of [*Organisation*] will not be accepted.

Questions can be submitted to [*email*]

Questions will be accepted up to [*date*]

All questions and answers will be promptly distributed to all companies who have expressed an interest in the RFQ

Reference House Description for System Design Options and RETScreen Estimates

Location

- [*location*] area

Roof Specifications

- Assume System is Flush Mount to Roof
- Assume Roof Slope is 4 in 12 (18 degrees)
- Assume orientation of Roof is Due South with No Shading
- Assume adequate Roof Area to install collector

House Specifications

- Assume 2 Story House with full basement
- Assume 10 m vertical height and 4 m horizontal length for glycol lines from collector to storage tank
- Assume gas-fired hot water tank with 55% efficiency

Occupant Specifications

- Assume two family configurations
    - o Family of 2
- Working Couple; 155 litres/day at 55C
    - o Family of 4
- 2 adults, 2 young children (home all day); 225 litres/day at 55C

Non-roof Mounted Systems

- Except for tracking collectors, assume the collector slope is 18 degrees from horizontal (for comparison with flush roof-mount)
- Except for tracking collectors, assume orientation of collectors is Due South
- Assume no solar shading

Appendix E: Further Reading

E1. Passive Solar Thermal

Passive solar is currently growing in popularity in building design and construction. Architects are constructing better-insulated homes, directing windows towards sunnier directions to allow sunlight be transferred into heat using furniture and other surface areas in a room. One example of passive solar building construction is the incorporation of a Trombe Wall, a sun-facing wall built from heat storing materials such as concrete, which acts as a heat regulator, capturing heat during the day and releasing it into the building during the night. This guidebook is intended primarily for active solar thermal projects, so this is a very simple and limited explanation of the passive solar concept. For additional resources regarding the use of passive solar thermal technology, see Appendix A2.

E2. Alternate Applications of Solar Thermal

There are some solar technologies that suit only larger projects. One emerging technology is the concentrating dish or tower collector. Concentrating collectors have a parabolic array of mirrors that are designed to direct sunlight to a single focal point. The focal point has a collector that becomes super-heated and transfers that heat into steam to power an electric generator.

Solar detoxification is another use for solar energy. Water can be purified using the Ultra Violet rays in sunlight, or by converting the light into heat energy to detoxify the water using heat. For further reading on other forms of solar power and other renewable energies, consult the Canadian Renewable Energy Network (Appendix A0).

E3. Solar Thermal Collectors

Back-Pass or Single-Pass Open Collector: This air-based collector works by having air pumped via a fan or pump from the area to be heated into the area behind the panel, where it heats up before being circulated back into the area that is to be heated. Installed primarily on rooftops, the most efficient usage is VAH which pumps heated air into a central heating system.

Unglazed Perforated Flat-Plate Collector: Also an air-based collector, instead of a closed air circuit such as the Back-Pass, small perforations allow fresh air to be drawn into the collector and heated. Air is drawn in from the exterior by creating a low air pressure behind the plate using a fan or air pump. The heated air is then pumped to the central heating system. This system is used almost exclusively for commercial VAH due to its low cost and swift payback.

Unglazed Flat-Plate Collector: This liquid-based collector is usually constructed of a dark UV protected sheet and has no glazing or insulation. Heat is transferred into water directly behind the collector. 97% of unglazed flat-plate collectors are used for OSP heating.

Batch, Bread-Box or Integral Collector: The simplest form of liquid-based solar collector, the batch collector is an outdoor tank formed of heat transferring material which heats the liquid inside the tank, typically water. For use with DHW, this collector is less efficient than other collectors due to its small surface area, and is impractical notably in Canada due to sub-zero temperatures during winter months.

Evacuated or Vacuum Tube Collector:

A series of vacuum tubes house the collector elements through which the Glycol passes. The vacuum acts similar to a thermos, acting as an insulator to keep the heat generated in the elements from radiating back into the air. Best suited for very cold sunny climates, this collector is very efficient at producing heat. It is used for DHW, CHW and ISPs. Due to the large number of manufacturers producing these collectors in China, the cost of evacuated tube collectors has come down drastically making them cost competitive with flat plate collectors.

Glazed Flat-Plate Collector: This is by far the most common Solar Thermal collector panel. It can act both as an air-based or liquid-based collector, but is almost always used as a liquid-based system. Glycol is pumped into solar radiation-absorbing tubes in the panel where it gains heat energy. The Glycol is then pumped to a heat exchanger to transfer the heat energy into water that is then typically pumped into a hot-water tank. It is most efficiently used for DHW, CHW and ISP heating, and most commonly used for DWH in Canada.

E4. Efficiency Improvements Used Together With a Solar Thermal System

Energy Conservation: The most immediate way to reduce energy consumption is to conserve energy by making targeted changes in your home or office. Energy conservation techniques include installing a programmable home thermostat to lower the heat at night and mid-day, switching to compact fluorescent bulbs, and turning off your computer when you're not using it.

Energy Efficient Appliances: Basic model and outdated appliances in your home or business are likely significant energy users, and it may make more financial sense to replace them before investing in a Solar Thermal system. For example, replacing a conventional natural gas furnace with a high-efficiency condensing gas furnace could increase system efficiency from 55% to 93%[1] and reduce monthly bills by over 40%.

Home Retrofit and Efficiency: Prior to investing in a Solar Thermal system, consider retrofitting your home to better retain heat energy that will be generated by the system. Replacing drafty doors or frames, installing double-paned windows, and insulating older walls or ceilings are all excellent long-term investments.

Each of these investments will be profitable in the long term, and will work together to increase the energy savings from a Solar Thermal installation. Consult the resources found in Appendix A1 for more information and details about each of these initiatives.

E5. Energy Service Companies (ESCO's); Possible Future Funding Method

Energy Service Companies (ESCO's) are the public business equivalent of a municipal LIC. They do not currently exist in Canada. ESCOs were mentioned earlier in Section 5.3, and they differ from Financial Intermediaries in that they transfer ownership of a system to the building owner after the term of the contract expires. An ESCO will install systems on a residential or commercial building at no capital cost to the owner, along with an energy meter. The ESCO will then bill the residence or business owner monthly for the calculated cost of energy savings. In Canada, ESCO's act almost exclusively in the home energy efficiency and retrofit industry, since energy savings are achieved with a short payback. ESCO's will retrofit a building rendering it more energy efficient, and based on the energy saved by the system the ESCO will bill for that amount. The savings are paid back in 3-4 years, as compared to a Solar Thermal system which carries a considerably longer payback period. Unlike Financial Intermediaries, ESCO's transfer ownership of the system to the building owner after a period of 7-8 years, once a profit has been realized.

It is also problematic due to difficulty in metering the cost savings. In Europe, almost exclusively, projects have been installed for CHW since it is the only Solar Thermal system to meter with any accuracy. If energy costs continue to rise, we can expect to see ESCO's moving into the Solar Thermal industry in the future.

Solar Space Heating

In Ontario, the majority of homes use forced air furnaces, hot water radiators, or in-floor radiant heating. Space heating accounts for over 60% of residential energy usage (see chart). Solar water heating systems can decrease the operational costs of space heating by preheating water before it is directed to air handlers, radiant infloor systems, and/or hot water radiators.

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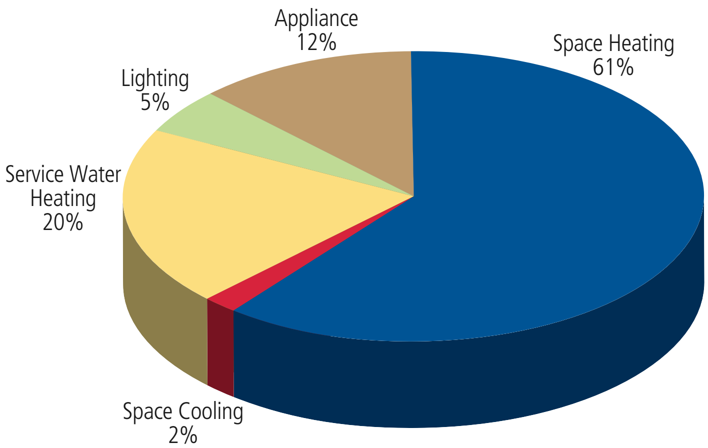
[1] CanREN, Natural Resources Canada: Typical Seasonal Heating System Efficiencies. **www.canren.gc.ca/prod_serv/index.asp?CaID=103&PgID=615**



Source: *Conservation Bureau*
www.conservationbureau.on.ca/Page.asp?PageID=122&ContentID=1535&SiteNodeID=168

It is important to carefully consider the sizing of the solar water heating system to prevent overheating the solar loop (the closed-loop which circulates from the solar storage tank to the roof and back). If a system is sized to provide preheating for a space heating system in the winter, steps must be taken to use or dispose of the excess heat in the peak months (the summer). Different hydronic (water) heating systems require varying temperatures some higher than others. Boiler/radiator systems typically require temperatures in the area of 130 - 180 degrees Fahrenheit. Also, once the water is circulated through the radiators the return temperature to the boiler has only dropped 20 – 30 degrees. Therefore solar would be required to make up for this loss in heat in high temperature range. This can be difficult to achieve with solar water heaters in the low production winter months, and as a result, a much larger system is typically required to produce sufficient heat to bring temperatures up to this level. However, radiant infloor heating (90 – 110 degrees Fahrenheit) and air handlers (120 – 160 Fahrenheit) work at much lower temperatures.

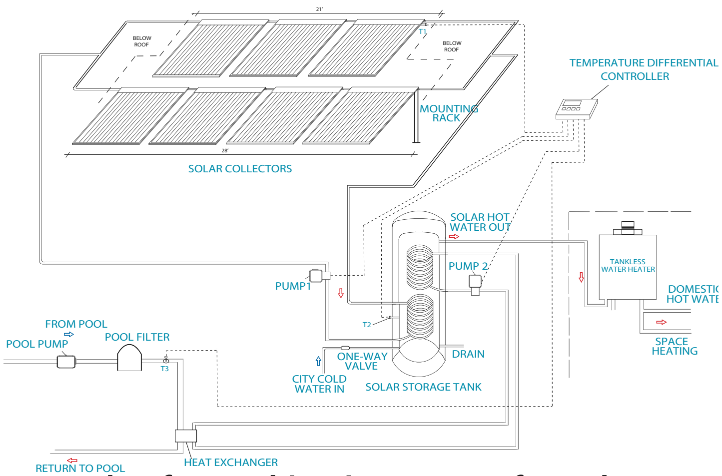
An air handler uses a hot water source such as traditional storage tank water heaters or tankless water heaters to circulate hot water through a coil inside of a water furnace. A fan within the furnace then blows air over the coil and distributes it throughout the home in the same fashion as a conventional furnace. One advantage of this kind of system is that the space heating and domestic hot water needs can be met with one water heater. Solar water heaters can be integrated easily to provide preheating for this kind of system. In addition, the air handler works in the same way as a conventional furnace and so the existing air ducts can be used.

These systems on their own are extremely efficient in how they transfer water heat to air heat (approx 99%). They are ideally used in conjunction with a modulating Tankless water heater or modulating boiler. They offer a gradual and more comfortable heat which is generally better distributed throughout the house than most conventional furnaces.

Combining solar water heating with Tankless water heaters is very effective in maximizing the solar potential. A Tankless water heater senses the flow of the water and ignites a burner assembly which heats up a copper heat exchanger. As the water passes through the heat exchanger within the unit it is heated which is why Tankless water heaters are commonly referred to as instantaneous water heaters. Tankless water heaters work differently from conventional water heaters in that they offer continuous hot water at a consistent temperature regardless of differing hot water flows and incoming temperatures.

The Tankless water heater is able to recognize the incoming solar preheated water at 1000 times per second and only uses the needed energy to boost the temperature of the water if required. When you incorporate air handlers and Tankless water heaters with a solar input, you can use the preheated water from the sun which in some cases can come out at the desired heating temperature of 140F (predominantly fall and spring) to heat the home thus using a renewable energy source to heat.

High efficiency Modulating Boilers can also be used for radiant infloor heating to compensate for when the solar production is low. In radiant infloor heating, the temperatures are typically much lower. As a result, solar thermal can be a good compliment for this type of space heating.



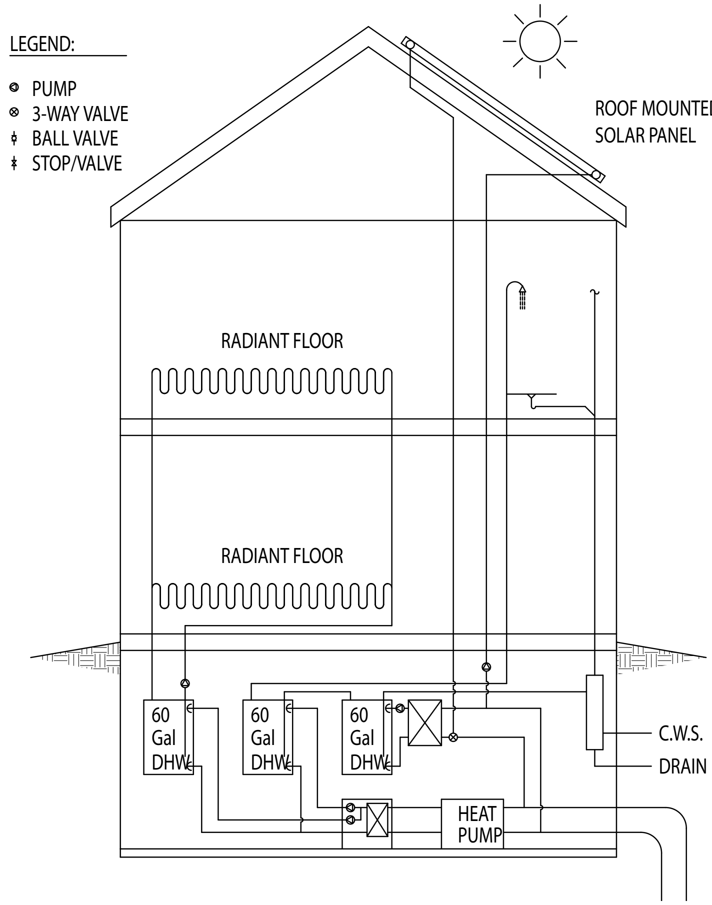
Example of a combination system for Solar pool, DHW, and space heating.

Aaron Goldwater

2.11.2 Combination of Solar Water Heating with Ground Source Heating (Geothermal)

Geothermal systems can be designed to provide space heating and cooling as well as domestic hot water. However, in many cases the geothermal systems aren't designed to provide domestic hot water. A simple integration between a solar water heater and a geothermal system can improve the winter performance of a SDHW system. A geothermal system contains a pump assembly internal to it that can take some of the heat gained in the winter and circulate it through the drain and cold water inlet of the solar storage tank to provide as much as 50% of domestic hot water needs in the colder months. This combination with solar and geothermal is a perfect compliment because of the lower performance of solar water heaters in the winter months due to the colder weather and shorter periods of solar radiation.

Another option for combining the systems is to take the solar thermal energy and pump it into the ground loop thereby increasing the temperature and performance of the geothermal system. In this case, careful consideration must be made to make use of or dispose of excess solar energy in the summer months when pumping solar radiation into the ground loop would have a negative effect on the efficiency of the geothermal system when cooling is desired.



Conceptual diagram integrating solar thermal with geothermal

Al Davies

Appendix F: Cost of Systems Dependant on Scale

Values are to be used as a guide only: Prices are averages based on specific project variables, individual prices will vary based on many variables illustrated in Section 5.4

Exclusive Ownership: Residential DHW		
System Components		
Collectors (2 x 3m^2)		$2,300.00
Piping, Controllers, and Heat Transfer		$2,250.00
	Total	$4,550.00
Installation		
Basic Installation (one-story, angled south-facing)		$1,000.00
Average Additional Requirements		$700.00
	Total	$1,700.00
Total System Cost		$6,250.00
Cost per m^2		**$1,042**
Bulk Purchase (50 identical systems)**: Residential DHW**		
System Components		
Collectors (50 x 2 x 3m^2)		$115,000.00
Piping, Controllers, and Heat Transfer		$112,500.00
Quantity Discount = 13%*		-$29,575.00
	Total	$197,925.00
Installation		
Basic Installation		$50,000.00
Average Additional Requirements		$35,000.00
Quantity Discount for Similar Installations		variable
	Total	$85,000.00
Total Systems Cost		$282,925.00
Cost per m^2		**$943.08**
Co-operative: Remotely Sited Project (Servicing approx. 300 people)		
System Components		
Commercial Collectors (100 x 3m^2)		$115,000.00
Quantity Discount on Collectors = 13%*		-$14,950.00
Property Lease		variable
Storage Tank		$4,000.00
Piping and Insulation		$6,500.00
High Efficiency Boiler		$17,500.00
Integration Piping or Equipment		$1,500.00
Heat Transfer Equipment		$60,000.00
Metering Equipment		$4,000.00
	Total	$193,550.00
Installation		
Project Planning & Development		$15,000.00
Installation		$40,000.00
Bracket Mounting		$10,000.00
	Total	$65,000.00
Total System Cost		$258,550.00
Cost per m^2		**$861.83**

*** Discount is based on the average discount offered by large-scale Canadian installers, and can only be achieved if the installer is the manufacturer. If the contract is with a private enterprise performing only installations, the maximum quantity discount that can be expected would be approximately 5%.**

Appendix G: Ontario Energy Co-operatives and Compliance with the "Business with Members Rule"

The original design for energy co-operatives contemplated a distribution of electrons (measured in kilowatt-hours) to co-op members in proportion to the amount of money invested in the co-op – essentially, a pre-purchase by the member of a proportionate share of the project's generation, for the life of the project.

This was to be accomplished by a credit to be given for the number of electrons generated for that member, on the member's utility bill, and an annual billing to members for their share of the costs of generation – maintenance, insurance, etc.

This approach was revised when it became apparent that, although the design of the open market for electricity did, in theory, provide for such delivery, in practice, such delivery was not feasible, or possible.

The original design was therefore modified to use money as the exchange medium, rather than the direct delivery of electrons – in return for their investment (or pre-purchase), members will be paid their proportionate share of the net revenue from the co-operative's sale of electrons into the electricity grid, which members would then apply to purchase equivalent electrons from the grid. This achieves the same result as the original design.

The volume of business, in an energy co-op, is the amount of energy "pre-purchased" through the financial investment – for practical purposes, by the purchase of a class of preference or membership shares designated for such purpose. To be effective, the maximum purchase of that designated class of shares should be linked, in a concrete way, to the value of the electricity consumed by the member.

Accordingly, a formula to establish the maximum permitted purchase of the designated class of shares should appear in the articles or bylaws, and the offering statement – a simple calculation of the present value of, say, 20 years' electricity costs to the member at today's rate of consumption.

Distribution on the basis of that pre-purchase is a distribution on the basis of patronage, even if done, for practical purposes, by way of dividends on shares.

For any questions regarding this requirement, please contact Brian Iler (biler@ilercampbell.com).

Appendix H: Solar Thermal System Sensitivity Analysis and Cash Flow using RETScreen

The following chart illustrates the sensitivity of Return on Investment (ROI) based on different levels of solar energy production (RE delivered), the initial cost of the system, and the annual costs for operation/maintenance. The example used is a typical SDHW system for a Family of 4 where the solar fraction is 60% of the hot water needs in a household using a conventional natural gas water heater, and the system initial cost is $5,750.

RETScreen© Sensitivity and Risk Analysis – Solar Water Heating Project

Use sensitivity analysis sheet?	Yes	Perform analysis on	After-tax IRR and ROI
Perform risk analysis too?	No	Sensitivity range	50%
Project name	Family of 4	Threshold	10.0 %
Project location	Toronto, ON, Canada		

Click here to Calculate Sensitivity Analysis

Sensitivity Analysis for After-tax IRR and ROI

RE delivered (MWh)		Avoided cost of heating energy ($/m³) 0.2600 -50%	0.3900 -25%	**0.5200** 0%	0.6500 25%	0.7800 50%
1.93	-50%	-1.5%	1.9%	4.3%	6.3%	8.0%
2.90	-25%	-1.9%	5.4%	8.0%	10.2%	12.1%
3.86	0%	4.3%	8.0%	**10.8%**	13.3%	15.5%
4.83	25%	6.3%	10.2%	13.3%	16.1%	18.6%
5.79	50%	8.0%	12.1%	15.5%	18.6%	21.5%

Initial costs ($)		Avoided cost of heating energy ($/m³) 0.2600 -50%	0.3900 -25%	**0.5200** 0%	0.6500 25%	0.7800 50%
2,875	-50%	9.7%	14.6%	18.7%	22.5%	26.1%
4,313	-25%	6.4%	10.5%	13.8%	16.6%	19.3%
5,750	0%	4.3%	8.0%	**10.8%**	13.3%	15.5%
7,188	25%	2.8%	6.2%	8.8%	11.1%	13.0%
8,625	50%	1.7%	4.9%	7.3%	9.4%	11.2%

Annual costs ($)		Avoided cost of heating energy ($/m³) 0.2600 -50%	0.3900 -25%	**0.5200** 0%	0.6500 25%	0.7800 50%
22	-50%	5.1%	8.5%	11.3%	13.8%	16.0%
33	-25%	4.7%	8.3%	11.1%	13.5%	15.7%
44	0%	4.3%	8.0%	**10.8%**	13.3%	15.5%
55	25%	4.0%	7.7%	10.6%	13.1%	15.3%
66	50%	3.6%	7.4%	10.4%	12.9%	15.1%

The following chart illustrates the sensitivity of Return on Investment (ROI) based on different levels of solar energy production (RE delivered), the initial cost of the system, the level of debt, changes in the debt interest rate, and the annual costs for operation/maintenance. It is for a large scale commercial system of 44 solar collectors on a multi-residential project with an initial capital cost of $90,000. The sensitivity analysis does not include any government funding available and is based on a contribution of 50% debt.

RETScreen© Sensitivity and Risk Analysis – Solar Water Heating Project

Use sensitivity analysis sheet?	Yes	Perform analysis on	After-tax IRR and ROI
Perform risk analysis too?	No	Sensitivity range	50%
Project name	Northshore	Threshold	10.0 %
Project location	Mississauga, ON, Canada		

Sensitivity Analysis for After-tax IRR and ROI

RE delivered (MWh)		Avoided cost of heating energy ($/m³) 0.2700 -50%	0.4050 -25%	**0.5400** 0%	0.6750 25%	0.8100 50%
58.66	-50%	-10.6%	-0.4%	4.4%	7.8%	10.7%
87.99	-25%	-0.4%	6.2%	10.7%	14.5%	17.9%
117.32	0%	4.4%	10.7%	**15.7%**	20.1%	24.3%
146.65	25%	7.8%	14.5%	20.1%	25.4%	30.5%
175.98	50%	10.7%	17.9%	24.3%	30.5%	36.6%

Initial costs ($)		Avoided cost of heating energy ($/m³) 0.2700 -50%	0.4050 -25%	**0.5400** 0%	0.6750 25%	0.8100 50%
45,742	-50%	13.2%	22.1%	30.3%	38.4%	46.6%
68,613	-25%	7.9%	14.9%	20.8%	26.3%	31.8%
91,485	0%	4.4%	10.7%	**15.7%**	20.1%	24.3%
114,356	25%	1.7%	7.8%	12.3%	16.2%	19.7%
137,227	50%	-0.6%	5.6%	9.8%	13.3%	16.5%

Annual costs ($)		Avoided cost of heating energy ($/m³) 0.2700 -50%	0.4050 -25%	**0.5400** 0%	0.6750 25%	0.8100 50%
537	-50%	6.0%	12.0%	16.8%	21.2%	25.4%
805	-25%	5.2%	11.4%	16.2%	20.6%	24.8%
1,074	0%	4.4%	10.7%	**15.7%**	20.1%	24.3%
1,342	25%	3.5%	10.1%	15.1%	19.6%	23.8%
1,610	50%	2.6%	9.5%	14.6%	19.1%	23.3%

Debt interest rate (%)		Debt ratio (%) 25.0% -50%	37.5% -25%	**50.0%** 0%	62.5% 25%	75.0% 50%
4.0%	-50%	14.8%	16.0%	17.6%	19.9%	23.8%
6.0%	-25%	14.4%	15.4%	16.7%	18.5%	21.4%
8.0%	0%	14.1%	14.8%	**15.7%**	17.0%	18.9%
10.0%	25%	13.7%	14.1%	14.7%	15.4%	16.5%
12.0%	50%	13.3%	13.4%	13.6%	13.9%	14.2%

Debt interest rate (%)		Debt term (yr) 5.0 -50%	7.5 -25%	**10.0** 0%	12.5 25%	15.0 50%
4.0%	-50%	16.0%	17.0%	17.6%	18.1%	18.4%
6.0%	-25%	15.4%	16.2%	16.7%	17.1%	17.4%
8.0%	0%	14.8%	15.3%	**15.7%**	16.1%	16.3%
10.0%	25%	14.2%	14.5%	14.7%	15.0%	15.1%
12.0%	50%	13.5%	13.6%	13.6%	13.9%	14.0%

Cash Flows for a 10-year and 25-year 50% Debt/Equity loan structure for the same large scale project. It takes into account a rise in energy prices of 8% yearly and a discount rate of 6%. In the case of the 25-year debt structure the cash flow is positive in year 1 and has a project NPV of $65,000 (greater than the initial cash investment of $45,000). However, with the 10-year loan, the cash flow is positive in year 2 but has a NPV of $108,000 over the lifetime of the project.

10-Year Loan – Yearly Cash Flows

Year #	Pre-tax $	After-tax $	Cumulative $
0	(45,742)	(45,742)	(45,742)
1	(147)	(147)	(45,890)
2	420	420	(45,470)
3	1,033	1,033	(44,436)
4	1,696	1,696	(42,740)
5	2,413	2,413	(40,327)
6	3,188	3,188	(37,139)
7	4,026	4,026	(33,113)
8	4,931	4,931	(28,183)
9	5,909	5,909	(22,273)
10	3,919	3,919	(18,354)
11	14,927	14,927	(3,427)
12	16,162	16,162	12,735
13	17,497	17,497	30,231
14	18,939	18,939	49,170
15	20,498	20,498	69,668
16	22,182	22,182	91,850
17	24,002	24,002	115,852
18	25,968	25,968	141,820
19	28,093	28,093	169,913
20	26,673	26,673	196,587
21	32,868	32,868	229,455
22	35,548	35,548	265,003
23	38,443	38,443	303,446
24	41,570	41,570	345,016
25	44,949	44,949	389,965

25-Year Loan – Yearly Cash Flows

Year #	Pre-tax $	After-tax $	Cumulative $
0	(45,742)	(45,742)	(45,742)
1	2,385	2,385	(43,358)
2	2,952	2,952	(40,406)
3	3,565	3,565	(36,841)
4	4,228	4,228	(32,612)
5	4,945	4,945	(27,668)
6	5,720	5,720	(21,948)
7	6,557	6,557	(15,390)
8	7,463	7,463	(7,928)
9	8,441	8,441	514
10	6,451	6,451	6,965
11	10,642	10,642	17,606
12	11,877	11,877	29,483
13	13,212	13,212	42,695
14	14,654	14,654	57,349
15	16,213	16,213	73,561
16	17,897	17,897	91,458
17	19,717	19,717	111,175
18	21,683	21,683	132,858
19	23,808	23,808	156,666
20	22,388	22,388	179,055
21	28,583	28,583	207,638
22	31,263	31,263	238,901
23	34,158	34,158	273,058
24	37,285	37,285	310,344
25	40,664	40,664	351,007

Suppliers and Installers

The Solar Thermal industry is new and growing quickly in North America so a list of suppliers and installers quickly becomes outdated. The most up-to-date resource for finding local Solar Thermal installers is the CanSIA index of Member Organizations (www.cansia.ca/directory). An additional source is the Government of Canada Business Directory Strategis, which contains an extensive list of renewable energy companies in the Canadian Company Compatibilities database (Appendix A6).

CanSIA offers solar thermal installer certification courses in order to provide consumers with a credible way to evaluate the credentials of SHW installers. CanSIA certifies Solar Thermal Installers, which can be found through their training website, at www.cansia.ca/training.asp

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