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# The Solar Envelope

by Shawna Henderson

There are over 7.9 million homes in Canada, only 2% of these are classed as 'new', that is, they were built after 1996. What this means is the bulk of Canadian housing is in need of upgrading, especially in terms of the insulating factors and the 'envelope'. Most houses in Canada also have asphalt shingles on the roof, which must be replaced regularly. These two facets of home ownership could both be improved by integrating solar thermal into the building envelope – where the roof (and/or wall) provides shelter and collects solar energy at the same time. These systems could reduce energy consumption at the household level by more than 50 percent. As well, proper integration of a solar collector system into the shell of a building could reduce the system costs and improve collector efficiency.

Reasonably-priced building integrated solar thermal (BIST) systems and assemblies that are geared to retrofit/renovation situations could help homeowners meet or exceed the federal One Tonne Challenge. BIST systems and assemblies would also have great applicability in new construction projects, and would dovetail with efforts by the Canadian Solar Industries Association and the Net Zero Energy Coalition to minimize fossil-fuel derived energy use in housing by 2025.[1]

Most thermal collector systems utilize between 30% and 50% of the peak available solar energy.[2] Depending on the efficiency of the building envelope, the location and the installation, that can translate into enough energy to supply 50% to 75% – or more – of the annual space and water heating needs of a house. Reducing the reliance of households on thermal resistance heat and fossil fuel-burning systems also reduces greenhouse gas emissions.

At a broader scale, widespread application of 'solar envelope' systems and assemblies would decrease capacity load requirements for utilities as while the potential for self-generated heat in emergency situations (blackouts, etc), where lives are put at risk. Generally, systems that deliver low (below 38°C/100°F) and medium temperatures (38°-93°C/100-200°F) heat match the needs of residential installations, while high temperature (up to 200°C/750°F) systems are more appropriate for large-scale applications that require process heat or steam.

Experimentation in building integrated solar thermal (BIST) systems started in the USA as early as the 1940's, however, Europe now leads the way in modelling and demonstrating various systems and assemblies. There are low and high temperature systems, unglazed and glazed collector systems, and now, systems that combine solar thermal and photovoltaics (PV). The PV/Thermal (PVT) systems are based on the fact that PV is more efficient with lower temperatures. Stripping the heat from a PV panel and using it for space and/or water heating should increase the available solar energy for both systems.

There are three general categories of products or systems that roughly correspond to the range of temperatures noted above. These are (from low to high supply temperature): metal roof or corrugated metal walls; roof slates or tiles and hidden collectors for flat roof/roof screens. Most of the systems that have been identified are integrated into the roof as opposed to the walls of houses.

One of the first documented BIST system designs in the 20th century was invented in the 1940s.[3] This early design incorporated water filled tanks attached to the roof and walls of a building and then glazed with hollow, evacuated glass blocks which were mortared together to form the outer skin of the building. In 1950 a patent was issued for an invention that used a fan to pull outside air from the top of a tobacco-curing barn into a conduit running along the bottom side of the roof. As the air moved through the conduit, it was warmed by the heat trapped in roof cavity. Also in 1950, a patent application was filed for a sawtooth roof that focused winter sun through several glazed apertures to heat ceiling panels filled with a phase change material. Summer sun was reflected away from the apertures.

In 1974, a patent was granted for a modular air-heating collector designed to nest together with other identical collectors. In 1975, a Swiss patent application was taken out on a solar collection system design "…for incorporation in a dwelling, especially in a tiled roof…". This was the first design where roofing tiles were used as the glazing for a thermal collector. As interest in solar energy grew in the 1970s, many homes and test facilities were built with integrated solar thermal systems. The Colorado State University Test Houses – capable of delivering 50 to 60% of the required winter heating load – represent a typical configuration with absorber plates and large glazing panels incorporated in the south-facing roof.

Throughout the last three decades, most BIST patents followed the general direction of the examples above, with variations in panel size, fluid conduit configurations glazing and other components. In the last decade, there have been some innovations that are pointing to a new generation of BIST roofing systems. Three types of systems are currently being developed: the transpired collector, a high temperature collector with focussing mirror integrated into the roof, and a solar roofing tile.

Research into building integrated solar applications is heading more towards combining photovoltaic and thermal solar collectors into one unit – the PV/Thermal or PVT system – that can be integrated into a building's rooftop or façade, combining two functions and improving the efficiency of both systems. It has been shown that PVT collectors require 38% less roof space than a combined system of PV panels and thermal collectors with the same efficiency yield.[4]

In combination with an effective seasonal storage, heat requirements can be met with solar collectors, while PV panels convert sunlight into the electricity necessary to run pumps, system controls and household electronics and lighting. However, A PV laminate not only produces electricity, but also heat. PV converts sunlight into electricity with an efficiency of about 10%. Since about 20% of the incident radiation is reflected; the remaining 70% is converted into heat. The temperature of PV panels can reach up to 70°C for high levels of irradiation. The question is whether it is possible to extract this heat from the panel and to put it to use, and what thermal efficiency can be achieved. An additional advantage is that the PV cell efficiency increases slightly when it is being cooled, which may result in an increase in electrical output for the PVT panel.

There are two types of PVT systems, the first is a glass-covered collector that produce high temperature heat with lower electrical yield, the second is an uncovered PV panel that produces lower temperature heat but has higher electrical performance. The basic concept PVT collector consists of a standard PV laminate that is connected to a standard sheet-and-tube type thermal absorber with an extra glass cover. This results in high temperature heat, which can be used directly for domestic hot water or space heating. When a heat pump is used in the energy system, solar heat of a lower temperature will be sufficient and uncovered panels can be used to produce this heat, in combination with higher electrical efficiency due to the lack of the extra cover. Different types of uncovered PVT panels are currently being investigated.

Other research is focused on the use of air as the heat transfer fluid and on the possibility of using semi-transparent PV panels in a PVT panel with a different geometry where the production of electrical and thermal energy take place in different locations in the panel.

Note: This is the first part of a two part article. Some of this article was printed in the last newsletter.

**Footnotes**

[1] www.cansia.ca see the link to the 25/25 program

[2] from www.americansolar.com

[3] Information on the history of BIST compiled from a presentation by John Archibald of the American Solar Roofing Company, made at the American Solar Energy Society's 1999 Conference, a full copy of the report can be found at www.americansolar.com/solar99.pdf

[4] Elwijk, M.J. et al, PV/T Collectors in Large Solar Thermal Systems, page 1

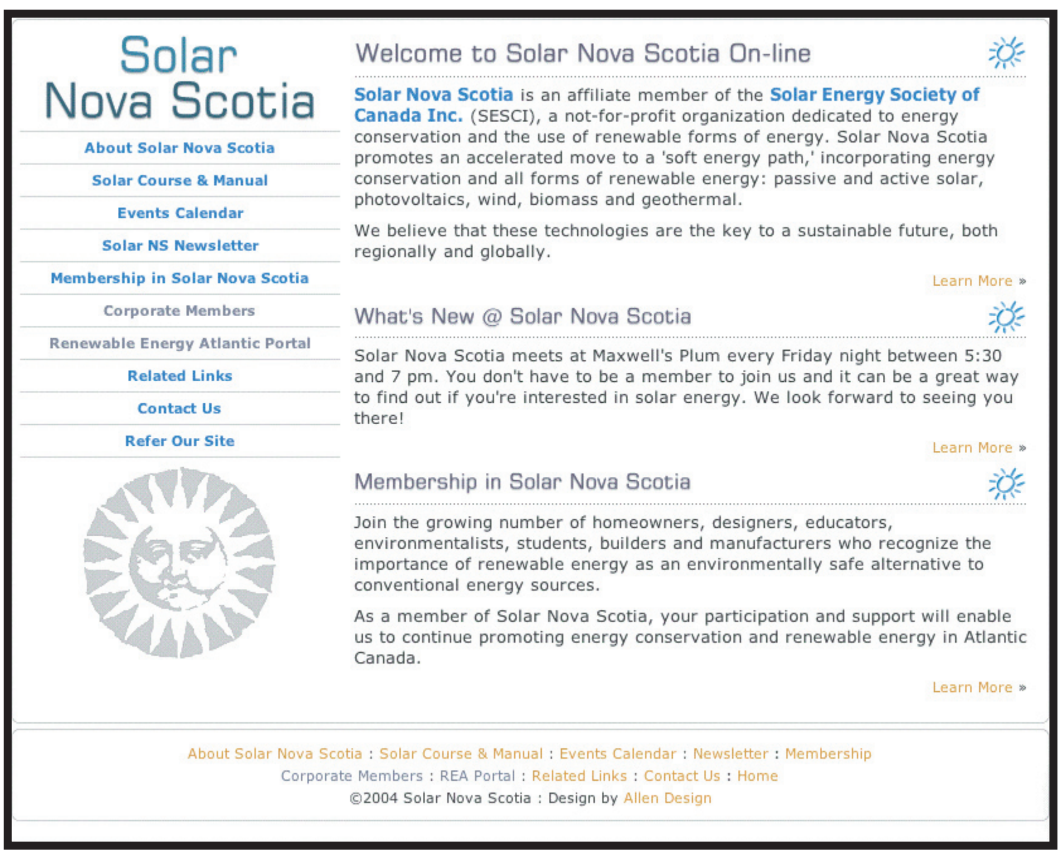
# Website News

By Daniel MacKay

If you haven't checked out the Solar Nova Scotia website recently, you should!

A year ago, your Board asked for portfolios from a number of webdesigners and picked ace web designer Aaron Allen. We worked with him to completely overhaul the look of the site.


The previous look was designed by Dalhousie Computer Science students Paul Awad and Wendy Butt in 1999, and although the price was right (a student project, free) and the design was functional and fun, it was time for a renovation.




The overall structure is the same, but the much-hated dancing icons have been dragged to the trashbin, and the look of the page has been moved from a "fun" theme to a more professional, informative and ... well, why don't you take a look yourself? The URL is on the front cover of the newsletter.

Please check out the updated supplier section of the webpage and, as always, try to patronize our corporate members.

If you have any suggestions about content for the website, the link to send us email is there too.

Our continuing thanks to Chebucto Community Network for hosting the site.

## Upcoming Events

Join us for the ***Spring Solar Tour*** on Sunday, April 17th from 2-5 pm. We will begin at a new active solar house complete with interior cistern and hydronic floor heating from roof-mounted arrays near Musquodoboit Harbour. The home is also off-grid with pv array and backup generator. Next we will visit Derek and Marta for a second time, because their home has been almost entirely redone. An initial Interhab home has been tripled in size and new heating systems added. This house is also offgrid. Both houses have lovely ocean views.

The tour is available only to Solar Nova Scotia members, but you can join on the tour. A potluck takes place at the last house, so bring something to share that keeps for a few hours. To reserve a spot and get directions, call Norval Collins at 455-8417 or Dan MacKay at 499-0488.

Join us every Friday afternoon at Maxwell's Plum Pub, Market & Sackville Streets, Halifax, 5:30 - 8:00 pm.

## solar shelter courses

Solar Nova Scotia offers a practical, how-to course on designing and building solar shelter, including greenhouses, solariums, additions and especially solar homes. The course includes solar basics, climate control, site designing, shelter designing, solar construction, and making it happen. The main instructor is Don Roscoe, one of Canada's most experienced solar designer-builders.

In Halifax, a two Saturday, all day course will be offered April 9th and 16th at the NSCC, Leeds St. Campus (formerly NSIT). Register with Solar Nova Scotia at 852-4758 or solardon@chebucto.ca.

Course fees are normally $80 for individuals and $140 for couples. The course includes handouts with an optional textbook for $15.

It has been a decade since the Solar Shelter Course has been taught outside Nova Scotia. This March that all changed. On Prince Edward Island an evolving solar group, in conjunction with UPEI, held a free Friday evening ***Solar Basics Talk*** followed by the weekend ***Solar Home Design Course***. The following weekend, this was repeated in Sackville N.B. through an environmental group, EOS Eco-energy, with Mount Allison University. Both events resulted in energetic crowded classes. This interest has lead to an upcoming ***Builders Workshop*** to be held in New Brunswick on April 23rd. Stay tuned.

## solar nova scotia membership form

name: ________________________________________

co. name: _____________________________________

address: ______________________________________

______________________________________________

postal code: ________________ phone: ____________

email: ________________________________________

membership fees:

- ❏ $10.00 unwaged/student
- ❏ $20.00 waged
- ❏ $75.00 corporate
- ❏ $10.00 SESCI members
- ❏ $_____ donation

Tell us what you are interested in:

- ❏ passive solar
- ❏ technical support
- ❏ promotion
- ❏ networking
- ❏ active solar
- ❏ education
- ❏ newsletter writing
- ❏ other: _______________

How did you find out about Solar Nova Scotia?

- ❏ print advertising
- ❏ radio or tv promo
- ❏ phone book
- ❏ home show
- ❏ earth festival
- ❏ solar shelter course
- ❏ friend
- ❏ other: _______________