



Survey of Active Solar Thermal Collectors, Industry and Markets in Canada (2017)

FINAL REPORT:

Report presented to:
Dr. Reda Djebbar
Natural Resources Canada

Report prepared by:
ClearSky Advisors Inc.

Acknowledgements

The funding for this report was provided by Natural Resources Canada. Dr. Reda Djebbar was the technical authority for this work.

We gratefully acknowledge the contributions of Doug McClenahan, along with Dr. Djebbar, both of Natural Resources Canada, who provided invaluable assistance to this project. We also acknowledge the cooperation and assistance of the staff of the Canadian Solar Industries Association (CanSIA).

Most importantly, we acknowledge all of those people within the Canadian solar thermal industry who took the time to complete the survey questions. Without your ongoing cooperation, this survey would be impossible.

Any reference to trade names or commercial products in this document does not constitute a recommendation or endorsement for use by Natural Resources Canada.

For more information on this survey report and related inquiries, please contact:

Dr. Reda Djebbar
CanmetENERGY
Natural Resources Canada
580 Booth Street
Ottawa, Ontario
K1A 0E4
Email: rdjebbar@nrcan.gc.ca

Executive Summary

This report is a summary of a survey of the Canadian solar thermal industry covering the 2017 calendar year, conducted between January and March 2017.

The Canadian solar thermal industry experienced a decrease in terms of top-line revenue and collector area in 2017 versus 2016. From a revenue standpoint, domestic revenue dropped 37% while export revenue decreased 47%, resulting in a total market decline of 41%. Total industry revenue in 2017 was \$6.2 million compared to \$10.6 million in 2016. Collector sales dropped from 69,645 m² in 2016 to 45,083 m² in 2017. It should be noted that the small size of the Canadian solar thermal market is making it increasingly susceptible to the fortunes of individual companies and projects, particularly for technologies that focus on the commercial sector. Moreover, the residential sector is susceptible to a myriad of factors and most residential technologies experienced declines in both 2016 and 2017.

When the Canadian domestic market is analyzed by collector type, it becomes clear that all technologies were impacted by the industry downturn. All collector types experienced declines in 2017. The air glazed market segment experienced a continued weakness, showing an 86% decline (collector area). Liquid glazed declined at 50% (vs. 51% in 2016). The liquid evacuated and air unglazed market segments decreased at 52% and 36% respectively, and the air unglazed segment experienced a 36% decrease in domestic revenue. The liquid unglazed market also experienced a significant decline at 25% when compared to 3% in 2016. All figures in this paragraph refer to collector area.

On a national basis, Ontario remained the largest market in 2017, representing 34 % of all domestic revenue generated by the industry in 2017, a decrease from 51 % in 2016. The Atlantic region maintained its position as the largest market in terms of revenue per capita, however, at \$ 0.34 per capita. The Prairie and Atlantic provinces both accounted for 20% domestic revenue, with Quebec following at 19%.

Industry optimism was not high. Most respondents felt that the industry is continuing to decline and there is not much lower to go, although it should be noted that similar sentiments were expressed in previous years. Indeed, 94% of respondents expect no growth or small declines over the next two years. It should be noted that many of those respondents had experienced declines of the vast majority of their business in previous years and now consider themselves at the bottom of the market.

Table of Contents

Acknowledgements	i
Executive Summary	ii
List of Tables.....	iv
List of Figures	iv
1. Introduction	5
1.1. Comparison to Earlier Surveys.....	5
2. Survey Process	6
2.1. Survey Development and Distribution.....	6
2.2. Estimated Data Capture Rates and Comparison to 2016 Survey.....	6
3. Survey Results.....	7
3.1. Industry Characterization	7
3.2. Industry Size and Growth.....	9
3.3. Applications of Solar Thermal Technology	12
3.4. Geographical Distribution.....	13
3.4.1. Domestic Sales	13
3.4.3. Exports.....	14
3.5. Anticipated Sales Growth	15
3.6. Sales of Packaged Systems.....	16
4. Estimate of Avoided Greenhouse Gas Emissions.....	17
4.1. Background	17
4.2. Reference System Definitions.....	18
4.3. GHG Emissions Avoidance Calculations.....	19
4.4. Forecast GHG Emission Avoidance from Collectors sold in 2017	20
5. Conclusions	20
6. References	22
Appendix A - Survey Questionnaire (English).....	23

List of Tables

Table 1: Solar collector sales by type (2016 and 2017).	9
Table 2: Solar heating collector type by sector (2016 and 2017).	12
Table 3: Solar heating collector type by application (2016 and 2017).	12
Table 4: Regional distribution of solar thermal exports, by revenue (2016 and 2017).	14
Table 5: Solar thermal collector exports, by revenue (2016 and 2017).	14
Table 6: Domestic sales of packaged residential systems (2016 and 2017).	16
Table 7: Analysis of avoided GHG emissions, 2017.	19

List of Figures

Figure 1: Sector involvement within the solar thermal industry.....	7
Figure 2: Respondent activity by collector type.....	7
Figure 3: Solar thermal revenue as a percentage of total corporate revenue (2016 and 2017).....	8
Figure 4: Number of employees per company engaged in solar thermal activities (2016 and 2017).....	8
Figure 5: Collector area growth rates by collector type (2016 and 2017).	10
Figure 6: Historical annual domestic collector sales (m2).	11
Figure 7: Canadian solar thermal industry revenue growth.....	11
Figure 8: Regional solar collector sales (2017).	13
Figure 9: Regional distribution of domestic revenue (2017).....	13
Figure 10: Estimate of future sales growth.	15
Figure 11: History of operating solar thermal collectors in Canada.	17
Figure 13: Market share of five collector types by total revenue in 2017.	21

1. Introduction

This report provides the results of a survey of the solar thermal industry in Canada covering the calendar year of 2017. The survey was commissioned by Natural Resources Canada (NRCan), and was undertaken by ClearSky Advisors. This survey is a continuation of annual surveys going back to 2002.

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 to help create a sustainable market for those systems. The ecoENERGY for Renewable Heat program replaced the REDI program in 2006, and ended on March 31, 2011. Active solar thermal systems, including air and water heating, represent two of the types of renewable energy technologies previously supported by the ecoENERGY program.

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).

The purpose of this study was to survey the Canadian active solar thermal collector industry to obtain data for the 2017 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.

Survey respondents were asked a series of questions about employment, revenue, sales by collector area, and detailed breakdowns of sales by five collector types: unglazed air, glazed air, evacuated tube (liquid), unglazed liquid, and glazed liquid.

1.1. Comparison to Earlier Surveys

Comparisons to data from previous surveys are made throughout this report. Note that the identity of companies responding to the survey varies from year to year, and therefore may introduce some uncertainty in the comparisons. All attempts were made to ensure that the underlying methodology for analysis of the 2017 survey data remained consistent with past surveys.

The reader should also be aware that the authors of this report are not aware of which companies responded to the survey in any particular year. To protect commercially sensitive information, access to individual responses was limited to only select members of the survey team. Outside staff members of ClearSky Advisors and all staff members of NRCan have no access to either the individual survey responses or the identity of companies who submit responses.

2. Survey Process

2.1. Survey Development and Distribution

In January 2017, a bilingual survey was sent by email to over one hundred Canadian companies believed to be active in the solar thermal industry. The survey could be completed online, or returned by email, fax, or regular mail. The companies were then contacted by phone to confirm receipt of the survey, and to encourage them to respond. Most respondents completed the survey online.

A copy of the survey may be found in Appendix A.

2.2. Estimated Data Capture Rates and Comparison to 2016 Survey

This study involved three phases:

- 1) Data collection
- 2) Analysis
- 3) Verification and Validation

During data collection the goal was to capture as much of each market segment as possible. A comparison of revenue and sales data reported in the latest survey to the 2016 survey indicates the capture of data from 7 of the top 10 contributors by revenue. The 2016 survey covered 27 respondents of which 21 provided both 2015 and 2016 revenues. The latest survey covered 19 respondents of which 15 provided both 2016 and 2017 revenues.

3. Survey Results

3.1. Industry Characterization

The following three figures categorize the business characteristics of the companies responding to the survey. Figures 1 and 2 provide a breakdown by industry role and collector type for the 19 respondents participating in the 2017 survey. The number of industry participants continues to shrink consistently, which might skew results relative to previous surveys.

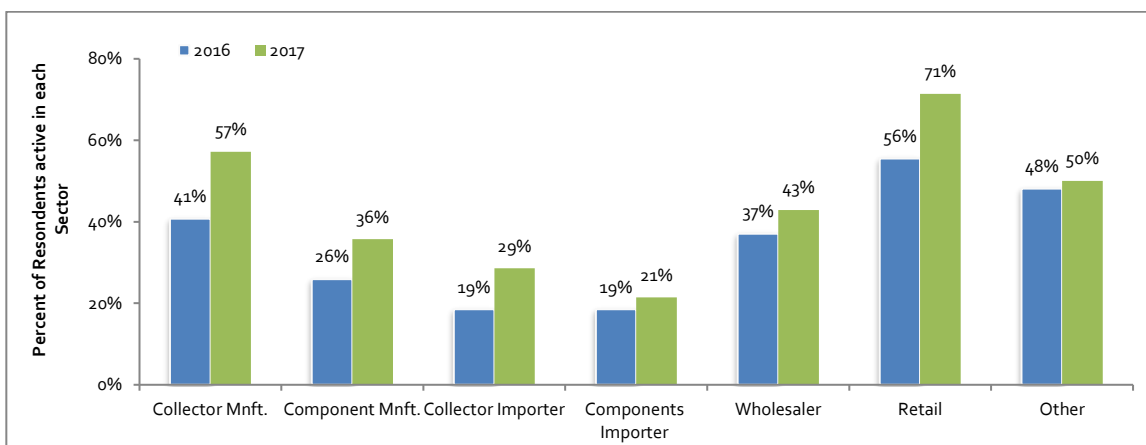


Figure 1: Sector involvement within the solar thermal industry.

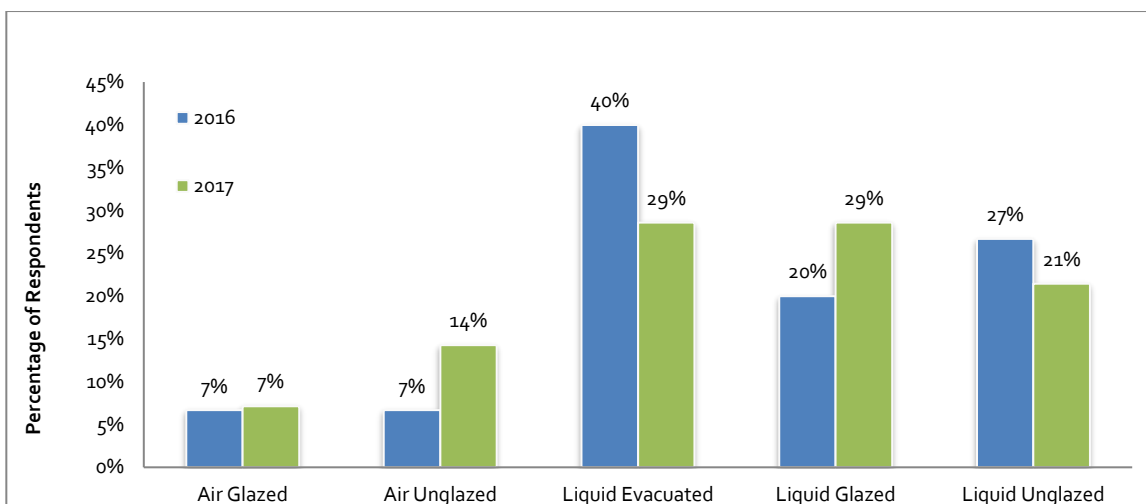


Figure 2: Respondent activity by collector type.

Nineteen percent of 2017 survey participants indicated that 80% or more of their corporate revenue is derived from solar thermal activities (Figure 3). Overall, 32% of respondents generated at least half of their revenue from solar thermal activities in 2017, down from 41% in 2016.

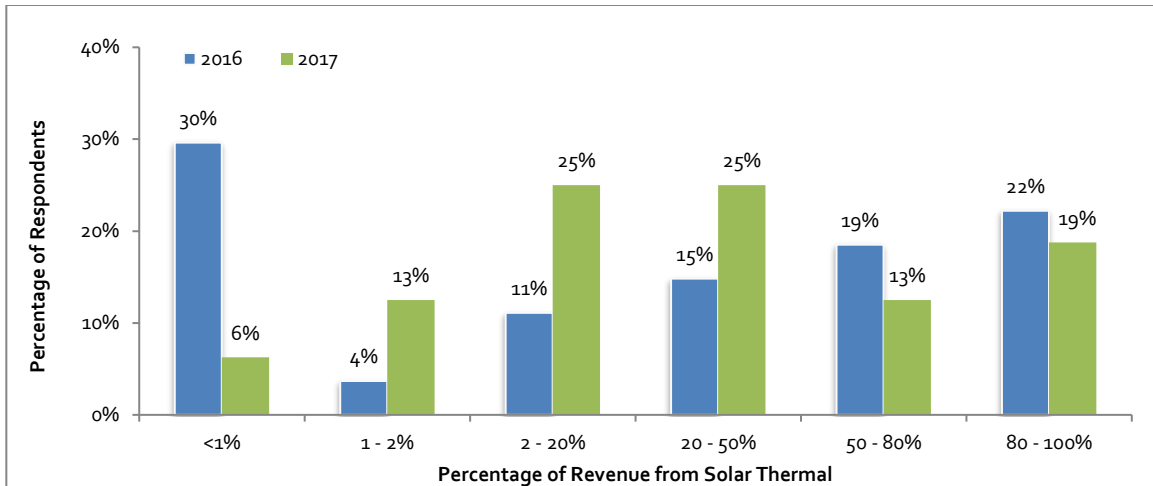


Figure 3: Solar thermal revenue as a percentage of total corporate revenue (2016 and 2017).

Respondents with at least one full-time equivalent employee focused on solar thermal related work remained steady at 69% in 2017 (compared to 70% in 2016). Total employment among respondents was reported to be 56 employees in 2017, down from 61 in 2016 and 93 employees in 2015. Note that this survey was not designed to capture all employment at the manufacturing, distribution, retail and installer levels, and therefore total employment in the Canadian solar thermal industry may be higher than is presented in this report (note that not all respondents provided these details).

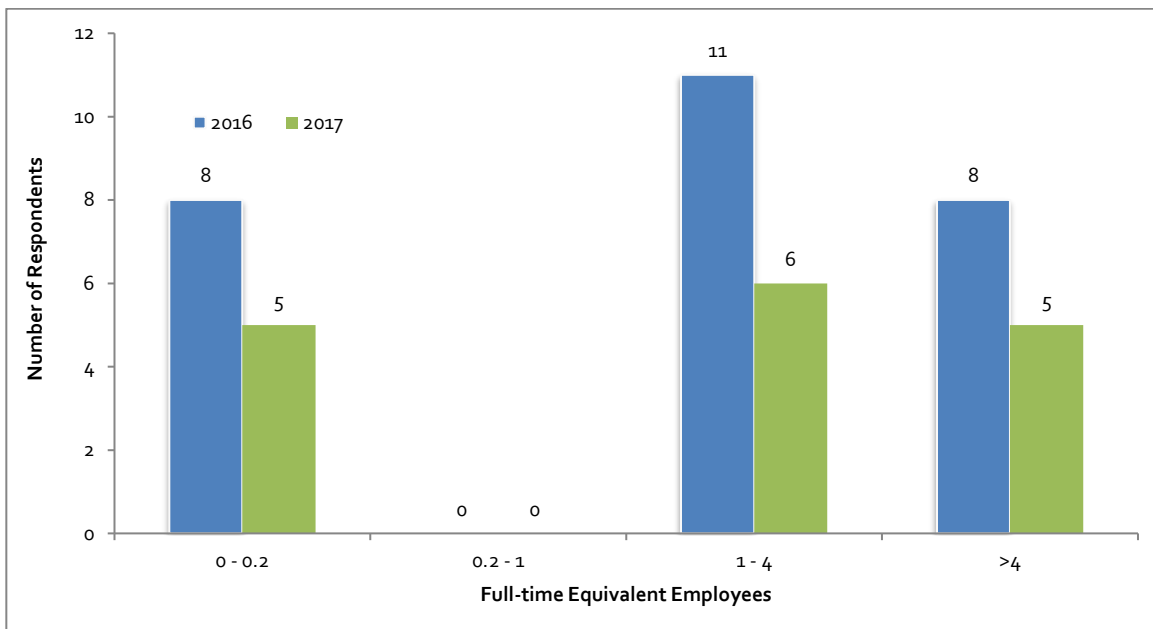


Figure 4: Number of employees per company engaged in solar thermal activities (2016 and 2017).

3.2. Industry Size and Growth

Overall, the Canadian solar thermal industry continued to decline in 2017, after previous steep declines in 2016. A comparison of key metrics for 2016 and 2017 is provided below. Refer to Table 1 for detailed 2016 and 2017 industry sales segmented by collector type.

- Total industry revenue decreased from \$10.6 million to \$6.2 million.
- Total area of collectors sold decreased from 69,645 m² to 45,083 m².
- Revenue from domestic sales decreased from \$6.5 million to \$4.1 million.
- Collector area from domestic sales decreased from 36,173 m² to 24,953 m².
- Revenue from export sales decreased from \$4.1 million to \$2.2 million.
- Collector area from export sales decreased from 33,472 m² to 20,129 m².

Table 1: Solar collector sales by type (2016 and 2017).

Collector Type	Domestic Sales Revenue (\$ thousands)		Collector Area (m ²)		Thermal Capacity (MW)	
	2016	2017	2016	2017	2016	2017
Air - Glazed	22	7	58	8	0.0	0.0
Air - Unglazed	2,058	1,308	10,438	6,688	7.3	4.7
Liquid - Evacuated	1,139	521	2,367	1,129	1.7	0.8
Liquid - Glazed	756	378	1,303	651	0.9	0.5
Liquid - Unglazed	2,509	1,878	22,008	16,478	15.4	11.5
Total	6,483	4,092	36,173	24,953	25.4	17.5

Collector Type	Export Sales Revenue (\$ thousands)		Collector Area (m ²)		Thermal Capacity (MW)	
	2016	2017	2016	2017	2016	2017
Air - Glazed	1095	540	7,300	3,481	5.2	2.5
Air - Unglazed	1,587	765	9,875	4,887	6.9	3.4
Liquid - Evacuated	214	6	449	6	0.3	0.0
Liquid - Glazed	161	76	391	184	0.3	0.1
Liquid - Unglazed	1,028	769	15,457	11,571	10.8	8.1
Total	4,084	2,156	33,472	20,129	23.5	14.1

Collector Type	Total Sales Revenue (\$ thousands)		Collector Area (m ²)		Thermal Capacity (MW)	
	2016	2017	2016	2017	2016	2017
Air - Glazed	1,117	547	7,358	3,489	5.2	2.5
Air - Unglazed	3,644	2,072	20,313	11,574	14.2	8.1
Liquid - Evacuated	1,352	528	2,815	1,135	2.0	0.8
Liquid - Glazed	917	454	1,693	836	1.2	0.6
Liquid - Unglazed	3,537	2,648	37,466	28,049	26.3	19.7
Total	10,567	6,248	69,645	45,083	48.9	31.6

Figure 5 presents the rate of growth in the domestic market by collector type, for five types of solar thermal collectors. No collector types experienced growth in 2017. Air glazed experienced a continued weakness, showing an 86% decline. Liquid glazed held steady at 50% (vs. 51% in 2016). The liquid evacuated segment decreased at 52%, and the air unglazed segment decreased at 36%. The liquid unglazed market also experience a significant decline at 25% when compared to 3% in 2016.

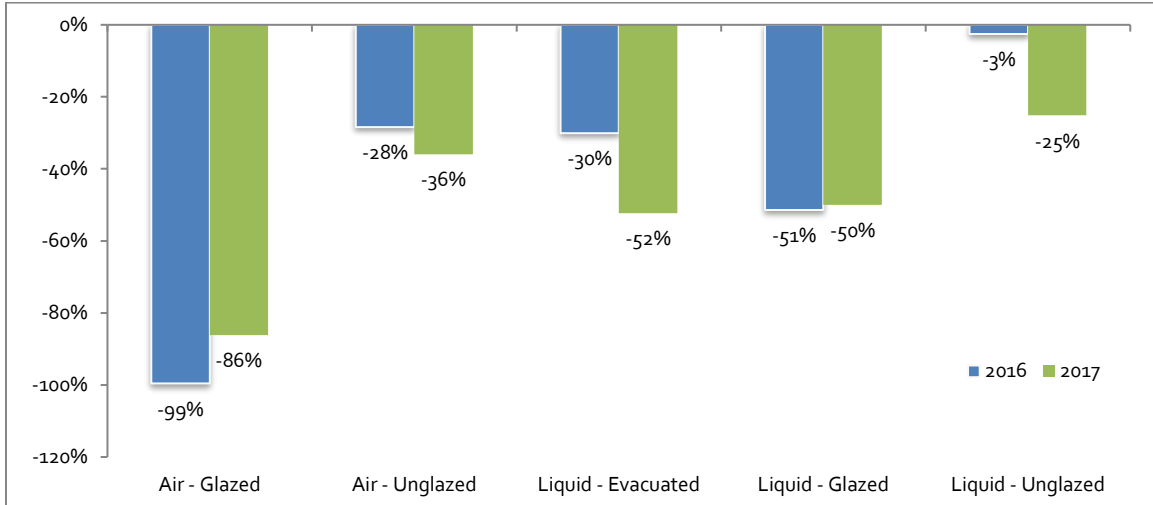


Figure 5: Collector area growth rates by collector type (2016 and 2017).

Figure 6 provides a historical overview of annual domestic collector sales from 2002 to 2017 for glazed liquid, air (glazed and unglazed), and unglazed liquid collector types. Figure 7 provides annual revenue data for domestic and total collector sales from 2003 to 2017. Export revenues dropped slightly to 34% of total sales in 2017 (by Revenue), compared to 39% in 2016.

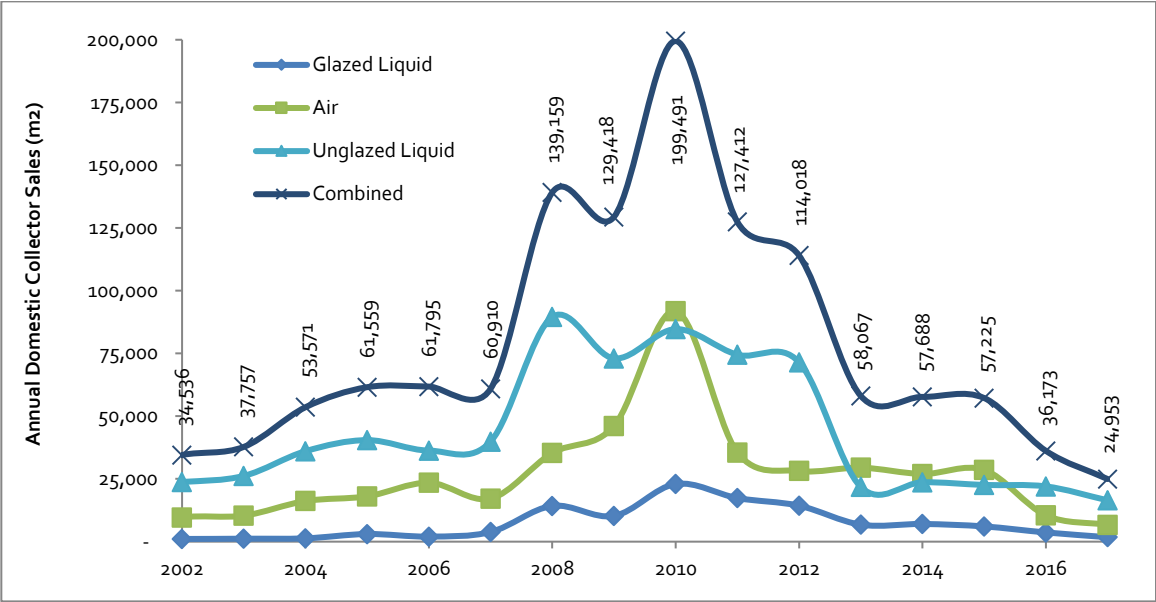


Figure 6: Historical annual domestic collector sales (m2).

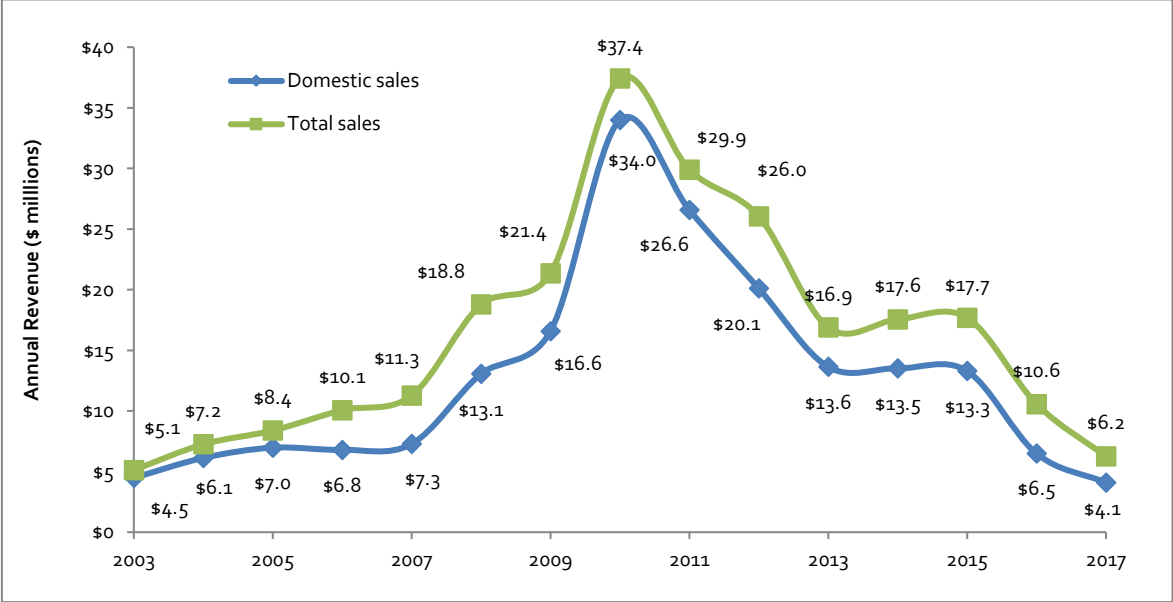


Figure 7: Canadian solar thermal industry revenue growth.

3.3. Applications of Solar Thermal Technology

Tables 3 and 4 provide a breakdown of revenue by collector type and end-use application. There are some changes when compared to the distribution found in 2016. Most notably, air glazed collector distribution shifted from 100% in the residential sectors in 2016 to 100% in the industrial/commercial/institutional (ICI) sectors in 2017, likely due to the small sample size. Unglazed liquid collectors remained consistent with previous years, and are used primarily for residential pool heating (99%). Conversely, liquid glazed collectors shifted further towards distribution in the residential sector in 2017, as did liquid evacuated collectors (98%) which can be attributed to small sample size.

Table 2. Solar heating collector type by sector (2016 and 2017).

Revenue by Sector	Air - Glazed		Air - Unglazed		Liquid – Evacuated		Liquid - Glazed		Liquid - Unglazed	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Residential	0%	0%	0%	0%	40%	98%	63%	70%	96%	99%
ICI ¹	100 ² %	100%	100%	100%	60%	2%	37%	30%	4%	1%
Unknown	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table 3: Solar heating collector type by application (2016 and 2017).

Revenue by Sector	Air - Glazed		Air - Unglazed		Liquid – Evacuated		Liquid - Glazed		Liquid – Unglazed	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Residential – Pool	0%	0%	0%	0%	0%	0%	0%	0%	96%	99%
Residential – DHW	0%	0%	0%	0%	30%	83%	61%	67%	0%	0%
Residential – Space	0%	0%	0%	0%	5%	0%	0%	0%	0%	0%
Residential– Combined/Other	0%	0%	0%	0%	5%	15%	2%	2%	0%	0%
ICI – Pool	0%	0%	0%	0%	0%	0%	3%	4%	4%	1%
ICI – DHW	0%	0%	0%	0%	19%	2%	19%	8%	0%	0%
ICI – Process Heat	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
ICI – Space Heat	100%	100%	100%	100%	41%	0%	0%	0%	0%	0%
ICI – Combined/Other	0%	0%	0%	0%	0%	0%	15%	18%	0%	0%
Unknown/Wholesale	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

¹ Industrial, Commercial, Institutional

² Correction: reported 2016 revenues were previously misclassified as originating from the Residential sector.

3.4. Geographical Distribution

3.4.1. Domestic Sales

Solar thermal collectors were sold throughout most of Canada in 2017. Ontario remained the largest market by revenue accounting for 34% of domestic sales, followed by the Atlantic and Prairie provinces, both at 20% of domestic sales, and Quebec at 19% of domestic sales. The Atlantic region had the highest revenue per capita (\$0.34 per capita). The national average was \$0.11 per capita in 2017.

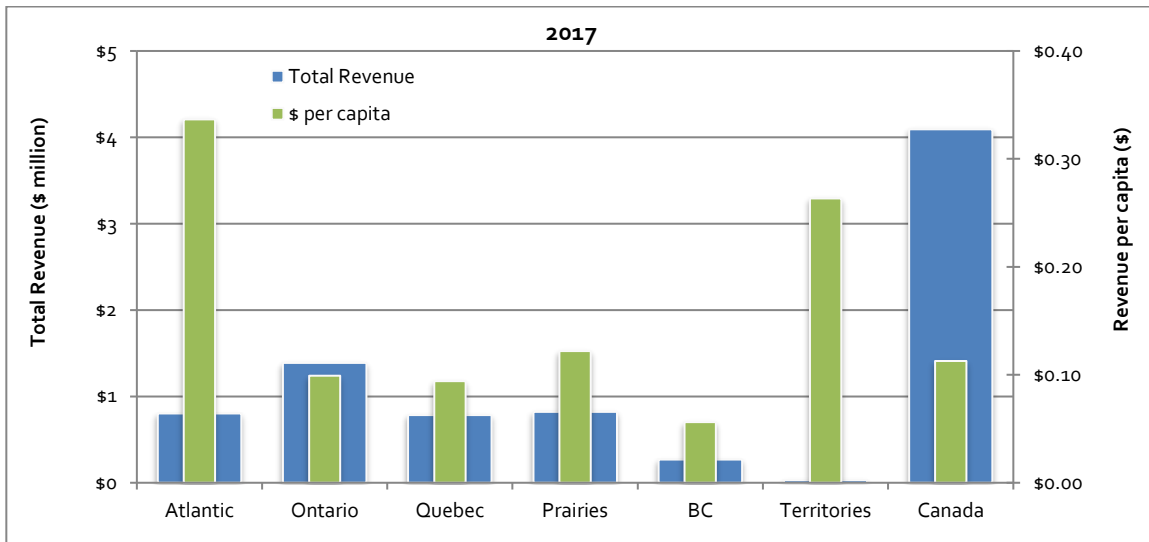


Figure 8: Regional solar collector sales (2017).

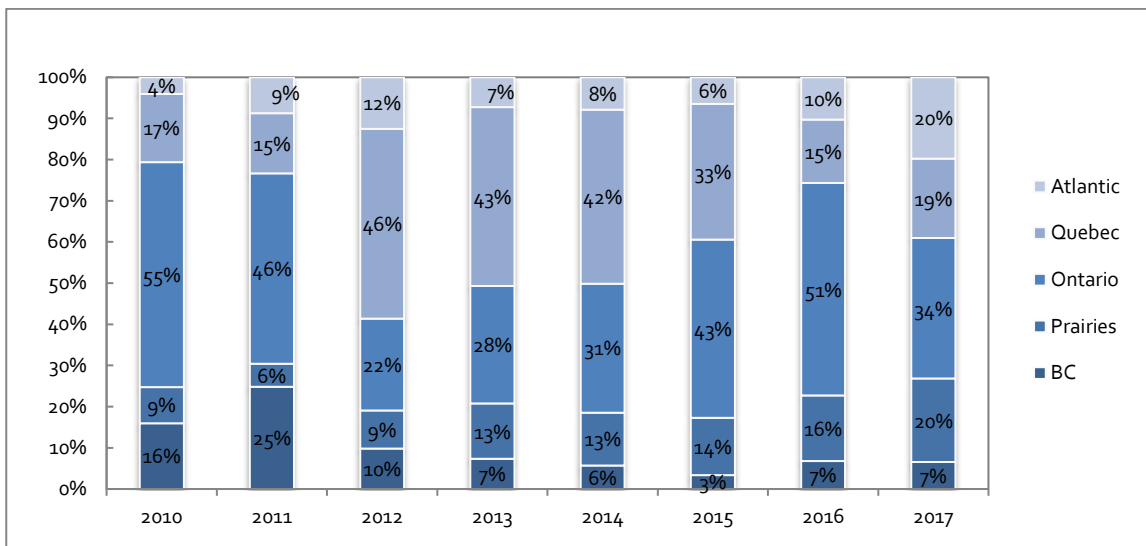


Figure 9: Regional distribution of domestic revenue (2017)

3.4.3. Exports

In 2017, Canada exported \$2.1 million of solar thermal collectors, down from \$4.3 million in 2016 and peak exports of \$5.9 million in 2012. While Europe shows a slight increase to 20% of total export revenue, compared to 17% in 2016, gross export revenues decreased substantially. Exports to the United States remain the primary source of exports, holding steady with 2016 and representing 76% of all exports in 2017. Exports to Latin America decreased to 1% (compared to 5% in 2016), Asia and the Middle East at remained at 3%, and there were no reported exports to Africa or Oceania in 2017. By collector type, glazed air collectors, unglazed air and unglazed liquid collectors continued to account for most exports.

Table 4: Regional distribution of solar thermal exports, by revenue (2016 and 2017).

Distribution of Solar Thermal Exports	2016	2017
United States	75%	76%
Latin America	5%	1%
Europe	17%	20%
Asia and Middle East	3%	3%
Africa	0%	0%
Oceania	0%	0%
Total	100%	100%

Table 5: Solar thermal collector exports, by revenue (2016 and 2017).

Distribution of Solar Thermal Exports	2016	2017
Air - Glazed	25%	26%
Air - Unglazed	37%	37%
Liquid - Evacuated	5%	0%
Liquid - Glazed	3%	3%
Liquid - Unglazed	29%	34%
Total	100%	100%

3.5. Anticipated Sales Growth

Figure 10 provides a compilation of participant's outlook for future sales growth, relating to their 2017 solar thermal revenue. Only 6% percent of respondents expected positive sales growth (16% in 2016) while a significant 56% of respondents predicted a decrease in sales over the same time period (24% in 2016). 38% of 2017 respondents reported expecting stability in the next two years, down from 60% in 2016, but some stated their reasoning to be the fact that there was little room for the industry to decline further.

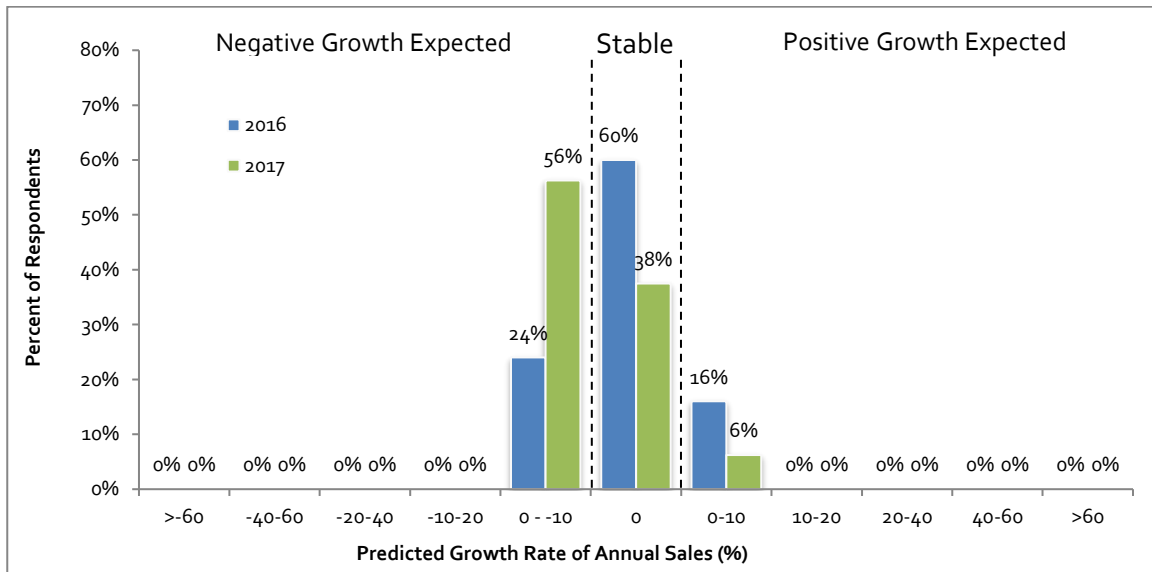


Figure 10: Estimate of future sales growth.

3.6. Sales of Packaged Systems

Respondents were asked if they sold packaged residential systems, either for domestic hot water or pool heating. Based on our results, when comparing the revenue of packaged systems to total revenue for the same collector types, approximately 52% of all liquid evacuated and glazed collectors (by revenue) were sold as packaged residential DHW systems in 2017.

Due to low response in our sample from the pool-heating sector, data for packaged pool heating systems were not reported. It is probable that many more such systems were sold, just not reported in our survey. Note that the pricing below does not reflect the fully installed price, but rather the packaged system equipment price.

Table 6: Domestic sales of packaged residential systems (2016 and 2017).

Packaged Residential DHW Systems		
	2016	2017
Systems Sold	99	95
Average Collector Area per System	6	6
Total Collector Area (m ²)	575	558
Total Revenue from Packaged Systems	\$472,450	\$467,450
Average Revenue per System	\$ 4,756	\$4,903

4. Estimate of Avoided Greenhouse Gas Emissions

4.1. Background

The estimation of avoided GHG emissions from solar thermal installations in Canada involves numerous variables such as displaced fuel mix, system sizes, system efficiency, and operating conditions, many of which are difficult to accurately estimate. The methodology for estimating GHG emission avoidance in a current year involved the following major steps:

- Researching historical sales data, and interpolating as necessary to provide estimates for missing data.
- Estimating the useful operational life of various solar thermal collectors or systems, to estimate the total solar collector area operational in a specific year.
- Developing typical or reference systems and applications, from which to estimate annual energy production per square meter of collector surface.
- Analyzing the fuel being displaced by solar, for each of the reference systems.
- Calculating the quantity of displaced fuel, and thus the GHG emissions avoided.

To maintain consistency in reporting, this document continues to use the method that was used for previous reports for estimating avoided GHG emissions, developed by Weiss et al with the support of the International Energy Agency (IEA). Section 4.2 provides a summary of the reference systems used.

Figure 11 shows historical solar thermal collector area that is installed and operating in Canada. By the end of 2017, 1,387,696 m² of solar thermal collectors were operating in Canada.

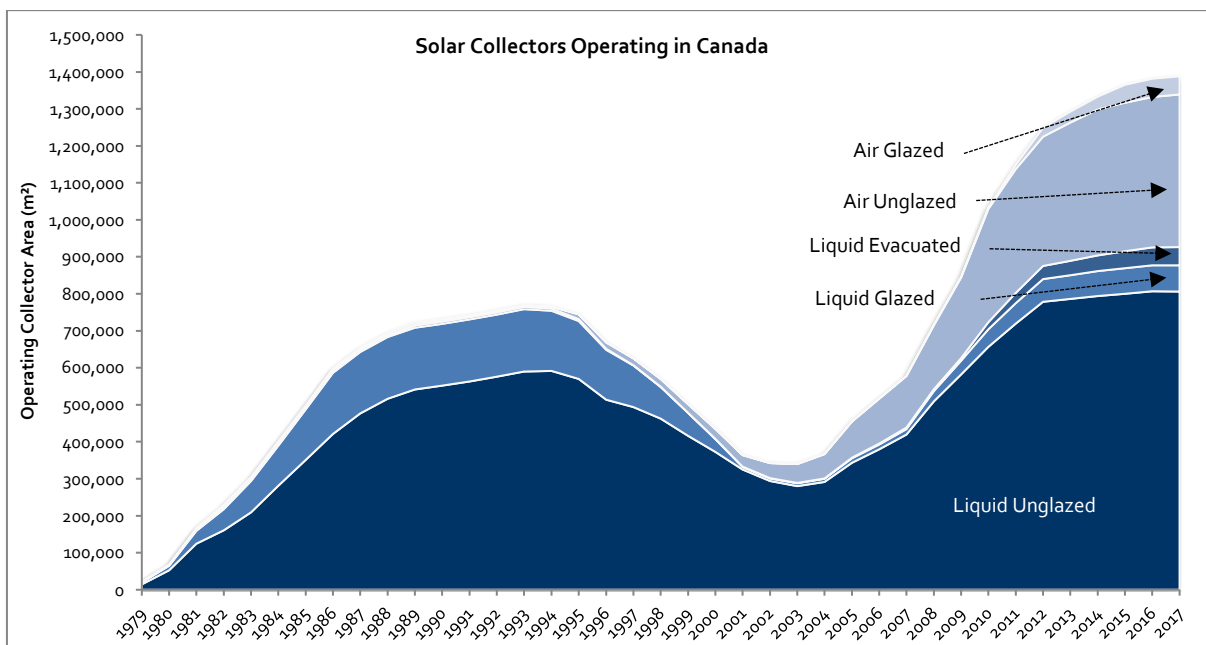


Figure 11: History of operating solar thermal collectors in Canada.

4.2. Reference System Definitions

Three of the four reference systems developed by Weiss et al are applicable for solar thermal systems in Canada, which were selected for estimating GHG savings. Adjustments were made to reflect the Canadian market, and a commercial air category was added to capture a segment of the market not present in Weiss' methodology.

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.³ 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. 200 m² was selected as the reference system size, 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.

³ 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. Moreover, because the relevant assumptions made for annual and specific yields per system were not far from those of a 225 L system, the actual effect of using Weiss' figures are reduced even further.

4.3. GHG Emissions Avoidance Calculations

Table 8 details the calculations used to estimate avoided GHG emissions in 2017 based on the total operating solar thermal collectors in Canada. The avoidance is equivalent to 111,494 tonnes of CO₂.

Table 7: Analysis of avoided GHG emissions, 2017.

Parameter	Residential DHW	Commercial Water	Residential Pool	Commercial Air
Collector type	glazed	Glazed	unglazed	unglazed air
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)	1.6	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)	97.6	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)	15/20	15/20	15/20	30
Total operating collector area (m ²)	60,113	60,113	806,142	461,601
Calculated number of systems	10,019	1,202	32,246	2,308
Total annual CO ₂ avoided (t/a)	9,618	5,819	36,760	58,393
Total annual CO ₂ avoided, all types (t/a)	110,590			

The 110,590 tonnes of avoided GHG emissions from solar thermal installations in Canada is equivalent to removing more than 22,110 mid-sized cars from Canadian roads, or the total GHG emissions of over 4,808 Canadians.⁴

⁴ "Human Activity and the Environment: Annual Statistics – 2007 and 2008" Statistics Canada, March 2009. This report indicates that the per capita GHG emissions from a typical Canadian are 23 tonnes per annum, and that a typical mid-size car driven 25,000 km each year emits 5 tonnes of GHG's.

4.4. Forecast GHG Emission Avoidance from Collectors sold in 2017

A similar calculation to that above was performed to estimate the total avoided GHG emissions over the lifetime of solar thermal collectors installed in Canada in 2017. Based on the 24,953 m² that was installed, the equivalent of 44,963 tonnes of CO₂ will be avoided over the lifetime of these systems (assuming a 20 year expected life for all systems).

The Canadian solar thermal industry earned \$4.1 million in revenue from domestic sales in 2017, this amounts to a displacement of one tonne of CO₂ for every \$91 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 2017 will be responsible for avoiding approximately 42,792 tonnes of CO₂ equivalent, during their operating life.

5. Conclusions

The Canadian solar thermal industry experienced significant declines across the board in 2017. Our survey efforts indicated that companies continue to exit the business, leaving just a few manufacturers and a consolidated set of installers and distributors.

Figure 12 summarizes the 2017 solar thermal industry domestic market share by collector type. Unglazed liquid collectors accounted for the largest market share by collector area (66%). Unglazed and glazed air collectors accounted for 32% of the market by revenue and accounted for 57% of the lifetime GHG savings from 2017 installations. Conversely, glazed and evacuated liquid collectors made up 22% of domestic market share by revenue but only 7% of domestic market share by collector area.

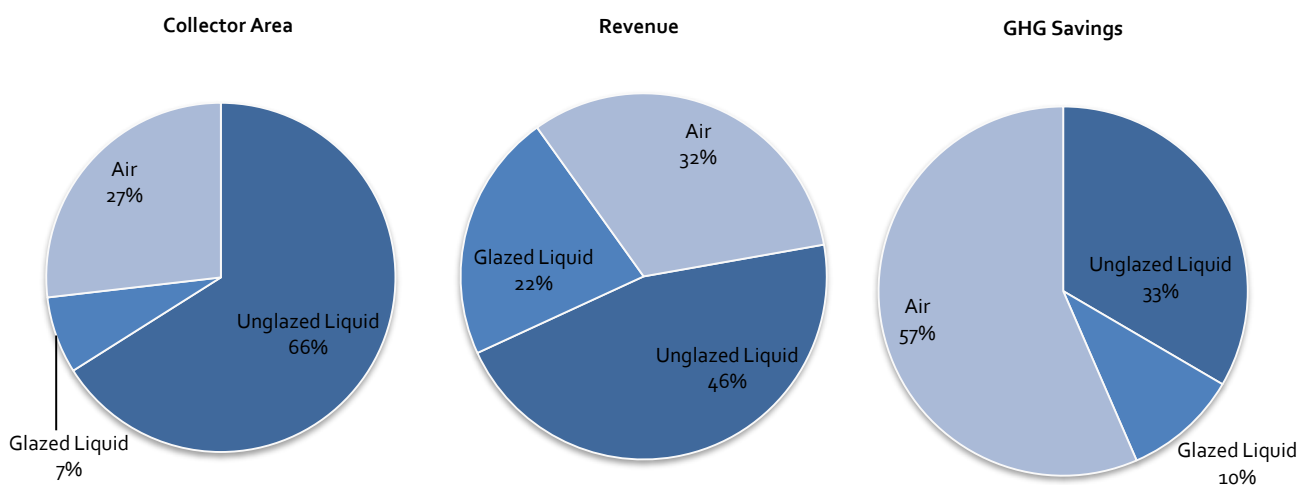


Figure 12: 2017 domestic market share by collector area, revenue, and projected GHG savings.

Table 8 below, provides a breakdown of domestic end-use for glazed liquid and evacuated tube collectors based on collector area. Glazed liquid and evacuated tube collectors installed in Canada were predominantly used for domestic hot water (DHW) supply (81% in 2017 and 84% in 2016). 63% of total installed collectors (1,130 m²) were for DHW systems in single-family houses in 2017. (Note: DHW systems for single-family houses include packaged and non-packaged system sales).

Table 8: Domestic sales of evacuated and glazed liquid collectors, by application (2017)

Application	2017 Gross Collector Area (m ²)
Swimming pool heating	-
DHW system for single family houses	1,130
DHW system for multiple family houses	312
DHW system for the tourism sector	-
DHW system for the public sector	54
Solar combi systems for single family houses	112
Solar combi systems for multiple family houses	173
Solar district heating systems	-
Solar process heat applications	-
Solar air conditioning and cooling	-

Figure 13 summarizes market share of each of the five collector types by total revenue in 2017. Air glazed collectors remained fairly stable, dropping from 11% of the market in 2016 to 9% of the market in 2017. Air unglazed also remained steady, with 33% of the market in 2017 compared to 34% in 2016. Liquid evacuated experienced a decrease in market share, moving from 13% in 2016 to 8% in 2017, and liquid glazed also decreased slightly from 9% in 2016 to 7% in 2017. Liquid unglazed collectors experienced the only increase in market share, moving from 33% in 2016 to 42% in 2017.

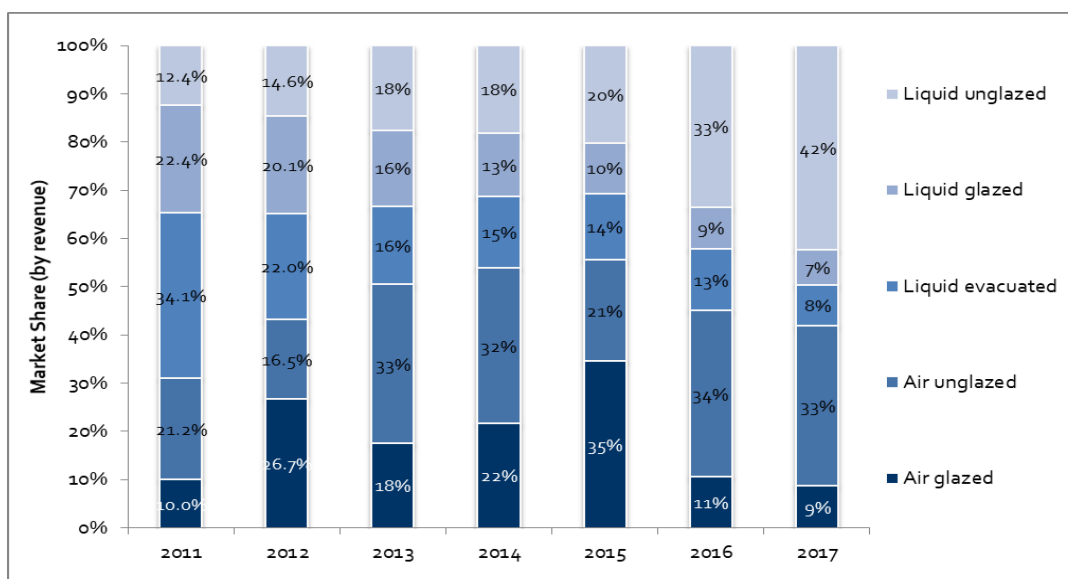


Figure 13: Market share of five collector types by total revenue in 2017.

6. References

1. **Survey of Active Solar Thermal Collectors, Industry and Markets in Canada (2016)**, March 2017, ClearSky Advisors.
2. **Survey of Active Solar Thermal Collectors, Industry and Markets in Canada (2015)**, March 2016, ClearSky Advisors.
3. **Survey of Active Solar Thermal Collectors, Industry and Markets in Canada (2013/2014)**, March 2016, ClearSky Advisors.
4. **Survey of Active Solar Thermal Collectors, Industry and Markets in Canada (2012)**, July 2013, ClearSky Advisors.
5. **Survey of Active Solar Thermal Collectors, Industry and Markets in Canada (2011)**, August 2012, ClearSky Advisors.
6. **Final Report Survey of Active Solar Thermal Collectors, Industry and Markets in Canada (2002 – 2004)**, August 2005, SAIC Canada report no. CM001743.
7. **Final Report Survey of Active Solar Thermal Collectors, Industry and Markets in Canada (2005)**, October 2006, SAIC Canada report no. CM002056.
8. **Final Report Survey of Active Solar Thermal Collectors, Industry and Markets in Canada (2006 & 2007)**, March 2008, SAIC Canada report no. CM002208.
9. **Final Report Survey of Active Solar Thermal Collectors, Industry and Markets in Canada (2008)**, September 2009, SAIC Canada report no. CM002285
10. **Final Report Survey of Active Solar Thermal Collectors, Industry and Markets in Canada (2009)**, August 2010, SAIC Canada report no. CM002285
11. Omboli, Eugène and McClenahan, Doug, 2002, **NRCAN In-house Survey of Solar Collectors for 1995 – 2001**, Natural Resources Canada.
12. 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.

Appendix A - Survey Questionnaire (English)

You have been invited to participate in a study of the Canadian Solar Thermal industry, commissioned by Natural Resources Canada (NRCan) and undertaken by ClearSky Advisors. The study results will help to provide comprehensive and reliable information on market size and industry trends, including sales and revenue, import and export, as well as employment figures. This pdf file can either be scanned and emailed or faxed to ClearSky Advisors.

Before you begin this questionnaire, it would be helpful for you to have the following information for your company on hand: 1) employment figures for 2017; 2) 2017 sales and revenue (\$ and gross collector area) by region, collector type, and end use; and 3) information on your equipment supplier and sources.

Please note that your responses will be kept anonymous and your privacy protected. Collected data will only be presented in aggregate. You may choose not to answer any of the descriptive questions by writing "N/A" in the comment text. A copy of the 2016 Solar Thermal industry survey report may be found at the following CanSIA's web site: www.cansia.ca/market-intelligence/solar-thermal

ClearSky Advisors (www.clearskyadvisors.com) is an independent research and advisory firm focused on renewable energy offering fact-based advice to the industry. We offer our clients the value of up-to-date research and thought leadership from a fast changing industry. ClearSky Advisors serves a range of different stakeholders in the solar industry and regularly publishes reports on timely issues.

[Start Questionnaire]

Please enter company contact information:

- 1) Company Name: _____
- 2) Company Address: _____
- 3) Contact Name: _____
- 4) Title: _____
- 5) Phone: _____
- 6) Email: _____

7) Please select the primary business that your company carried out in 2017 (select only one).

- Solar Thermal
- Other Renewable Energy (e.g. solar PV, wind, etc.)
- Swimming Pool Sales and Installation
- Plumbing Contractor
- HVAC Contractor
- HVAC Equipment Manufacturer or Distributor
- Building Contractor
- Other Building Trades
- Other (please specify): _____

- 8) In addition to your primary business as indicated in Q8, please indicate if your business was involved in any of the following business segments in 2016 and 2017. Check all that apply.

2016

- Solar Thermal
- Other Renewable Energy (e.g. solar PV, wind, etc.)
- Swimming Pool Sales and Installation
- Plumbing Contractor
- HVAC Contractor
- HVAC Equipment Manufacturer or Distributor
- Building Contractor
- Other Building Trades
- Other (please specify): _____

2017

- Solar Thermal
- Other Renewable Energy (e.g. solar PV, wind, etc.)
- Swimming Pool Sales and Installation
- Plumbing Contractor
- HVAC Contractor
- HVAC Equipment Manufacturer or Distributor
- Building Contractor
- Other Building Trades
- Other (please specify): _____

- 9) 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 2016 and 2017? Check all that apply.

	2016	2017
Solar Thermal Collector Manufacturer	<input type="checkbox"/>	<input type="checkbox"/>
Solar Thermal System Component Manufacturer	<input type="checkbox"/>	<input type="checkbox"/>
Solar Thermal Collector Importer	<input type="checkbox"/>	<input type="checkbox"/>
Solar Thermal System Components Importer	<input type="checkbox"/>	<input type="checkbox"/>
Wholesale Distributor	<input type="checkbox"/>	<input type="checkbox"/>
Retailer/Installer	<input type="checkbox"/>	<input type="checkbox"/>
Design/Consulting Services	<input type="checkbox"/>	<input type="checkbox"/>
Other (please specify): _____	<input type="checkbox"/>	<input type="checkbox"/>

- 10) Please estimate the time spent on Solar Thermal activities by all employees (full and part-time), and contractors, to provide the number of full-time employee equivalents. A full-time employee is defined as an employee who works 40 hours a week, 52 weeks a year (e.g., If two employees each spend approximately 20 hours per week over the course of a year on your Solar Thermal business, this would be counted as one full-time Solar Thermal employee).

2016: _____

2017: _____

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

2016: _____

2017: _____

12) What percentage of your organization's total revenue was from active Solar Thermal business?

2016: _____

2017: _____

13) Please report your total revenue earned from solar thermal activities in 2016 and 2017, and provide the percentage of this revenue that was earned from various types of sales. Please include all types of revenue related to Solar Thermal activities (e.g., product sales, service contracts, installation fees, consulting revenues). The percentages provided should sum to 100%. (Please note that two years of revenue information is being requested to ensure accuracy and continuity of data.)

	2016	2017
Total Sales Revenue from Solar Thermal Activities	\$	\$
Revenue of All Export Sales	%	%
Revenue from Sales to Canadian Resellers	%	%
Revenue from Sales Direct to Canadian End Users	%	%
Revenue from Other Canadian Sales	%	%

- 14) Please provide total Solar Thermal collector sales in 2016 and 2017, by collector gross area, and provide the percentage of Solar Thermal collector sales, export and Canadian, by gross collector area. The percentages provided should sum to 100%.

2016

Total Solar Thermal Collector Sales (square meters) _____m²

Percent of Collectors Exported _____%

Percent of Collectors Sold Within Canada _____%

2017

Total Solar Thermal Collector Sales (square meters) _____m²

Percent of Collectors Exported _____%

Percent of Collectors Sold Within Canada _____%

- 15) Compared to 2017, does your organization expect more, less or about the same revenues in the Solar Thermal collector and components sales and services area over the next 2 years?

- About the same
- Increase by ____% average per year
- Decrease by ____% average per year

16) Please report collector sales in 2017 by collector type in both collector gross area (m²) and revenue (\$). If your business involved the sale of complete systems, and/or related services and components along with solar collectors, please report the total revenue earned for the sale in the most appropriate column.

	Air - Glazed ⁵		Air - Unglazed		Liquid – Evacuated		Liquid - Glazed		Liquid - Unglazed	
		2017		2017		2017		2017		2017
Revenue from manufacturing ⁶		\$		\$		\$		\$		\$
Revenue from distribution		\$		\$		\$		\$		\$
Revenue from installations		\$		\$		\$		\$		\$
Revenue from other sources		\$		\$		\$		\$		\$
Total Solar Thermal Revenue		\$		\$		\$		\$		\$
Collector Gross Area		m ²		m ²		m ²		m ²		m ²

If **Other Sources** selected, please specify the nature of the revenue: _____

⁵ Includes transpired glazed

⁶ Includes sales of all associated equipment (e.g., thermal fluid) and shipping costs

- 17) Please provide a percentage distribution, by collector type for dollar sales by application in 2017. The total for each column should sum up to 100%. If a collector type is not applicable, please leave the column blank. If you were wholesaling the product to re-sellers, and are unaware of the final application, please report these shipments in the "unknown" category. (ICI: Industrial/Commercial/Institutional)

	Air - Glazed ⁷		Air - Unglazed		Liquid - Evacuated		Liquid - Glazed		Liquid - Unglazed	
		2017		2017		2017		2017		2017
Residential – Pool		%		%		%		%		%
Residential – DHW		%		%		%		%		%
Residential – Space		%		%		%		%		%
Residential – Combined/Other (includes hot tubs)		%		%		%		%		%
ICI – Pool		%		%		%		%		%
ICI – DHW		%		%		%		%		%
ICI – Process Heat		%		%		%		%		%
ICI – Space Heat		%		%		%		%		%
ICI – Combined/Other		%		%		%		%		%
Unknown/Wholesale		%		%		%		%		%

⁷ Includes transpired glazed

18) Within each region, please report the 2016 sales by revenue and collector gross area for each collector type. If your business did not conduct sales in a particular region, please leave the applicable section blank.

2017		Air - Glazed ⁸	Air - Unglazed	Liquid - Evacuated	Liquid - Glazed	Liquid - Unglazed
Atlantic Provinces	Revenue	\$	\$	\$	\$	\$
	Collector Gross Area	m ²	m ²	m ²	m ²	m ²
Ontario	Revenue	\$	\$	\$	\$	\$
	Collector Gross Area	m ²	m ²	m ²	m ²	m ²
Quebec	Revenue	\$	\$	\$	\$	\$
	Collector Gross Area	m ²	m ²	m ²	m ²	m ²
Prairie Provinces	Revenue	\$	\$	\$	\$	\$
	Collector Gross Area	m ²	m ²	m ²	m ²	m ²
British Columbia	Revenue	\$	\$	\$	\$	\$
	Collector Gross Area	m ²	m ²	m ²	m ²	m ²
Canadian Territories	Revenue	\$	\$	\$	\$	\$
	Collector Gross Area	m ²	m ²	m ²	m ²	m ²
United States	Revenue	\$	\$	\$	\$	\$
	Collector Gross Area	m ²	m ²	m ²	m ²	m ²
Latin America	Revenue	\$	\$	\$	\$	\$
	Collector Gross Area	m ²	m ²	m ²	m ²	m ²
Europe	Revenue	\$	\$	\$	\$	\$

⁸ Includes transpired glazed

	Collector Gross Area	m ²	m ²	m ²	m ²	m ²
Asia, Middle East	Revenue	\$	\$	\$	\$	\$
	Collector Gross Area	m ²	m ²	m ²	m ²	m ²
Africa	Revenue	\$	\$	\$	\$	\$
	Collector Gross Area	m ²	m ²	m ²	m ²	m ²
Australia, New Zealand, Oceania	Revenue	\$	\$	\$	\$	\$
	Collector Gross Area	m ²	m ²	m ²	m ²	m ²

19) a) Do you manufacture any Solar Thermal collectors in house?

Yes

No

b) If yes, please select the collector types that you manufacture and indicate the cumulative dollar value of all Solar Thermal collectors manufactured in the year 2017.

Air - Glazed

Air - Unglazed

Liquid - Evacuated

Liquid - Glazed

Liquid - Unglazed

Revenue Earned from of Solar Thermal Collector Sales (\$): _____

20) Please list your sources of Solar Thermal collectors, including: the collector type, the name of the supplier, the location of the supplier (using the regions listed in Q18), and the total dollar value (Revenue Earned) for each collector source for the year 2017.

2017	Collector Type	Supplier Name	Supplier Location	Dollar Value (Revenue) of Supply
Purchased Within Canada				\$
				\$
				\$
				\$
				\$
Purchased Outside of Canada				\$
				\$
				\$
				\$
				\$

21) Please briefly describe any changes to your business during 2017 (e.g., merger, acquisitions, etc.) that have had a significant impact on solar thermal sales from previous years. If none, please enter "N/A".

22)

23) Does your business sell packaged residential solar systems in Canada?

Yes

No

If yes, please provide information on the number and type of systems sold in 2017. Please provide data only on Canadian sales, excluding exported systems.

	Solar DHW Systems	Solar Pool Heating Systems
	2017	2017
Total Revenue from Packaged Residential Sales (including all packaged equipment revenue but excluding any related labour and/or services revenue)	\$	\$
Number of Packaged Systems Sold		
Total Solar Thermal Collector Area in Packaged Residential Sales (gross)	m ²	m ²

24) This question is relevant to domestic sales (not exports) of liquid glazed flat plate and evacuated tube collectors only. Please estimate in collector gross area, the breakdown by end user for total sales of these two types of collectors in 2017.

Application	Gross Collector Area (m ²)
	2017
DHW System for single family houses	m ²
DHW System for multiple family houses	m ²
DHW System for the tourism sector	m ²
DHW System for the public sector	m ²
Solar combi systems for single family houses	m ²
Solar combi systems for multiple family houses	m ²
Solar district heating systems	m ²
Solar process heat applications	m ²
Solar air conditioning and cooling	m ²
Total (m ² of all 2013/2014 sales of liquid flat plate and evacuated tube collectors)	m ²

25) For any 2017 Solar Thermal business conducted in Canada, did you or the system end user take advantage of any federal, provincial, or municipal initiatives? If applicable, indicate the initiative and approximate collector gross area per initiative (if known).

Incentive, Program or Procurement Initiative	Gross Collector Area (m ²)
	m ²
	m ²
	m ²
	m ²
	m ²
	m ²
	m ²
	m ²

26) Has your company been involved in any way with concentrating collector projects in 2017?

Yes or No

27) If Yes - please describe the nature of your company's involvement (e.g. project development, manufacturing, re-seller, etc.)

Open ended response

28) If Yes to first question: Please describe the size of the project or projects your company has been involved with for concentrating collector projects in 2017. Where possible, please use aperture area in m² for this question)

Open ended Response