

Final Report
Survey of Active Solar Thermal Collectors,
Industry and Markets in Canada (2005)



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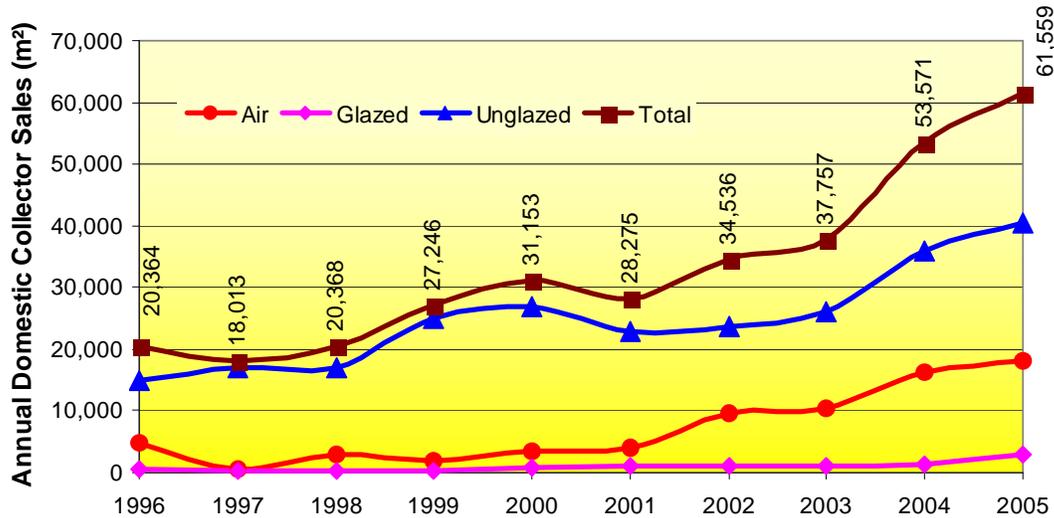
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EXECUTIVE SUMMARY

The Canadian solar thermal industry continued to show strong growth in 2005, with all three major product categories (air collectors, unglazed pool collectors and glazed collectors) showing growth annual rates ranging from 12% to 130%. The chart shows the growth of solar collector sales (m²) over the past ten years.



Optimism within the solar industry continues, with every company surveyed predicting further growth in 2006 and 2007. Actual domestic sales in 2005 totalled 61,558 m², as detailed below.

| <i>Domestic Sales</i> | |
|-----------------------|----------------------------------|
| Collector Type | Collector Area (m ²) |
| | 2005 |
| Air | 18,061 |
| Liquid Glazed/Evac. | 3,043 |
| Liquid Unglazed | 40,455 |
| Total | 61,559 |

Solar thermal systems in Canada continue to substantially decrease the amount of greenhouse gases generated in Canada. The estimated 418,897 m² of solar collectors operating in Canada during 2005 avoided the release of 27,383 tonnes of CO₂ into the Canadian atmosphere during 2005. This is an increase of 18% over the 23,208 tonnes avoided in 2004. Furthermore, the 61,558 m² of solar thermal collectors that were installed in 2005 will reduce Canada's GHG emissions by 112,849 tonnes over their predicted 20 – 30 year life.

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1 INTRODUCTION

This report provides results of a survey of active solar thermal collectors, industry and markets in Canada. The survey was commissioned by Natural Resources Canada (NRCan), in early 2006 and was undertaken by a consortium led by SAIC Canada and including the Canadian Solar Industries Association (CanSIA) and Simhan Research Associates (SRA). The survey covered the 2005 calendar year, building on a previous survey that covered 2002 through 2004.

NRCan's Renewable Energy Deployment Initiative (REDI) was launched in April 1998 to stimulate the demand for cost-effective renewable energy heating and cooling systems and help create a sustainable market for those systems. Active solar thermal systems (ASTSs), including air and water heating, represent two of the types of renewable energy technologies (RETs) presently supported by Natural Resources Canada's REDI program. These ASTSs can play a considerable role in the implementation of the climate change plan for Canada.

In part, this survey was undertaken in support of Canadian contributions to the solar heating market survey of the Solar Heating and Cooling Program of the International Energy Agency (IEA).

Solar thermal collectors are the key component of active solar energy systems. These collectors absorb energy from the sun's rays and convert it into thermal energy that can be used for water and space heating and cooling. Collectors are designed to meet the specific temperature requirements and climate conditions of each use.

The purpose of this study was to survey the Canadian active solar thermal collector industry to obtain data for the 2005 calendar year. The main objectives of the study were:

- To capture comprehensive and reliable information on market size and industry trends, including Canadian sales and revenues, import and export, and employment figures.
- To estimate delivered thermal energy and displaced CO₂ emissions of all active solar thermal systems operating in Canada.
- To analyze and report obtained data for publication and wider dissemination.

The Canadian solar thermal industry is a diverse, growing industry active across Canada, with roots going back to the mid-1970's. Five distinct types of solar collectors were sold in Canada in 2005:

1. Unglazed, liquid plastic collectors;
2. Unglazed, air collectors;
3. Glazed, liquid collectors;
4. Evacuated tube liquid collectors, and;
5. Glazed, air collectors.

Of these, evacuated tube collectors and glazed air collectors both had sales sufficiently small that releasing their sales figures risks the confidentiality of the survey data. For this reason, their sales data was combined with glazed liquid and unglazed air collectors, respectively.

As the solar collector designs are diverse, so are the applications. The latter include residential and commercial swimming pool heating, heating of ventilation and makeup air in industrial buildings, commercial buildings and livestock barns, heating of potable hot water in any style of building, from single family homes to large office complexes. Newer applications are coming into use, including residential space heating via radiant floor heating systems.

2 SURVEY PROCESS

2.1 Survey Development and Distribution

The survey questionnaire used for 2005 was very similar to the one used for the 2002 – 2004. Several questions were dropped, as they did not need to be repeated annually, and questions were adjusted to cover only a one year period. This resulted in a considerable simplification of the survey, with the number of questions being reduced from fifteen to eleven. Most of the remaining questions were exact duplicates of the earlier questionnaire, although minor adjustments were made to a few questions. The deletion of questions did result in a change to the numbering of the questions. (In this report, the question numbers used will be those from the 2005 survey.)

The 2004 survey was the first survey of its type in many years, and was thus distributed widely, to 268 recipients, including many small retailers, and some companies no longer in the solar thermal business. The 2005 survey was mailed out to 188 recipients, consisting of all those companies which were contacted during the 2004 survey, and indicated that they did have an interest in the solar thermal industry. Both to focus the survey effort, and to reduce the cost, a shorter list of recipients was developed for follow up. This more select group consisted of all companies that completed the 2004 survey, as well as any company thought to be involved in manufacturing or distribution. There was no follow up with the bulk of the 188 survey recipients, most of who were thought to be smaller retailers.

A copy of the questionnaire can be found in Appendix A.

2.2 Survey Response Rate

Sixteen completed surveys were received. Although this represents only 8.5% of the 188 surveys issued, it does represent a significant portion of the larger companies that were specifically targeted for follow up, and the results compare favourably with the 2004 survey. Although there were more respondents to the 2004 survey (32), the response to the 2005 survey compares favourably in several important categories:

- Collector manufacturers: 1 fewer;
- Component manufacturers: same;
- Wholesale distributor: 1 more;
- Companies with 1 – 4 employees: same;
- Companies with more than 4 employees: 1 fewer;
- Companies that derive more than 80% of revenue from solar: same.

The above would indicate that the useful response to the 2005 survey was at a similar level to the 2004 survey, even though the absolute numbers of respondents was down. The decrease in the number of respondents can be attributed to the fact that in 2005 the smaller retail companies received no follow up to encourage completion of the survey. Thus several companies with low sales volumes that completed the survey in 2004 did not complete the 2005 survey.

Of the sixteen companies that completed this survey, eleven also completed the previous survey. This allows for direct year-to-year comparison of a significant sample.

2.3 External Data Sources

In addition to the data received from survey respondents, data from external sources was sought, either to supplement or verify the survey data.

Both the U.S Energy Information Agency (EIA) and Canadian Spool & Spa Marketing (PSM) magazine have reported regular growth in Canadian sales of solar collectors over the past few years, including annual growth rates of 77% and 10%, respectively, in 2005. The EIA data includes all types of solar collectors exported to Canada; traditionally, the vast majority has been unglazed collectors. The PSM data includes only unglazed collectors used for pool heating, and has been calculated based on PSM's report of retail sales revenue.

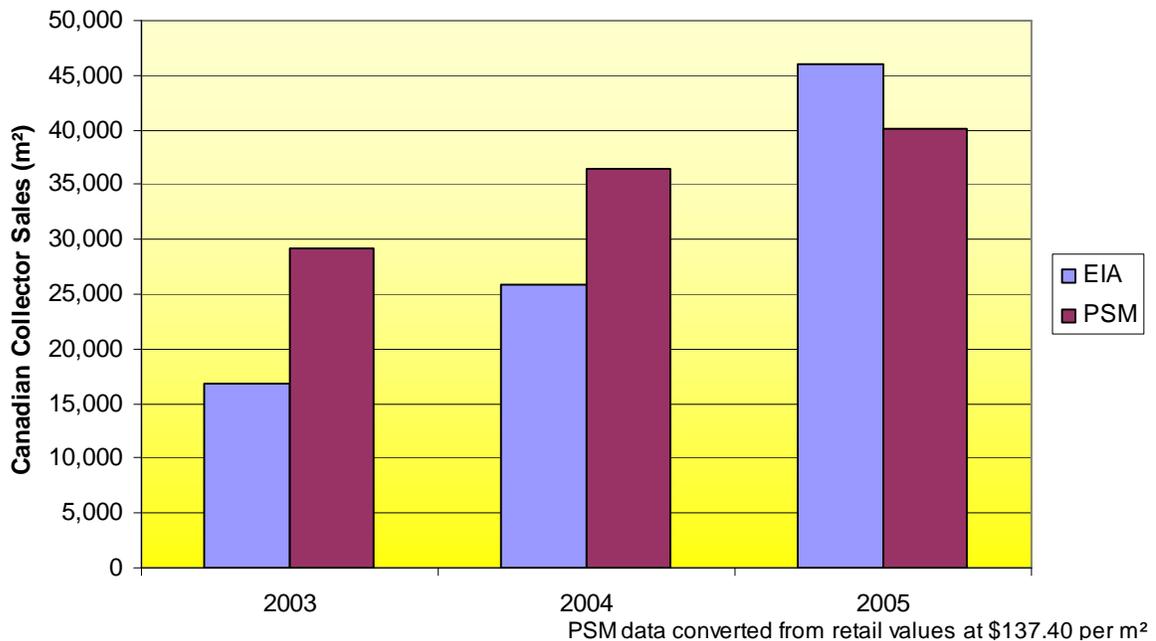


Figure 1: Collector sales from independent sources (m²)

2.4 Estimated Data Capture Rate

To properly estimate the size of the total solar thermal industry in Canada from the survey results, it is necessary to estimate the data capture rate of the survey. The data capture rate is separate from the survey response rate discussed in the preceding section. The survey response rate is based on the number of forms completed, with all businesses given equal weight, and can be accurately counted. The data capture rate is an estimate – never a count – of the fraction of the available data which was captured by the survey process. In effect, it is a weighted average of the survey response rate, where each business receives a weighting in accordance with its volume of business. The procedure of estimating the data

capture rate in this survey is complicated by the fact that there are at least three distinct market segments – and specialized businesses to serve them – within the solar thermal industry. Table 1 lists the three business segments, and the estimated data capture rate for each.

Table 1: Estimated data capture rates by business segment/collector type

| Business Segment | Description | Collector Types | Estimated Data Capture Rate |
|-------------------------|---|--------------------------|------------------------------------|
| Solar air heating | Heating of ventilation air. Primarily for commercial applications, with some residential. | Unglazed & glazed air | 100% |
| Outdoor pool heating | Heating of seasonal use, outdoor pools. Primarily residential, but including some seasonal use commercial facilities. | Unglazed liquid | <10% |
| General water heating | A wide range of applications including residential domestic hot water, indoor pool heating, and commercial water heating applications | Glazed liquid, Evacuated | 80% |

In estimating the above data capture rates, the survey team reviewed historical data on the Canadian solar thermal industry, as well as current data from other sources, along with the survey completion rate. The justification for these data capture rates can be summarized as follows:

- Solar air heating: This segment of the industry is uniquely strong in Canada, compared to other nations, so most collectors installed in Canada are manufactured and sold by a very small number of Canadian-based companies. A review of the 2005 data reveals that it is likely that all major companies active in this sector completed the survey.
- Outdoor pool heating: This segment of the industry is very diverse, with much of the product distribution going through pool industry channels. There are several major manufacturers in both the U.S. and Canada, with shipments going both ways across the border. Our response rate from this industry appears very low, so for this segment of the industry we have relied heavily on sources of information outside of this formal survey process (U.S. EIA survey of solar exports, PSM magazine), using the survey responses to supplement this other data.
- General water heating: This segment of the industry uses a mix of Canadian-made collectors, from a handful of manufacturers, and imported collectors from several sources. Distribution is primarily through specialty “solar” channels. Comparing the

survey data to other information sources (e.g. knowledge of larger installations) leads us to believe that we have captured the majority – but by no means all – of this sector.

Important Note

In the body of this report, **all** quantified information (e.g. area of collector shipments; value of sales) have had the estimated data capture rates from Table 1 applied, to correct from the raw survey data.

3 SURVEY RESULTS

3.1 Industry Characterization

Figure 2: Sector involvement within the solar thermal industry

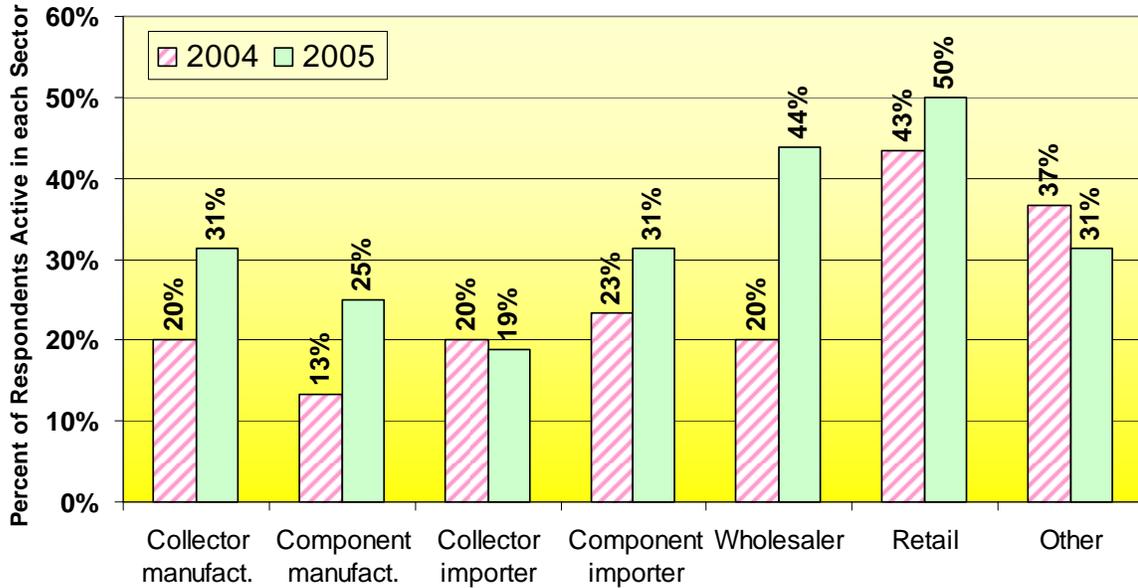


Figure 3: Solar thermal revenue as a percent of total corporate revenue

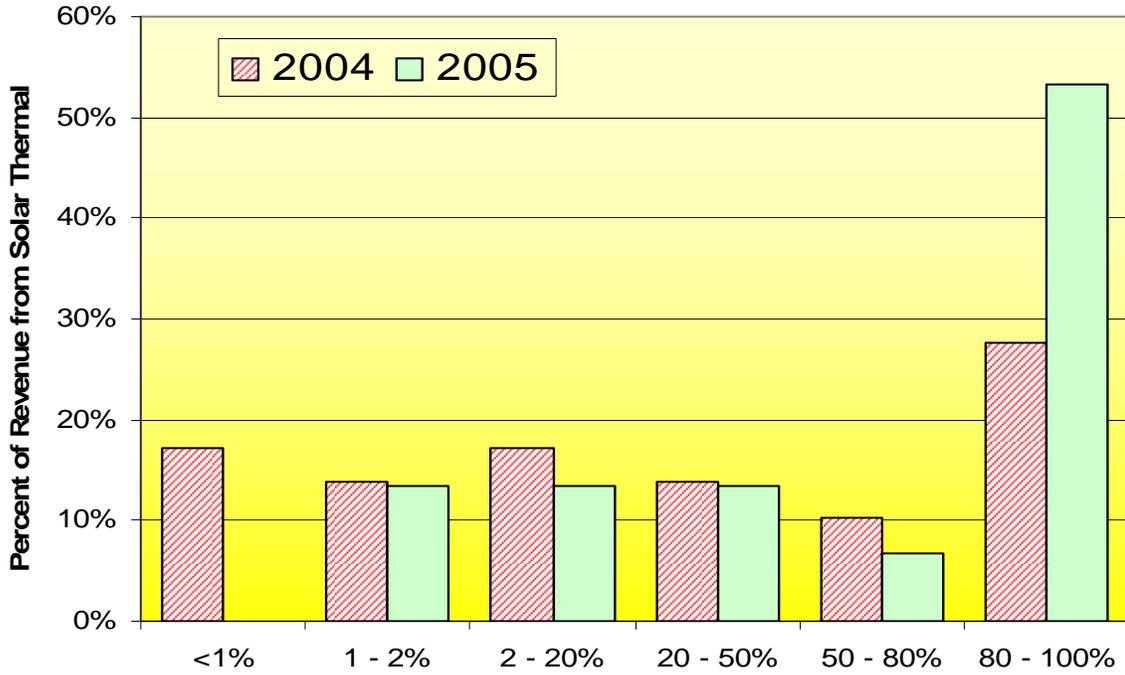
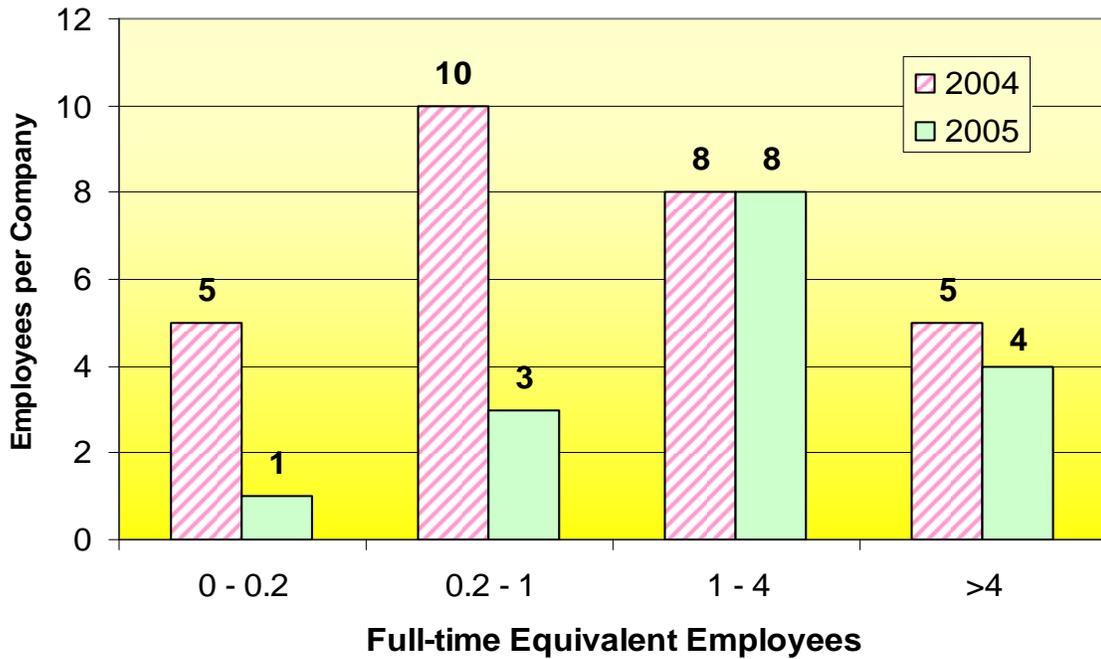


Figure 4: Number of ST employees per company



3.2 Industry Size and Growth

The pace of solar collector sales in Canada – of all types of collectors - continues to grow. Table 2 provides summary of solar collector sales, both for domestic and export sales, for 2004 and 2005. Figure 5 shows year-over-year growth rates, by collector area, for 2005.

The 2005 growth continues a trend that has been developing over the past several years. Refer to Figure 6 for a summary of industry growth over the past ten years.

Table 2: Solar collector sales by type, 2004 and 2005

| <i>Domestic Sales</i> | | Thermal Capacity (MW) | | Collector Area (m ²) | | Revenue (\$1,000's) | |
|-----------------------|-------------|-----------------------|---------------|----------------------------------|----------------|---------------------|--|
| Collector Type | 2004 | 2005 | 2004 | 2005 | 2004 | 2005 | |
| Air | 11.3 | 12.6 | 16,196 | 18,061 | \$2,354 | \$1,316 | |
| Liquid Glazed/Evac. | 0.9 | 2.1 | 1,325 | 3,043 | \$1,568 | \$1,812 | |
| Liquid Unglazed | 25.2 | 28.3 | 36,050 | 40,455 | \$2,199 | \$3,845 | |
| Total | 37.5 | 58.5 | 53,571 | 61,559 | \$6,121 | \$6,973 | |

| <i>Export Sales</i> | | Thermal Capacity (MW) | | Collector Area (m ²) | | Revenue (\$1,000's) | |
|---------------------|-------------|-----------------------|---------------|----------------------------------|----------------|---------------------|--|
| Collector Type | 2004 | 2005 | 2004 | 2005 | 2004 | 2005 | |
| Air | 1.2 | 2.1 | 1,698 | 3,054 | \$117 | \$421 | |
| Liquid Glazed/Evac. | 0.5 | 1.0 | 749 | 1,428 | \$345 | \$658 | |
| Liquid Unglazed | 14.0 | 7.1 | 20,024 | 10,010 | \$665 | \$333 | |
| Total | 15.7 | 18.2 | 22,471 | 17,822 | \$1,127 | \$1,412 | |

| <i>Total Sales</i> | | Thermal Capacity (MW) | | Collector Area (m ²) | | Revenue (\$1,000's) | |
|---------------------|-------------|-----------------------|---------------|----------------------------------|----------------|---------------------|--|
| Collector Type | 2004 | 2005 | 2004 | 2005 | 2004 | 2005 | |
| Air | 12.5 | 14.8 | 17,894 | 21,115 | \$2,471 | \$1,737 | |
| Liquid Glazed/Evac. | 1.5 | 3.1 | 2,074 | 4,471 | \$1,914 | \$2,469 | |
| Liquid Unglazed | 39.3 | 35.4 | 56,074 | 50,556 | \$2,864 | \$4,179 | |
| Total | 53.2 | 76.6 | 76,042 | 109,840 | \$7,249 | \$8,385 | |

There are several distinct differences between the 2004 and 2005 data reported in Table 2. While some of these may result from changes in the market, it is likely that some are simply a result of the relatively small sample size in both 2004 and 2005. This is particularly true of data related to unglazed, pool-type collectors, for which the survey's data capture rate was low in 2004, and even lower in 2005. Specific incidences include:

- Domestic shipments of air collectors, by area, increased, but the revenue dropped substantially.
- Domestic shipments of glazed liquid collectors more than doubled, but revenue increased by only ~40%.
- The level of unglazed liquid (pool) collector sales was determined indirectly from independent sources, rather than from the survey responses, as too few responses were received.

Figure 5: Annual domestic sales growth by collector type (m²)

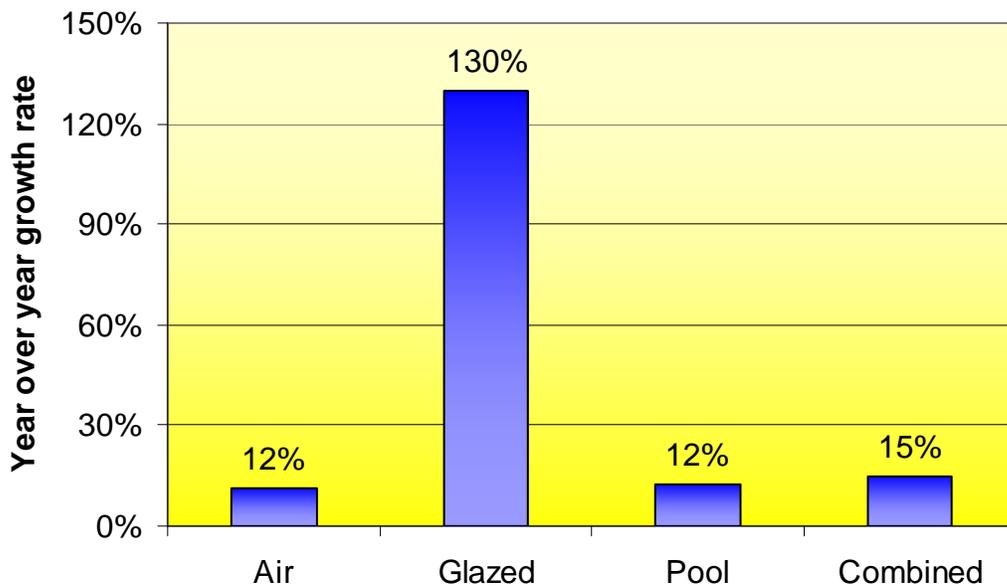
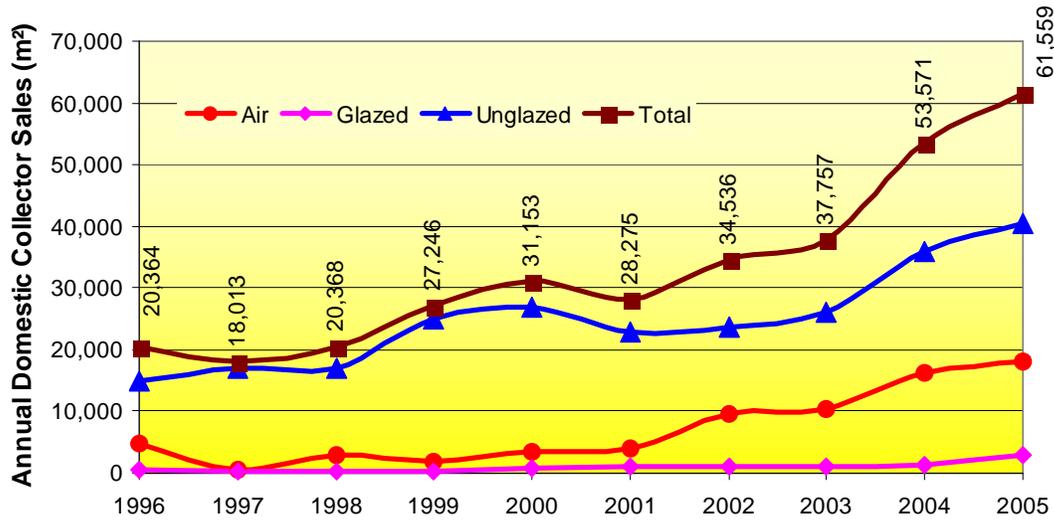


Figure 6: Ten-year history of domestic collector sales (m²)



3.3 Applications of Solar Thermal Technology

Respondents were asked to provide details of the types of systems where solar collectors were being employed. Table 3 provides the breakdown by sector and by application. Only major applications are listed; namely, those that were responsible for more than 10% of the reported revenue (in either 2004 or 2005), for that particular collector type.

The data show, unglazed liquid collectors have a very clear market focus – residential swimming pool heating – while the air collector market is concentrated on ICI space heating. For glazed and evacuated tube collectors, the market focus is on domestic water heating (72%, combined residential and ICI), with most of the balance being sold into residential space heating applications.

Table 3: Major solar heating applications (by revenue), by sector and collector type

| Revenue by Sector | Unglazed | | Glazed/Evac. | | Air | |
|---|----------|------|--------------|------|------|------|
| | 2004 | 2005 | 2004 | 2005 | 2004 | 2005 |
| Residential | 98% | 100% | 86% | 64% | 8% | 8% |
| Industrial/Commercial/Institutional (ICI) | 2% | 0% | 14% | 36% | 92% | 92% |

| Revenue by Solar Heating Application | Unglazed | | Glazed/Evac. | | Air | |
|--|----------|------|--------------|------|------|------|
| | 2004 | 2005 | 2004 | 2005 | 2004 | 2005 |
| Residential pool heating | 97% | 100% | | | | |
| Residential domestic water heating | | | 62% | 56% | | |
| Residential space heating | | | 5% | 21% | | |
| Residential combined space and water heating | | | 19% | 2% | | |
| ICI domestic water heating | | | 13% | 16% | | |
| ICI space heating | | | | | 77% | 91% |

3.4 Geographic Distribution

Table 4 shows the distribution of solar collector sales within Canada, by revenue. Figure 7 shows the same data, also expressed on a population basis. This data reveals substantial markets in all regions of Canada, except the north. Since no northern companies completed the survey, this should not be taken as conclusive evidence that there is no market in Canada's northern territories. It is also noteworthy that while there is a substantial market for solar collectors in Ontario, on a population basis they spend substantially less than people in other regions.

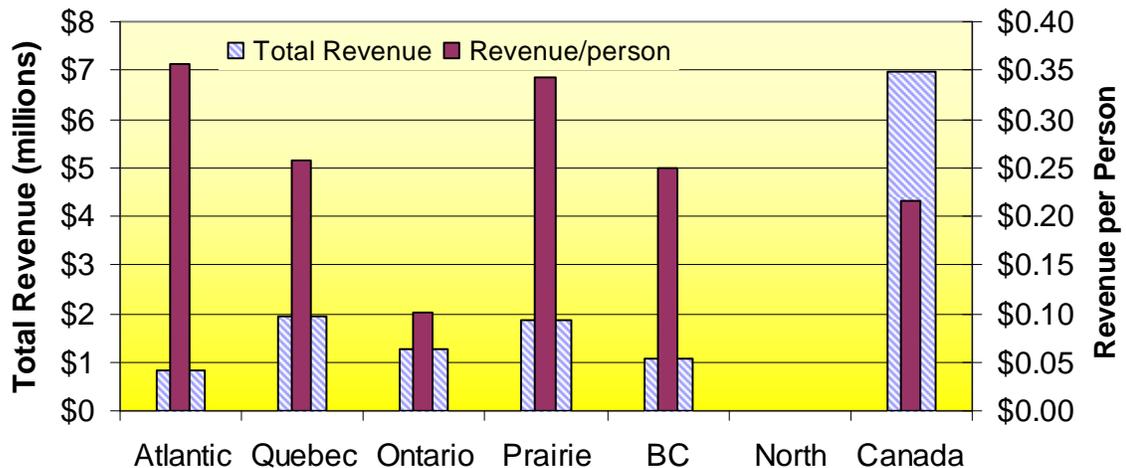
On average, each Canadian spent 22¢ on solar thermal collectors in 2005, up from less than 20¢ in 2004. This is a clear indication that the solar thermal market in Canada is not yet well developed.

Table 4: Distribution of sales within Canada

| | Region | Sales (\$1,000) | Sales (%) |
|-------------|--------------|-----------------|-------------|
| 2004 | Atlantic | 88 | 1.4% |
| | Ontario | 1,849 | 30.2% |
| | Quebec | 2,988 | 48.8% |
| | Prairies | 463 | 7.6% |
| | BC | 733 | 12.0% |
| | North | 0 | 0.0% |
| | Total | 6,121 | 100% |

| | | | |
|-------------|--------------|--------------|-------------|
| 2005 | Atlantic | 837 | 12.0% |
| | Ontario | 1,265 | 18.1% |
| | Quebec | 1,949 | 28.0% |
| | Prairies | 1,864 | 26.7% |
| | BC | 1,058 | 15.2% |
| | North | 0 | 0.0% |
| | Total | 6,973 | 100% |

Figure 7: 2004 solar collector sales, by population



3.4.1 Exports and Imports

Canadian exports of solar collectors continue to grow. In 2005 one company that had reported zero exports in 2004 reported some export revenue, and export revenue increased in all four areas to which exports were reported (USA, Europe, Asia and Central/South America).

Comparative data for 2004 and 2005 is presented in Table 5. It should be noted that the survey questions regarding exports were simplified in the 2005 survey; thus there may be systemic differences in how the respondents reported, and direct year-to-year comparisons may not be appropriate. Also, the number of respondents replying to questions on exports, so the small sample size may introduce errors in this data.

Table 5: Annual exports - collector area and value

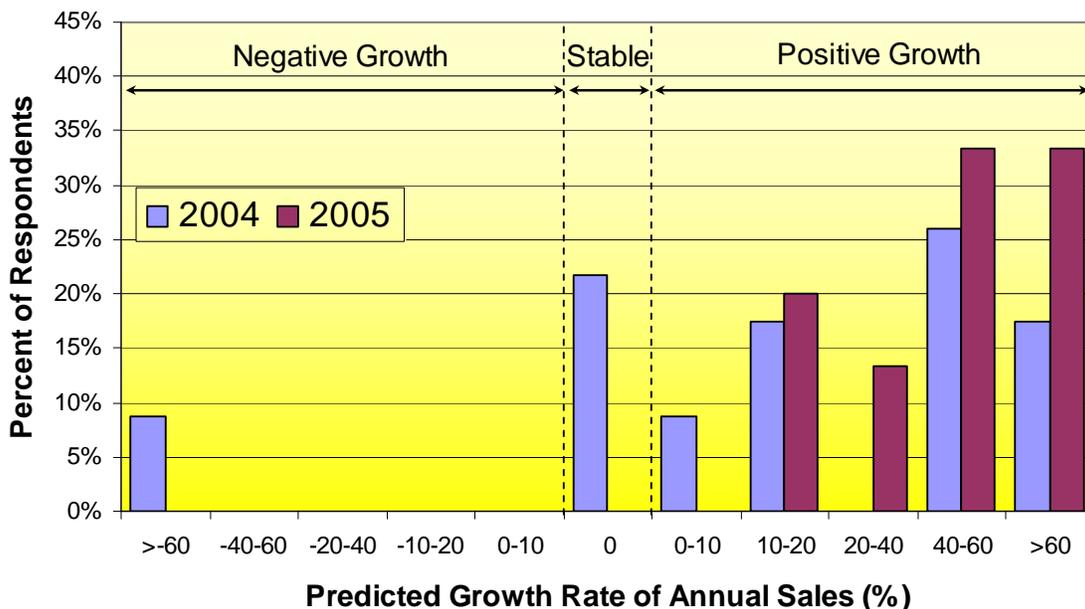
| Collector Area Exported (m ²) | 2004 | 2005 |
|---|---------------|---------------|
| Air | 1,698 | 3,054 |
| Liquid Glazed & Evacuated | 749 | 1,428 |
| Liquid Unglazed | 20,024 | 10,101 |
| Total | 22,471 | 14,583 |

| Value of Solar Thermal Exports | 2004 | 2005 |
|--------------------------------|--------------------|--------------------|
| Air | \$117,000 | \$421,000 |
| Liquid Glazed & Evacuated | \$345,000 | \$658,000 |
| Liquid Unglazed | \$665,000 | \$333,000 |
| Total | \$1,127,000 | \$1,412,000 |

3.5 Anticipated Sales Growth

Optimism continues within the solar thermal industry, with a weighted average expectation for 60% annual growth rates, and all respondents expecting annual growth in excess of 10%. Figure 8 shows the range of survey responses, indicating a strong expectation of growth over the next two years.

Figure 8: Anticipated sales growth in 2006 and 2007



4 ESTIMATE OF AVOIDED GREENHOUSE GAS EMISSIONS

4.1 Background

Estimating GHG emissions avoided due to solar thermal installations in Canada is a complex issue that involves estimating the operational effectiveness of all solar heating systems in Canada, the fuel that they displace, and the location of the systems within Canada, among other variables. These variables cannot all be known with precision. With the sponsorship of the IEA, Weiss *et al* developed a methodology for estimated GHG avoidance, using a system of reference solar heating systems. This methodology was adopted, with some modifications, for use on earlier Canadian data, and is described in detail in last year's report (ref 1). A summary of the reference system definitions follows.

Figure 9 shows an historical record of installed, operational solar collectors. This data – showing 419,000 m² of solar collectors operating in Canada at the end of 2005 – was used in calculating the amount of GHG's avoided due to the use of active solar thermal energy in Canada.

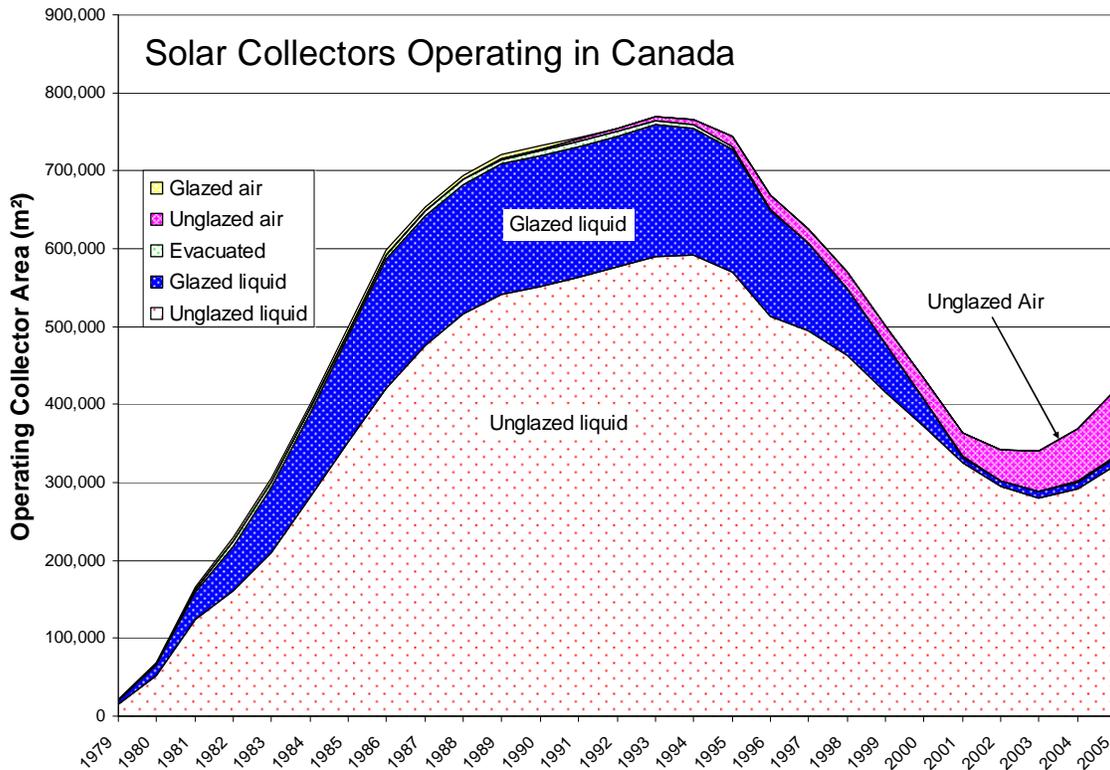


Figure 9: History of Operating Solar Collectors in Canada

4.2 Reference System Definitions

Weiss developed four reference systems in his work on estimating avoided GHG emissions, but only three of these four were applicable within Canada. We have chosen to use the

same three systems, albeit with some adjustments to reflect the Canadian market, plus a fourth – commercial air.

Residential DHW – This system is identical to Weiss’ solar domestic hot water systems for single family houses in Canada. It represents a typical solar DHW preheat system consisting of two 4’ x 8’ (6 m²) glazed solar collectors, 150 L/d hot water usage*, with a 300 L hot water storage tank. Commercial marketing material indicates that each system will produce about 50% of the energy required for hot water in a home, on an annual basis.

Commercial Water – This system is essentially a new name for Weiss’ solar domestic hot water systems for multi-family houses and district heating, retaining many of its features. This incorporates all larger scale systems with glazed, liquid collectors, covering applications from institutional or multi-residential DHW, to municipal indoor pool heating, to process water at car washes, laundries or other facilities. As with Weiss, the reference system consists of 50 m² of collectors, 2,000 L/d hot water draw and a 2,500 L storage tank.

Residential Pool – This system is identical to Weiss, except that the collector area has been reduced from 200 m² to 25 m², to more closely reflect the Canadian market (5-6 nominal 4’ x 12’ collectors per system). This reduction in size has little impact on the GHG analysis, but it does affect the calculation of the number of systems. Note that this reference system covers all unglazed, liquid-type collectors, and thus does include seasonal municipal or resort pools, which may have collector areas of 50 – 300 m². However, these commercial pools constitute well below 5% of the Canadian market, and they do perform similarly to the more common residential pools.

Commercial Air – This is a new reference system, based on the successful use of unglazed air collectors for preheating ventilation and makeup air in industrial, commercial and agricultural (livestock barns) applications. Within Canada, this is a strong market sector, and cannot be ignored. System sizes vary widely from below 50 m² to 10,000 m². For a reference system we have selected 200 m², because it is within the size range for both agricultural and industrial/commercial/institutional sectors, and should provide a reasonable estimate of the mean size of all systems.

4.3 GHG Emission Avoidance Calculations

Table 6 shows the calculations used to estimate the GHG emissions avoided due to all solar thermal systems operating in Canada at the end of 2005.

Table 6: Analysis of avoided GHG emissions, using four reference systems, 2005

| Parameter | Residential DHW | Commercial Water | Residential Pool | Commercial Air |
|----------------|-----------------|------------------|------------------|----------------|
| Collector type | glazed | glazed | unglazed | unglazed air |

* The 150 L/d hot water usage used by Weiss is probably low for Canadian practice, but we chose to keep this value for consistency with international reports. Using a larger hot water draw (~225 L/d is more typical of actual hot water usage in Canada) would have increased the estimate of GHG avoided, but since DHW heating systems are a small segment of the Canadian market, the overall effect would be negligible.

| | | | | |
|--|---------------|--------------|----------------|---------------|
| Collector area (m ²) | 6 | 50 | 25 | 200 |
| Annual yield per system (GJ/a) | 9.9 | 82.1 | 19.4 | 422 |
| Specific annual yield (GJ/a-m ²) | 1.65 | 1.64 | 0.78 | 2.11 |
| <u>Displaced fuel mix (%)</u> | | | | |
| • Oil (73 kg of CO ₂ /GJ) | 4% | 15% | 1% | 5% |
| • Natural gas (50 kg of CO ₂ /GJ) | 50% | 75% | 63% | 50% |
| • Propane (60 kg of CO ₂ /GJ) | -- | 5% | -- | 40% |
| • Electricity (151 kg of CO ₂ /GJ) | 46% | 5% | 12% | 5% |
| • Heat pump (38 kg of CO ₂ /GJ) | -- | -- | 24% | -- |
| • No fuel | -- | -- | -- | -- |
| Blended CO ₂ avoided (kg of CO ₂ /GJ) | 97 | 59 | 59 | 60 |
| Annual CO ₂ avoided (t/a-system) | 0.96 | 4.84 | 1.14 | 25.3 |
| Annual specific CO ₂ avoided (kg/a-m ²) | 160 | 97 | 46 | 127 |
| Estimated system life (years) | 20 | 20 | 20 | 30 |
| Total operating collector area (m ²) | 9,236 | 3,000 | 321,381 | 85,280 |
| Calculated number of systems | 1,539 | 60 | 12,855 | 426 |
| Total annual CO ₂ avoided (t/a) | 1,478 | 291 | 14,784 | 10,831 |
| Total annual CO ₂ avoided, all types (t/a) | 27,383 | | | |

4.4 Forecast GHG Emission Avoidance from Collectors sold in 2005

An alternative view of GHG emission avoidance - and one that is more representative of the current sales rate of solar thermal systems, rather than past sales - is to estimate the total GHG's that will be avoided over the operating life of systems installed in the current year. Applying the same calculations in the previous section to the 61,558 m² of collectors installed in Canada during 2005, leads to the conclusion that 112,849 tonnes of CO₂ equivalent will be saved over the lifetime of these systems (using a 20 year expected life for all water systems and a 30 year life for commercial air systems). Since the solar industry earned almost seven million dollars in revenue from domestic sales in 2005, this means that one tonne of CO₂ is saved for every \$60 of revenue (neglecting any service and repair revenue that may be earned over the life of the systems). Depending upon climatic conditions and displaced fuel data in the country of use, it is likely that the solar collectors exported from Canada during 2005 will be responsible for avoiding another 30,000 tonnes of CO₂ equivalent, during their operating life.

5 REFERENCES

- 1) McClung, Larry *et al*, August 2005, ***Final Report Survey of Active Solar Thermal Collectors, Industry and Markets in Canada***, SAIC Canada report no. CM001743.
- 2) Mayes, Fred *et al*, July 2005. ***Renewable Energy Trends 2004: With Preliminary Data for 2004***. Energy Information Administration, Office of Coal, Nuclear, Electric and Alternate Fuels, U.S. Department of Energy.
- 3) Mayes, Fred *et al*, July 2005. ***Renewable Energy Trends 2005: With Preliminary Data for 2005***. Energy Information Administration, Office of Coal, Nuclear, Electric and Alternate Fuels, U.S. Department of Energy.
- 4) Omboli, Eugène and McClenahan, Doug, 2002, ***NRCan In-house Survey of Solar Collectors for 1995 – 2001***, Natural Resources Canada.
- 5) Weiss, Werner; Bergmann, Irene and Faninger, Gerhard, February 2004. ***Solar Heating Worldwide: Markets and Contribution to the Energy Supply 2001***. IEA Solar Heating & Cooling Program.
- 6) Hubbard, Richard, 2005, ***Canadian Swimming Pool Industry: 2004 Market Report***, Pool & Spa Marketing, spring 2005.
- 7) Hubbard, Richard, 2006, ***Canadian Swimming Pool Industry: 2005 Market Report***, Pool & Spa Marketing, spring 2006.
- 8) Energy, Mines and Resources Canada, ***Energy in Canada 1986 Handbook***
- 9) Sibbitt, Bruce, 2006, a summary of recent REDI-supported solar thermal installations in Canada, private communication

APPENDIX A – Survey Questionnaire



Canadian Solar Industries Association
L'Association des Industries Solaires du Canada

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1-866-522-6742
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**SURVEY OF THE COMMERCIAL ACTIVITIES IN THE
ACTIVE SOLAR THERMAL INDUSTRY IN CANADA**

February 14, 2006

Dear solar industry colleague,

Last year at this time, the Canadian Solar Industries Association (CanSIA) assisted in an industry survey sponsored by Natural Resources Canada. Many of you completed the survey forms, and for this we thank you. The results of this effort were presented at the CanSIA conference in November 2005 and a summary is included in this mailing. Among the findings of this survey:

- In 2004, the Canadian solar thermal market grew by over 40%, almost double the 22% increase in the U.S. market, and well above most other IEA member countries.
- In the past three years, the total capacity of solar thermal collectors operating in Canada increased by over 50%, from 170 MW_{TH} in 2001 to 258 MW_{TH} in 2004.
- The revenue earned by the solar industry in Quebec is now more than double the Canadian average, on a per capita basis, due to the recent growth in systems using air collectors.

For those of you who wish to review last year's survey results in more detail, the complete report is available for download from the REDI website:

English: <http://www2.nrcan.gc.ca/es/erb/erb/english/View.asp?x=469&oid=1183>

The questionnaire for this year's survey is enclosed. CanSIA believes that a sound information base is one of our most effective tools for influencing government actions and public opinion and I would encourage you to complete this form before the due date of March 31. I realize that this survey is arriving at a busy time of year, but it is important to provide timely information to Canada's public policy makers. The questionnaire has been shortened and simplified from last year's survey.

CanSIA has carefully reviewed the process of data collection to insure that strict confidentiality is maintained. NRCan, CanSIA and the survey analysis only receive aggregated total results and your individual firm's data will not be released to anyone. SAIC has developed a confidentiality protocol (available on request) which I feel will insure the confidentiality of your information.

I thank you for your participation in this important initiative and I believe it will be an invaluable tool for the industry in developing long term plans for its growth in the future.

Yours truly,

Rob McMonagle
Executive Director

ID No.

To be assigned during processing

Questionnaire

Solar Thermal Collector Survey

Calendar Year 2005

Please note that, for the purpose of this survey, active Solar Thermal (ST) includes activity pertaining to solar collector-based systems only. Any solar technology that does not incorporate manufactured solar collectors – such as most passive solar applications – is beyond the scope of this survey.

Please enter company contact information:

COMPANY _____

ADDRESS _____

NAME _____

TITLE _____

TELEPHONE _____

FAX _____

E-MAIL _____

DEADLINE FOR COMPLETION IS MARCH 31, 2006

Completed surveys should be returned to:

Sandi Mish
SAIC Canada
Suite 1516, 60 Queen Street
Ottawa, Ontario
K1P 5Y7

Tel: (613) 563-7242
Fax: (613) 563-3399
toll-free number: 1-888-SAIC-CAN

e-mail: mishs@saiccanada.com

1. Please provide some profile information pertaining to your Solar Thermal business. Which of the following business segments were/are applicable to your organization for the calendar years 2004 and 2005?

| Business Segments | 2004 | 2005 |
|--|--------------------------|--------------------------|
| a. ST Collector Manufacturer | <input type="checkbox"/> | <input type="checkbox"/> |
| b. ST System Component Manufacturer | <input type="checkbox"/> | <input type="checkbox"/> |
| c. ST Collector Importer | <input type="checkbox"/> | <input type="checkbox"/> |
| d. ST System Components Importer | <input type="checkbox"/> | <input type="checkbox"/> |
| e. Wholesale Distributor | <input type="checkbox"/> | <input type="checkbox"/> |
| f. Retailer/installer | <input type="checkbox"/> | <input type="checkbox"/> |
| g. Other: Design/consulting services: Please describe: | <input type="checkbox"/> | <input type="checkbox"/> |

2. a) Please estimate the time spent on ST activities of all employees (full and part-time), and contractors, to provide the number of full-time employee equivalents.

_____ Person-years in 2005

- b) Including full-time, part-time and seasonal staff, but excluding contractors, what was the peak number of persons employed at any single time during 2005? _____

3. In 2005, what proportion of your organization's total revenue was from active solar thermal business?
_____ %

4. In addition to solar thermal, please indicate if your business was involved in any of the following business segments in 2005. Check all that apply in the left column; in the right column, check only one, and only if you would describe one of these as your primary area of business.

| Business Segments | Some Involvement | Primary Business |
|---|--------------------------|--------------------------|
| Other renewable energy (e.g. PV, wind, wood stoves, etc.) | <input type="checkbox"/> | <input type="checkbox"/> |
| Swimming pool sales and installation | <input type="checkbox"/> | <input type="checkbox"/> |
| Plumbing contractor | <input type="checkbox"/> | <input type="checkbox"/> |
| HVAC contractor | <input type="checkbox"/> | <input type="checkbox"/> |
| HVAC equipment manufacturer or distributor | <input type="checkbox"/> | <input type="checkbox"/> |
| Building contractor | <input type="checkbox"/> | <input type="checkbox"/> |
| Other building trades | <input type="checkbox"/> | <input type="checkbox"/> |
| Other | <input type="checkbox"/> | <input type="checkbox"/> |

5. Please report your total revenue earned from solar thermal activities, and then provide the percentage of this revenue that was earned from various types of sales. For this table, please include all types of revenue related to ST activities (e.g. product sales, service contracts, installation fees, consulting revenues).

| | |
|--|----|
| Total Sales Revenue from Solar Thermal Activities | \$ |
|--|----|

| Revenue from All Export Sales | Revenue from Sales to Domestic Re-sellers | Revenue from Sales Direct to Domestic End Users | Revenue from Other Sales |
|-------------------------------|---|---|--------------------------|
| % | % | % | % |

6. Compared to this year, does your organization expect more, less or about the same revenues in the ST collector and components sales and services area over the next 2 years?

- Remain the same
- Increase by _____% average per year
- Decrease by _____% average per year

ID No.

To be assigned during processing

7. Please report collector sales in two units, square metres and dollars. If your business involved the sale of complete systems, or related services or components along with solar collectors, please report the total revenue earned for the sale, in the most appropriate column.

| Sales | Collector Type | | | | |
|-------------------------------------|----------------|----------|---------------|--------|----------|
| | <i>Air</i> | | <i>Liquid</i> | | |
| | Glazed | Unglazed | Evacuated | Glazed | Unglazed |
| Collector area (m ²) | | | | | |
| Revenue (\$) | | | | | |

8. Please provide a percentage distribution, by collector type, of dollar sales by application. If you were wholesaling the product to re-sellers, and are unaware of the final application, please report these shipments in the “unknown” category.

| Sector | Application | Collector Type | | | | |
|--|---------------------------------------|----------------|----------|---------------|--------|----------|
| | | <i>Air</i> | | <i>Liquid</i> | | |
| | | Glazed | Unglazed | Evacuated | Glazed | Unglazed |
| Residential | Pool | % | % | % | % | % |
| | DHW | % | % | % | % | % |
| | Space | % | % | % | % | % |
| | Combined/other (includes hot tubs) | % | % | % | % | % |
| Industrial/ Commercial/ Institutional | Pool | % | % | % | % | % |
| | DHW | % | % | % | % | % |
| | Process heat | % | % | % | % | % |
| | Space heat | % | % | % | % | % |
| | Combined/other | % | % | % | % | % |
| Unknown/Wholesale | | % | % | % | % | % |
| Total | | 100% | 100% | 100% | 100% | 100% |

9. Please provide details on the geographic area to which the ST Collectors were shipped/sold. Within each region, please report the distribution of collector types, by percentage. **Example:** *If you sold \$40,000 of liquid unglazed collectors plus \$10,000 of liquid glazed collectors into the Atlantic region, report regional sales as \$50,000, and then write 80% beside "liq-UNGL" and 20% beside "liq-GLAZ".*

| Domestic Sales | | | Export Sales | | |
|--------------------|--------------|----------|--|--------------|----------|
| Region | Revenue (\$) | Type (%) | Region | Revenue (\$) | Type (%) |
| Atlantic Provinces | | air-GLAZ | United States | | air-GLAZ |
| | | air-UNGL | | | air-UNGL |
| | | liq-EVAC | | | liq-EVAC |
| | | liq-GLAZ | | | liq-GLAZ |
| | | liq-UNGL | | | liq-UNGL |
| Ontario | | air-GLAZ | Central & South America, Mexico, Caribbean | | air-GLAZ |
| | | air-UNGL | | | air-UNGL |
| | | liq-EVAC | | | liq-EVAC |
| | | liq-GLAZ | | | liq-GLAZ |
| | | liq-UNGL | | | liq-UNGL |
| Quebec | | air-GLAZ | Europe | | air-GLAZ |
| | | air-UNGL | | | air-UNGL |
| | | liq-EVAC | | | liq-EVAC |
| | | liq-GLAZ | | | liq-GLAZ |
| | | liq-UNGL | | | liq-UNGL |
| Prairie Provinces | | air-GLAZ | Asia, Middle East | | air-GLAZ |
| | | air-UNGL | | | air-UNGL |
| | | liq-EVAC | | | liq-EVAC |
| | | liq-GLAZ | | | liq-GLAZ |
| | | liq-UNGL | | | liq-UNGL |
| British Columbia | | air-GLAZ | Africa | | air-GLAZ |
| | | air-UNGL | | | air-UNGL |
| | | liq-EVAC | | | liq-EVAC |
| | | liq-GLAZ | | | liq-GLAZ |
| | | liq-UNGL | | | liq-UNGL |
| Northern | | air-GLAZ | Australia, New Zealand, Oceania | | air-GLAZ |
| | | air-UNGL | | | air-UNGL |
| | | liq-EVAC | | | liq-EVAC |
| | | liq-GLAZ | | | liq-GLAZ |
| | | liq-UNGL | | | liq-UNGL |

ID No.

To be assigned during processing

10. Please list your sources of ST collectors, including in-house manufacturing. For calculation purposes, use dollar value of ST collectors from all sources for the year as 100%. Use an additional sheet, if needed.

| Collector Source | Collector Type(s) [†] | Supplier Name | Supplier Location* | % of total supply |
|---------------------------------|--------------------------------|---------------|--------------------|-------------------|
| Manufactured In-house | | n/a | n/a | |
| Purchased Within Canada | | | | |
| | | | | |
| | | | | |
| | | | | |
| Purchased Outside Canada | | | | |
| | | | | |
| | | | | |
| | | | | |
| Total | | | | 100% |

[†] Please use the five collector types used in questions 7, 8 and 9.

* Please use a Canadian or global region from the table in question 9 (e.g. Atlantic provinces).

11. Have there been any changes in your business during 2005 (e.g. merger, acquisition, etc.) that have had a significant impact on solar thermal sales from previous years? If so, please describe the change briefly.

Instructions

Solar Thermal Collector Survey

Calendar Year 2005

General Instructions and Explanations

1. If your firm earns no revenue from solar thermal activities, please complete the company details section on page 1, write “no ST business” on it, and fax page 1 to SAIC Canada. Your company name will be removed from the survey distribution list for future years.
2. All responses should be by calendar year, not fiscal year.
3. All dollar values should exclude sales taxes.
4. All dollar values may be rounded off to the nearest thousand.
5. To determine the date a sale occurred, please use the date that you booked the revenue for the sale (e.g., the invoice date).

Instructions and Explanations Relating to Individual Questions

- Q4 If you check the “other” category for either “some involvement” or “primary business”, it is not necessary to indicate the nature of this business.
- Q5 This is the only question that requests revenue data for purely service or other non-collector related sales.
- Q7-10 If your business does not sell solar collectors, you may skip questions 7 through 10.
- Q7 The revenue figures in this table should exclude any revenue that is not associated with a particular collector type (e.g. a study of various solar heating projects). Thus the total of all revenue values in this table may be lower than the total revenue reported in Q5.
- Q8 Note that the values in each column must add to 100%, which should equate to the revenue reported by collector type in Q7.
If you sold collectors to a re-seller, please report by the location of the re-seller, not the ultimate destination of the products.
- Q9
 - Atlantic – Newfoundland, Nova Scotia, Prince Edward Island & New Brunswick
 - Prairie – Manitoba, Saskatchewan & Alberta
 - Northern – Yukon, North West Territories & Nunavut
- Q10 Please note that this question is asking for the source of purchased, completed solar collectors, whether imported or purchased domestically. If you manufacture solar collectors, it is not necessary to report the source of the various materials.

Inquiries

If you have questions about any facet of this survey, please direct them to the SAIC Canada employee identified on page 1 of the survey document.

Confidentiality Protocol:

Project Name: Solar Thermal Industry Survey

Version #: 2

Plan Date: January 7, 2005

SAIC Project Number: 10806.B.01

CM Number: 001712

Plan Sign-Off

| | | |
|----------------------------|---------------|--------------------|
| Protocol Review by: | _____ | Date: _____ |
| | Larry McClung | |
| Protocol Audit by: | _____ | Date: _____ |
| | Ken Donovan | |
| Project Manager: | _____ | Date: _____ |
| | Bill Wong | |

A. Protocol management plan

A-1 Project scope and requirements

This document defines the procedure for handling completed surveys and the data that they contain, after they are received by SAIC Canada (in paper form), and of any electronic or hardcopy documents derived from the survey documents. The primary purpose of this protocol is to ensure confidentiality of the data supplied by individual respondents.

A-2 Approach

Natural Resources Canada (as the commissioning agent), SAIC Canada (as the prime contractor), and Simhan Research Associates and CanSIA (as subcontractors) all recognize the absolute necessity of maintaining the confidentiality of data submitted by respondents to the solar thermal collector survey. This protocol, detailing how the data will be handled, has been developed to ensure that the strictest confidentiality is maintained throughout the data gathering and reporting process.

An essential element for ensuring confidentiality is the physical arrangement of the Ottawa area offices of SAIC Canada. SAIC Canada maintains two widely separated offices in the Ottawa area, at 335 River Road South and at 60 Queen Street. The River Road facility houses the staff of the Renewable Energy and Climate Change Program, who oversaw the development of the survey, and who will be involved in analysis and reporting of aggregate data, but who will have no access to sensitive data such as individual survey responses. The survey responses are to be sent directly to our Queen Street facility, where a small number of the staff have been specifically trained to handle the sensitive survey data, and deliver it to authorized staff of Simhan Research, an independent subcontractor who will analyze and aggregate the data into reports that contain no sensitive information. These reports will be the only survey data available to the staff of SAIC's Renewable Energy and Climate Change Program, to CanSIA staff, and to NRCan.

A-3 Definitions

A “completed survey” shall be considered any survey document (paper) received from a respondent that contains one or more answers, complete or partial, to any of the survey questions.

The “survey log” is a password-protected, electronic file that cross-references the survey respondent’s administrative information with their assigned ID number. It resides on a computer at SAIC Canada’s 60 Queen Street facility, and is backed up following standard procedures.

The “survey database” is a password-protected, electronic file containing all survey data. It resides on a computer at the offices of Simhan Research Associates, and is backed up following standard procedures.

The “secure file area” refers to a locked, restricted access filing facility located at SAIC Canada’s 60 Queen Street facility.

A-4 Project team structure.

Completed surveys are to be handled only by persons specifically authorized in the following table (“authorized personnel”), and only for the purposes outlined within this document. No other person shall be permitted to handle or view any portion of the completed surveys.

| Role | Personnel |
|--------------------------|--|
| Survey administrator | <ul style="list-style-type: none">• Sandi Mish, SAIC Canada• Gerry Clermont, SAIC Canada |
| Survey assistant analyst | <ul style="list-style-type: none">• Anna Mastilovic, SAIC Canada• Monica Hornof, SAIC Canada |
| Survey chief analyst | <ul style="list-style-type: none">• Vasantha Narasimhan, Simhan Research Associates• Perfecto Vélez Macho, Simhan Research Associates |
| Protocol Auditor | <ul style="list-style-type: none">• Ken Donovan, SAIC Canada |

B. Permissions and Restrictions

1. Only the listed administrators and assistant analysts have permission to access or view the originals of the completed surveys.
2. Only the listed administrators and assistant analysts have permission to produce a photocopy of a completed survey, and only one photocopy of a completed survey shall exist at any time.
3. Only the listed administrators and assistant analysts have permission to access or view the survey log.
4. No hardcopy of the survey log shall be permitted, unless it is either filed in the secure area, or destroyed by the individual who created it, prior to the close of business on the day it was created.
5. Only listed administrators, assistant analysts and chief analysts are permitted to access or view any data from a single respondent, or any aggregate data that is from a sufficiently small sample that identification of data from individual respondents becomes a risk.
6. Only the listed chief analysts shall access the survey database.
7. All SAIC Canada employees who are members of the Renewable Energy and Climate Change Program are specifically prohibited from any access to sensitive survey data.
8. Similarly, all NRCan staff and all CanSIA staff are specifically prohibited from any access to sensitive survey data.
9. Notwithstanding any of the above, the auditor is permitted to access any and all documents judged necessary to verify compliance with this protocol.

C. Project operations plan.

C-1 Procedures during the survey process.

| Step | Task Description | Responsibility |
|------|--|-------------------|
| 1 | Receive and open completed surveys. Assign respondent ID number, and enter on every page of the survey original. Enter respondent's data into the survey log. | Administrator |
| 2 | Ensure that respondent's name and contact info appear only on page 1 of the original. Produce a single photocopy, omitting page 1. File the original document in the secure file area. | Administrator |
| 3 | Review the photocopy for completeness and readability. | Assistant Analyst |
| 4 | Issue acknowledgement of receipt to the respondent, requesting clarifications or additions, if necessary. | Assistant Analyst |
| 5 | Enter data into the database; produce and analyze preliminary reports. | Chief Analyst |
| 6 | Review data for consistency. Request assistant analysts to perform additional follow up with respondents, as necessary. | Chief Analyst |
| 7 | Request clarifications and/or additional data from respondents, as necessary. | Assistant Analyst |
| 8 | Once sufficient data is entered to ensure the confidentiality of individual respondents, produce consolidated reports to share with the full survey team. | Chief Analyst |
| 9 | Verify compliance with this protocol. | Auditor |

C-2 Survey Wrap-up Procedures.

| Step | Task Description | Responsibility |
|------|---|-------------------|
| 1 | Make two electronic copies of the survey database (on CD or other suitable media) and delete all electronic versions of the survey database. | Chief Analyst |
| 2 | Return both copies of the survey database, along with all copies of completed surveys, to SAIC Canada's facility at 60 Queen Street. | Chief Analyst |
| 3 | Destroy the photocopies of all completed surveys. Record destruction in the survey log. | Assistant Analyst |
| 4 | Make two electronic copies (on CD or other suitable media), plus one hardcopy, of the survey log. | Administrator |
| 5 | File the copies of the survey database and the survey log in the secure filing area | Administrator |
| 6 | The survey auditor is to issue a report evaluating compliance with this protocol. This report will be included with the final project report. | Auditor |
| 7 | The original copies of the completed surveys, and the copies of the survey log and the survey database, are to be kept for two years after project completion, after which they will be destroyed. Originators to be informed of destruction of material. | Administrator |