



## Executive summary

This study evaluates the installation of 2 MW of solar photovoltaic panels on City of Toronto Facilities and further expanding the technology city wide. The solar PV industry is evaluated from an economic development perspective, focusing on green jobs creation, workforce development and local business opportunity. A user interactive job estimation model is developed as a part of this study. Model results, combined with literature review, online surveys and conversations with industry players inform the major findings of this study. The following provides an overview of these findings:

- The potential economic benefits in employment generation and local business development associated with solar PV industry in Toronto are significant.
- Over 70 person-years of employment are expected to be generated through installation of 2 MW of solar PV on City facilities, 53 of which are expected to be local jobs. Increasing percentage of locally procured modules from 50% to 100% would increase local employment estimates by almost 25%.
- Close to 100,000 local jobs can be expected to be generated in the solar industry assuming city wide coverage of solar PV panels at suitable locations.
- About half the estimated local employment is expected to be in system installation, and about one third in component manufacturing, with the remaining 15% in operation and maintenance.
- Almost half of the estimated local employment is expected to be in professional occupations, while the remaining are factory workers, field workers and sales and marketing representatives.
- Lack of qualified and experienced installation technicians, project managers and engineers with knowledge and background in the solar industry is posing a great challenge in workforce recruitment, not just in Toronto, but across the province and the country.
- There is a need for a provincial or national certificate programs in solar installations. Without a certificate program individuals are not guaranteed that they would have the required skills they need in order to enter the workforce, even after going through a college/training program.
- The need for a study on structural suitability of Toronto's building stock for solar PV installations is apparent. Lack of this data limits us from making accurate estimations on potential power and employment generation capacities.

**Contents**

Executive summary ..... i

Contents ..... ii

1 Background ..... 1

2 Introduction ..... 2

    Evaluated initiative: 2 MW of Solar PV on City of Toronto Facilities ..... 3

3 Methodology ..... 3

    User Interactive Employment Estimation Model ..... 5

4 Estimated Workforce Impacts ..... 6

    4.1 Scope and Assumptions for Current Program and Future Expansions ..... 6

    4.2 Employment Estimation Model Results ..... 8

5 Existing training programs ..... 10

6 Workforce and Training Challenges and Opportunities ..... 14

7 Local procurement opportunities ..... 16

8 Summary of Major Findings ..... 18

Appendix A ..... 19

Appendix B ..... 22

Appendix C ..... 24

## 1 Background

In December 2009, City Council approved The Power to Live Green: Toronto's Sustainable Energy Strategy, which detailed an approach to build upon the goals for reducing greenhouse and smog causing emissions by adopting a number of recommendations to act as principles and targets for Toronto's sustainable energy future.

In an effort to build upon its adoption of the Green Economic Sector Development Strategy, and in recognizing the creation of jobs and economic opportunities as a result of the emergence of the green energy sector, the Green Jobs Action Team has been established. The objective of this action team is to advance policies, investments, collaborations and partnerships in the city to ensure that Toronto is delivering its commitments in the Power to Live Green, by making more jobs green and by creating more green jobs.

A number of City divisions have been developing and implementing several environmental initiatives in order to meet the goals and objectives of the City's sustainable energy strategy. While the environmental benefits of these initiatives are mostly quantified, their economic impact, specifically green jobs potential and workforce requirements, have not been thoroughly evaluated. Many of the City's environmental initiatives present several prospects for creating a variety of local green employment and procurement opportunities.

This document reports the result of evaluating the project of installing 2 MW of solar photovoltaic (PV) panels on City facilities from a job creation and workforce development perspective. As a part of this analysis a Microsoft Excel model is developed. The model provides estimates for person-years of employment generated in various project phases and skill levels as a result of the initiative. Users have the option of modifying default assumptions, future scenario parameters, and program targets and observe the resulting changes in employment estimates. It must be noted that the model is not meant as a design tool, since the complexity of estimation parameters and their level of precision are not fit for that level of analysis. Rather, it is meant as a higher level evaluation tool for investigating aggregate employment impacts.

For the purposes of this study green jobs are defined as direct employment generated due to a City of Toronto environmental policy or program. Spin-off jobs related to this direct employment (e.g. clerical support, equipment transportation, etc) are considered indirect jobs and are not included in this analysis. Similarly, induced jobs, which are jobs generated due to re-spending of worker income in consumer goods and services, are not quantified.

*Together with two similar reports on other programs, this study is a part of an initiative by the Green Jobs Action Team for developing a framework for evaluating the economic impact of City of Toronto environmental initiatives.*

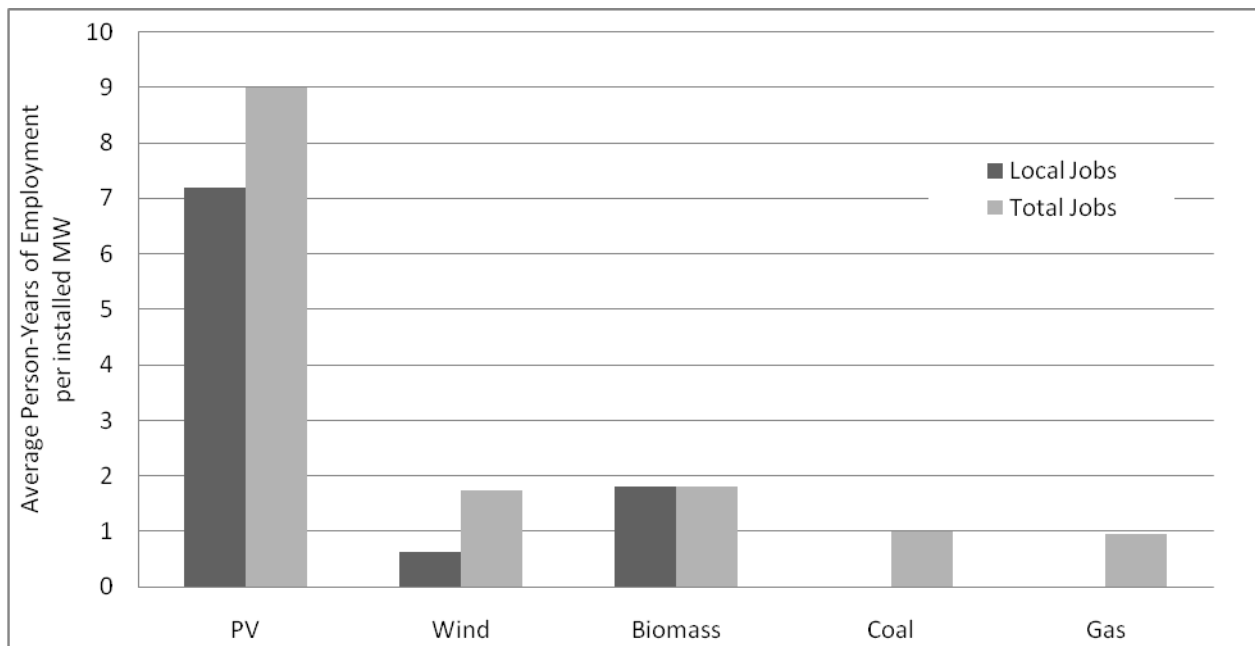
This document, together with two similar reports on other programs, is a part of an initiative by the Green Jobs Action Team for developing a framework for evaluating the economic impact of City of Toronto environmental initiatives. Results of this and future evaluations would allow the City to better understand additional benefits of environmental initiatives and plan for the future in order to strengthen Toronto's green economy.

## 2 Introduction

The solar industry has been growing rapidly in Ontario, specifically Toronto, in the last few years. This is mainly thanks to the Ontario Feed in Tariff (FIT) program. Under the FIT program the Ontario Power Authority contracts with producers of renewable electricity to purchase that power for a premium price. Prices for electricity produced by rooftop-mounted photovoltaic panels are higher than any other form of renewable electricity, which has led to a dramatic increase in interest in installing solar technologies. In addition, with plans for phasing out coal in Ontario by 2014, the province has a great opportunity for becoming a source of clean energy and clean PV products<sup>1</sup>. Currently, even with contribution of coal, the carbon content of Ontario's electricity mix is lower than those of Japan, Germany, and the US.

The solar industry has the potential for significant employment opportunities. Existing research suggests that 8.2 direct jobs and 7.6 indirect jobs can be expected from every \$1 million spending in the solar industry<sup>2</sup>. Moreover, Solar PV energy has a significantly higher potential for both total and local jobs per average MW of energy installed compared to other sources of energy. Figure 1 illustrates the results of preliminary analysis on comparing employment potential of different sources of energy<sup>3</sup>.

*Solar PV energy has a significantly higher potential for both total and local jobs per average MW of energy installed compared to other sources of energy.*



**Figure 1 - Overall and local job intensity (jobs per average installed MW) of various energy options<sup>4</sup>**

<sup>1</sup> McMonagle, Rob. (2006). "The Environmental Attributes of Solar PV in the Canadian Context". CanSIA

<sup>2</sup> Pollin, Robert and Heidi Garrett-Peltier (2009). " Building the Green Economy: Employment Effects of Green Energy Investments for Ontario" Report sponsored by Green Energy Act Alliance, Blue Green Canada and World Wildlife Fund

<sup>3</sup> Analysis based on data from Kammen, Daniel M.; Kamal Kapadia and Matthias Fripp (2004) "Putting Renewables to Work: How Many Jobs Can the Clean Energy Industry Generate?" RAEI Report, University of California, Berkeley

<sup>4</sup> 25% , 70% and 100% of manufacturing and installation of wind power, solar PV power and biomass power are assumed to take place locally in Toronto.

## Evaluated initiative: 2 MW of Solar PV on City of Toronto Facilities

In July 2010 Toronto City Council granted authority for the City of Toronto to enter into an agreement with Toronto Hydro for installation of solar photovoltaic cells on the roof space of a number of City owned buildings. The initiative will be taking advantage of the Province's FiT Solar program.

The 18 month pilot program is expected to be completed by end of 2011. This partnership between City of Toronto and Toronto Hydro aims to generate approximately 2 MW of energy, which generates about 2 million kWh annually, equivalent to the electricity consumption of 200 households in Toronto. To achieve this goal it is estimated that a total of 400,000 square feet of City owned roof space will be required. Currently applications for 13 sites have been submitted to the OPA, while approximately 7 more are expected to be submitted in the near future.

As a component of this initiative there are plans for Toronto Employment and Social Services and Economic Development & Culture to develop a pilot program for local green sector job training and employment for Toronto youth. Additionally, they will be involved in an engagement program for local solar manufacturers.

## 3 Methodology

In 2010 The Tower Renewal Office commissioned a study by Professor Ted Kesik from the University of Toronto to look at workforce challenges and opportunities in the tower renewal industry in Toronto<sup>5</sup>. The methodology adopted by this study has guided a major component of the work presented here. Given the difference between the tower renewal industry and the solar industry certain aspects of the methodology differ from those of the Tower Renewal study.

The solar industry in Toronto is fairly new and not yet well established. As a result, any attempt at collecting employment hour data locally, similar to the approach taken by the Tower Renewal study, would have resulted in significant variability and inconsistency in results. Moreover, there exists a fairly extensive body of research on the employment potential of this industry. The majority of such research is conducted in the US. Table 1 displays an inventory of existing research on solar PV job intensity per installed MW.

In order to estimate person-years of employment involved in the manufacturing, installation and operation & maintenance of solar PV systems majority of studies make an assumption about number of hours of work in a year. Each person-year of employment is considered to be made up of 1,960 hours of work. This figure is commonly used as average total number of hours in one year of full-time employment<sup>6</sup>. There are certainly limitations in making this broad assumption. Certain occupations have longer work hours than others. In addition, depending on the state of the industry, employers might ask employees to work overtime in the event of increased work load, rather than choosing to hire new staff. Nevertheless, this estimation approach is deemed acceptable at this level of analysis since it normalizes employment figures and facilitates further evaluation and comparisons.

*One person-year of employment is equivalent to 1,960 hours of work.*

<sup>5</sup> Kesik, Ted. (2010). "Tower renewal workforce challenges & opportunities" Report prepared for the Tower Renewal Office

<sup>6</sup> Singh, Virinder and Jeffrey Fehrs (2001). "the work that goes into renewable energy" Research report: Renewable Energy Policy Projects, Washington, DC.

**Table 1 - Overview of existing research on jobs per MW of installed Solar PV**

Study	Year of study	System size	Location	Manufacturing Jobs /MW	Installation Jobs /MW	O&M Jobs /MW <sup>7</sup>
Jobs and Economic Development Impacts (JEDI) Model, by National Renewable Energy Laboratory (NREL)	2008	100kw to 2 MW	New York	22.9	15.1	2.0
Jobs and Economic Development Impacts (JEDI) Model, by National Renewable Energy Laboratory (NREL)	2008	<5KW	New York	22.9	19.2	1.5
Job growth projections and analysis in Chicago's emerging green industries - by Chicago Jobs Council	2010	not specified	Chicago	16.9	7.9	0.4
Component Manufacturing: Ohio's Future in Renewable Energy Industry - by Renewable Energy Policy Project	2005	not specified	Ohio	15.2		
The work that goes into renewable energy- by Renewable Energy Policy Project in the US	2001	2-kW residential	USA-Wide	19.6	13.4	10.2
Renewable Energy Labour Calculator - by The Renewable Energy Policy Project	2003	overall	Nevada	25.1	7.3	2.5
Economic Impacts of Extending Federal Solar Tax Credits - by Navigant consulting for the Solar Energy Research and Education Foundation	2008	3.5 kw - residential	USA-Wide	13.0	14.5	2.0
Economic Impacts of Extending Federal Solar Tax Credits - by Navigant consulting for the Solar Energy Research and Education Foundation	2008	1500 kw - Commercial and Utility	USA-Wide	13.0	9.7	6.0
California Renewable Technology Market and Benefits Assessment, by Electric Power Research Institute (EPRI) for the CEC	2001	overall	California		6.4	0.1
Solar Generation V – 2008 Solar electricity for over one billion people and two million jobs by 2020 - by European Photovoltaic Industry Association	2008	not specified	Europe-wide	20.0	33.0	1.0
Asola GmbH	2011	not specified	Estimates for their Ontario plant	12.8		

<sup>7</sup> For studies where the period of operation & maintenance are specified the value was converted to jobs during 20 years of operation

A recent study commissioned by Economic Development & Culture has compiled an Inventory of existing training programs in the solar energy field offered through colleges and other organization<sup>8</sup>. This study, complemented by additional research on relevant higher level education programs in universities, is the basis of this report's inventory of training programs, presented in section 5.

In order to gain a good understanding of workforce development and recruitment challenges and needs an online survey was conducted. This survey, presented in Appendix A, collected information from industry players in the region on the following areas:

- Basic information about the respondent and their business size;
- Whether they would manage with their existing staff size if demand for their services suddenly doubled;
- What skill areas are most challenging to recruit?
- What are the primary sources for finding labour in this field?
- What partnerships are working to help with recruitment and workforce development?
- What are the barriers/obstacles with recruitment?
- What are the primary sources for workforce development in the industry? and
- What are some of the gaps in quality or quantity of existing training programs?

Respondents to the survey were approached during the CanSIA annual conference in December 2010, and through follow up e-mails where a link to the online survey was provided. Some 15 companies involved in design and manufacturing, installation, sales, system integration and operation & maintenance completed the online survey. The results of this survey will be discussed later in section 6 of this report.

A solar PV industry forum, organized by the Economic Development and Culture Division, was held at the Evergreen Brickworks in January 2011. This one day forum brought together about 25 members of the industry from colleges and training organizations, research, manufacturing, consulting, Toronto Hydro, TRCA and City of Toronto. Consultations during this forum form the basis for a large component of the findings of this study in the area of workforce and training needs.

## User Interactive Employment Estimation Model

This study has resulted in a user interactive Microsoft Excel based job estimation model. This open architecture estimation tool provides capabilities for users to view and modify the base assumptions used in calculations. In addition, a number of opportunities are built in to allow for variable modification and quick result visualization. The main user interface page of the model guides the user through colour coded cells indicating what is default information, what are modifiable default assumptions, what are modifiable system specific variables, and what are estimation outputs. The user interface allows for modification of variables such as degree of local procurement, percentage of roof

*This study has resulted in a user interactive Microsoft Excel based job estimation model. This open architecture estimation tool provides capabilities for users to view and modify the base assumptions used in calculations.*

---

<sup>8</sup> Toronto Renewable Energy Co-Operative (2011) "Solar Training Initiatives Reference Guide". Prepared for Strategic Growth and Sector Development, Economic Development and Culture, City of Toronto

covered with solar PV, percentage of building stock structurally suitable for Solar PV and system cost per installed MW. Model outputs include person-years of total and local employment by project phase and by occupation type, expected annual energy output and rough cost estimates.

The following is a brief description on the methodology of model development.

Table 2 displays average job generation estimates based on the literature review discussed above. Average values for jobs per MW of small scale (<10 kW) and large scale (>10 kW) projects are used in calculations and results presented later in this report. It is evident that there is a large range of job intensity values in the existing literature. Total number of jobs per MW of solar energy installed can be up to 80% larger and 45% lower than the average values displayed below. Therefore, while averages are used in our calculations, estimates could vary significantly.

**Table 2 - Summary of results of existing research on Solar PV jobs/MW**

	Jobs / MW			Total
	Manufacturing	Installation	Maintenance <sup>9</sup>	
<b>Small Scale (&lt;10kW)</b>	18	15	5	<b>37</b>
<b>Large scale (&gt;10KkW)</b>	18	13	4	<b>35</b>

As the solar industry advances and matures some improvements in system efficiencies are expected. As a result, in addition to making the distinction between small and large project scales, the model allows the user to select between two projection years of 2010 and 2020. This indicates the year based on which the employment estimation values are to be used in the calculations. Values presented in Table 2 correspond to the "current" or the 2010 option. Under the 2020 option, average values for total jobs in small scale and large scale projects are lowered to 29.2 and 27.6 jobs/MW, respectively<sup>10</sup>.

A research report by the Renewable Energy Policy Project in the US<sup>11</sup> provides a matrix breakdown of jobs in Solar PV with project components in as rows and occupation types as columns. This matrix is displayed in Appendix B and will be referred to as the *job component-occupation type* matrix. Individual cells in the *job component – occupation type* matrix are scaled according to the selected values for total job/MW under various scenarios (e.g. small scale based on 2020 employment intensities). The resulting matrix is then used to make employment estimations for different scenarios.

## 4 Estimated Workforce Impacts

### 4.1 Scope and Assumptions for Current Program and Future Expansions

Beyond assessing the employment impact of the 2 MW Solar project on City facilities, this study also makes estimates for expected number of jobs generated if all suitable flat and sloped roofs in Toronto were to be covered with solar PV. As the scenario specifications in Table 3 and Table 4 suggest, it is assumed that only 70% of structures with flat roofs and 60% of structures with sloped roofs are

<sup>9</sup> Not all studies mentioned in Table 1 have specified the time period over which O&M is quantified. Summary data provided here are based on only those studies that specified this period.

<sup>10</sup> Greenpeace (2008). "Solar generation: solar electricity for over one billion people and two million jobs by 2020"

<sup>11</sup> Singh, Virinder and Jeffrey Fehrs (2001). "the work that goes into renewable energy" Research report: Renewable Energy Policy Projects, Washington, DC.

structurally suitable for PV panel installations, without significant reinforcement costs. These assumptions are based on anecdotal evidence and personal conversations. Unfortunately, lack of any robust data on this matter inhibits us from making more accurate assumptions. Further, it is assumed that only 50% of the structurally suitable roof area will be covered with solar panels. This is to account for other purposes the roof may be occupied for, in addition to shading and other solar radiation restrictions.

*The need for a study on structural suitability of Toronto's building stock for solar PV installations is apparent. Lack of this data limits us from making accurate estimations on potential power and employment generation capacities.*

Assumptions regarding solar radiance, solar panel efficiencies, expected annual output of sloped and flat roofs and PV tilt factor are based on a study conducted by the Pembina Institute<sup>12</sup> and are summarized in Table 5. Table 13 and Table 14 in Appendix B provide further information about references for assumptions made for each individual field in the tables below.

**Table 3 - Characteristics of Future Solar PV projections on flat roofs (systems greater than 10kW)**

Available roof area [m <sup>2</sup> ]	49,840,000
% of suitable structures	70%
% of roof cover	50%
Total PV covered area [m <sup>2</sup> ]	17,444,000
Installed MW	3,689
Annual output [MWh]	3,689,406
System cost [CAD/W]	\$7.6
Total System cost [Million CAD]	\$28,039

**Table 4 - Characteristics of Future Solar PV projections on sloped roofs (systems smaller than 10kW)**

Available number of units	494,453
% suitable structures	60%
Power output [kW/unit]	3
Installed MW	890
Annual output [kWh per kW installed]	1000
Total annual output [MWh]	890,015
System cost [CAD/W]	\$8.0
Total System cost [Million CAD]	\$7,120

**Table 5 - Solar system calculation assumptions**

Solar resource	Average: ~1000 Watt/m <sup>2</sup>
Solar efficiencies	150 W/m <sup>2</sup> in Toronto (assuming 15%)
Expect annual output	~ 1000 kWh per kW installed
Assumed tilt angle factor	1.41 total PV area / roof area (based on 45° tilt)
Sloped roof solar PV capacity	3kW

<sup>12</sup> Weis, T., Haines, G. and Bell, J (2008) "Solar Opportunities for the City of Toronto" Pembina Institute

## 4.2 Employment Estimation Model Results

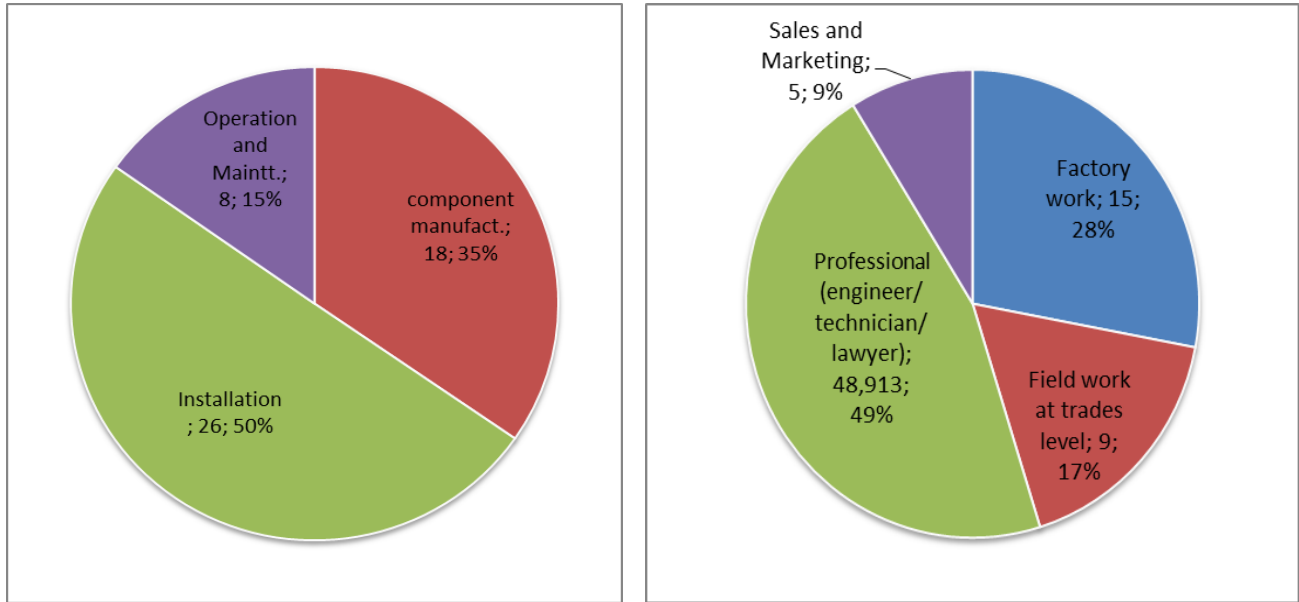
Results of employment estimation associated with installing 2 MW of solar PV on City facilities are presented in Table 6. These estimations are made based on 2010 job intensity factors. Over 70 person-years of employment are expected to be generated, 53 of which are local jobs. The scenario presented here assumes that none of the raw material and 60% of the manufactured PV components is procured locally (meeting Ontario FiT requirements). In addition, 100% of installation and operation and maintenance services are assumed to be through local businesses. The model suggest that about 23% higher local employment numbers can be expected if all manufactured PV components are procured locally for this project.

*Over 70 person-years of employment are expected to be generated through installation of 2 MW of solar PV on City facilities, 53 of which are expected to be local jobs. About 23% higher local employment numbers can be expected if all manufactured PV components are procured locally for this project*

**Table 6 - Total and local employment estimation for the 2 MW project**

	years of employment	Percentage Local employment	Person-years of local employment
<b>Person-years of employment by Project Phase</b>	<b>71</b>	<b>75%</b>	<b>53</b>
<b>Manufacturing</b>	<b>36.3</b>	<b>50%</b>	<b>18</b>
raw material extraction	5.8	0%	0
component manufacturing	30.5	60%	18
<b>Installation</b>	<b>26.5</b>	<b>100%</b>	<b>26</b>
<b>Operation and Maintenance</b>	<b>8.0</b>	<b>100%</b>	<b>8</b>
<b>Person-years of employment by Occupation Type</b>	<b>71</b>		<b>53</b>
<b>Factory work</b>	<b>28.5</b>		<b>15</b>
<b>Field work at trades level</b>	<b>9.1</b>		<b>9</b>
<b>Professional (engineer/technician/lawyer)</b>	<b>28.0</b>		<b>24</b>
<b>Sales and Marketing</b>	<b>5.2</b>		<b>5</b>

As Figure 2 illustrates, half the jobs generated as a result of the project will be in installation, and about one third in component manufacturing, with the remaining 15% in operation and maintenance. In terms of occupation type, almost half of the local jobs generated are in professional occupations, while the remaining are factory workers, field workers and sales and marketing representatives.



a) Job breakdown by job component

b) Job breakdown by occupation type

Figure 2 - Local employment breakdown - 2 MW solar initiative [number of jobs; percentage of total]

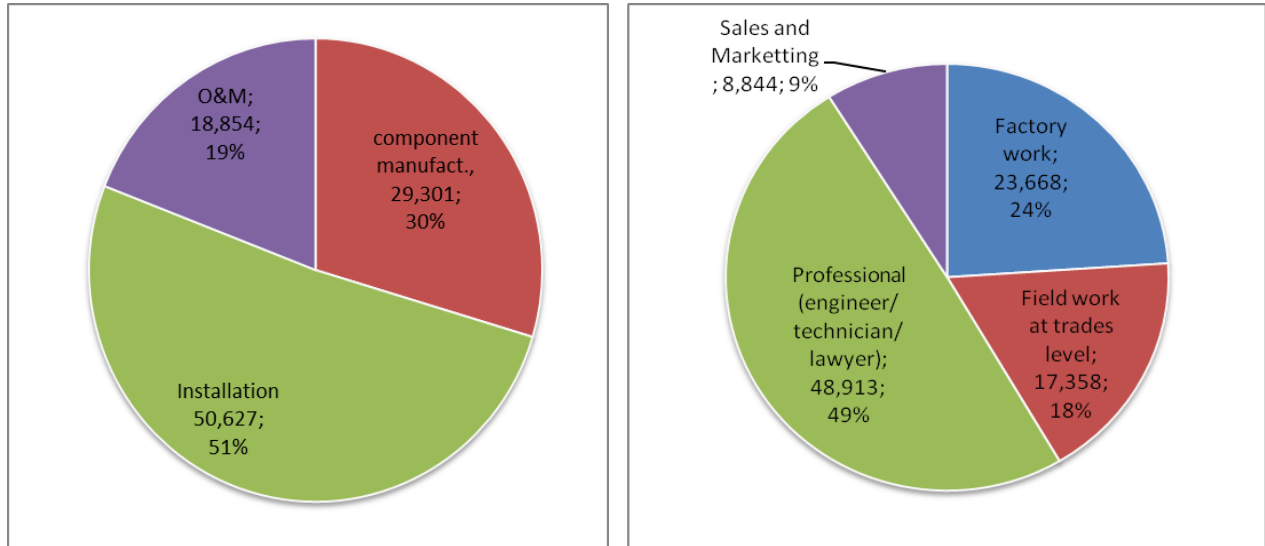
Table 7 presents employment estimates for installing solar PV on all suitable flat and sloped roofs in Toronto as per assumptions stated earlier. Results suggest that almost 100,000 local jobs can be expected in the solar industry under this scenario. As Figure 3 illustrates, the majority of these jobs are generated during the installation phase of projects and require professional (engineering/technical) skills.

*Close to 100,000 local jobs can be expected to be generated in the solar industry assuming city wide coverage of solar PV panels at suitable locations.*

Assumptions about percentage of local procurement of material and services are similar to those made for the 2 MW project. Estimations are made using 2020 employment intensity factors since the large magnitude of future expansions assumed here would take place over a long period of time. This results in about 20% lower job estimates compared to using 2010 values.

Table 7 - Total and local employment estimation for expansion of solar PV in Toronto

	Total person-years of employment	Percentage Local procurement	Person-years of local employment
<b>Pers-n-years of employment by Project Phase</b>	<b>127,629</b>	<b>77%</b>	<b>98,783</b>
<b>Manufacturing</b>	<b>58,148</b>	<b>50%</b>	<b>29,301</b>
raw material extraction	9,313	0%	0
component manufacturing	48,835	60%	29,301
<b>Installation</b>	<b>50,627</b>	<b>100%</b>	<b>50,627</b>
<b>Operation and Maintenance</b>	<b>18,854</b>	<b>100%</b>	<b>18,854</b>
<b>Person-years of employment by Occupation Type</b>	<b>127,629</b>		<b>98,783</b>
<b>Factory work</b>	<b>45,655</b>		<b>23,668</b>
<b>Field work at trades level</b>	<b>17,358</b>		<b>17,358</b>
<b>Professional (engineer/technician/lawyer)</b>	<b>54,864</b>		<b>48,913</b>
<b>Sales and Marketing</b>	<b>9,753</b>		<b>8,844</b>



**Figure 3 – Local employment breakdown – city wide expansion** [number of jobs; percentage of total]

Based on average system cost of \$7.6 M<sup>13</sup> the 2 MW solar PV project is expected to generate 4.7 total jobs and 3.5 local jobs for every \$1 million spent. These estimates are lower than those reported by the Greenpeace study<sup>14</sup> discussed earlier; however, estimates made here are based on average employment intensities. As the literature review summary suggest, some studies estimate up to 80% higher employment intensities than those used in our estimates.

## 5 Existing training programs

Table 8 and Table 9 provide an overview of programs offered in trades and engineering through colleges and universities in the city of Toronto and the region. This visualization follows a similar template used by a 2007 report by the Clean Air Partnership on skills for energy efficient construction<sup>15</sup>. Highlighted cells indicate that one or more programs on the specific area of interest are offered through the institution. In addition, some highlighted cells are accompanied by further description of the relevant component of the program. The tables also include a list of programs specifically on renewable energies. York University, Ontario College of Art and Design, Wilfred Laurier University and Trent University were also included in the inventory but do not offer relevant programs.

In addition to colleges and universities a number of other organizations offer training programs in the field. These include:

- The Ontario Solar academy;
- Ontario Sustainable Energy Association;
- Schüco Solar;
- Association of Canadian Community Colleges (ACCC);

<sup>13</sup> Wiser, Ryan; Galen Barbose & Carla Peterman (2009). "Tracking the sun, the installed cost of Photovoltaics in the US from 1998-2007". Lawrence Berkeley National Laboratory

<sup>14</sup> Greenpeace (2008). "Solar generation: solar electricity for over one billion people and two million jobs by 2020"

<sup>15</sup> Penney, Jennifer (2007). "Skills for energy efficient construction" Clean Air Partnership

- Canadian Renewable Energy Academy;
- North American Board of Certified Energy Practitioners (NABCEP);
- Kortright Centre;
- International Brotherhood of Electrical Workers; and
- Infinite Solar.

A recent study by the Toronto Renewable Energy Co-Operative provides details and descriptions of curricula and courses offered in Toronto and the GTA in the Solar PV field<sup>16</sup>. This reference guide can be accessed online at <http://www.greencollarcareers.ca/students/?q=node/19>. Appendix C provides descriptions of a few additional programs not mentioned in this reference guide.

---

<sup>16</sup> Toronto Renewable Energy Co-Operative (2011) "Solar Training Initiatives Reference Guide". Prepared for Strategic Growth and Sector Development, Economic Development and Culture, City of Toronto

Table 8 - College level programs related to the solar PV field

Educational Institution	Trades				Engineering			Solar/Renewable Energy specific programs
	Electrician	Facilities Maintenance Mechanic/ Electrical	Roofer	Welder	Civil	Electrical	Mechanical	
Centennial (Toronto)								Energy Systems Engineering Technology; IBEX - Industrial and Building Energy eXpertise Training; Solar Photovoltaic Training for Aboriginals.
Humber (Toronto)								Sustainable Energy and Building Technology.
Seneca (Toronto)								Photovoltaic Systems Program; Green Energy Systems; Bridging to green careers.
George Brown (Toronto)								
Willis (Toronto)								Ontario Solar Energy Technician Course; PV Technical Sales; Photovoltaic Installation Diploma
Mohawk (Hamilton)								Energy Systems Engineering Technology – Clean and Renewable Energy.
Fleming (Peterborough)								
Conestoga (Guelph)								Energy Systems Engineering.
Durham (Oshawa)								Renewable Energy Technician
Sheridan Oakville								
Georgian (Barrie)								Sustainable Systems Ontario Graduate Certificate program

Table 9 - University level programs related to the solar PV field

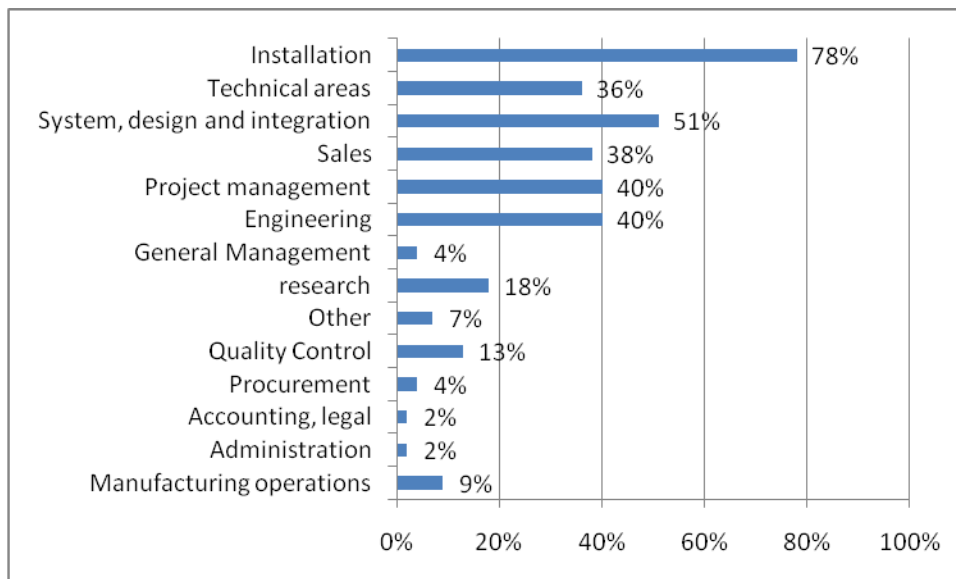
	Civil Engineering	Mechanical Engineering	Chemical Engineering	Electrical Engineering	Solar/Renewable Energy Specific Programs
University of Toronto	Terrestrial Energy System, Sustainable Energy System, Infrastructure for Sustainable Cities	Alternative Energy Systems			Minor in Sustainable Energy Engineering
Ryerson University			Sustainable Energy Resources/Technologies	Alternative Energy Systems	
University of Waterloo					Master of Engineering - Electric Power Engineering
McMaster University		Sustainable Energy Systems			Energy Engineering Technologies
University of Guelph		Wind and Solar Energy Design			Major in Wind and Solar power
UOIT					Energy Systems Engineering

## 6 Workforce and Training Challenges and Opportunities

The solar industry in Ontario has been growing quite rapidly in the last few years and is expected to continue to do so. There is the need to keep the industry sustainable by making sure adequate workforce is available as demand increases. The Canadian Solar Industries Association conducted a Canada wide labour force survey in 2009. The results of the survey suggest that:

“Solar companies anticipate a significant growth of 101% in the number of full-time equivalents to be employed by the end of 2011, despite the economic uncertainties that were starting to be experienced when the survey was conducted (October-November 2008)”<sup>17</sup>.

Over 40% of companies surveyed in this CanSIA study were experiencing labour shortages, especially in installation (78%) followed by systems design and integration (51%), project management (40%), and engineering (40%) (See Figure 4).



**Figure 4 - Functions expected to experience shortage of qualified personnel by 2011**<sup>17</sup>

Results of our own survey of manufactures, system installers and system developers, suggests that they would all need to hire more staff if demand were to increase. Our survey also confirms that there is high demand for all skill levels, including foreman, electricians, electrical engineers, mechanical engineer, manufacturing engineer, structural engineer, project managers and skilled installers.

<sup>17</sup> Electricity Sector Council (2009). “2009 Labour force survey of the Canadian Solar Industry”.

Recruitment challenges faced by the industry are largely a result of its rapid rate of growth. Some companies have expressed that this rapid growth has not allowed for adequate time and resources to even organize an HR department in order to deal with workforce recruitment. In addition, lack of qualified and experienced installation technicians, project managers and engineers with knowledge and background in the solar industry is posing a challenge. As the employment estimation results suggest, about 50% of generated jobs are expected to be in these occupations. Moreover, jobs at the trade levels are not often viewed as a career option and low salaries for apprenticeship, especially in manufacturing pose a recruitment challenge.

*Lack of qualified and experienced installation technicians, project managers and engineers with knowledge and background in the solar industry is posing a great challenge in workforce recruitment, not just in Toronto, but across the province and the country.*

*There is a need for a provincial or national certificate programs in solar installations. Without a certificate program individuals are not guaranteed that they would have the required skills they need in order to enter the workforce, even after going through a college/training program*

Although there are a number of training programs in the solar industry offered in the region, certain gaps remain:

There are currently no provincial or national certificate programs in solar installations. Without a certificate program individuals are not guaranteed that they would have the required skills they need in order to enter the workforce, even if they go through a college/training program. According to the 2009 CanSIA labour survey the introduction of an apprenticeship program for project management was a frequently-mentioned suggestion by respondents<sup>18</sup>.

A number of manufacturing companies have retooled their operations to supply the solar PV industry. It has been suggested that similar, there is a need for transition-programs for middle aged trade workers who want to transition into these new technologies. Seneca College offers a program titled “Bridging to Green careers”; however, the program is intended for higher skill levels such as engineers.

Concern has been raised over lack of adequate hands on experience by engineering graduates. Encouraging collaboration between university level engineering students and college level technology students as a part of their curriculum can help address this issue.

It is argued that most trade level jobs in installation/manufacturing have a high degree of transferability, so the training and skill development does not need to be very field-specific at this level. This is supported by the result of our survey that suggests that employees in manufacturing jobs are mostly trained in-house as opposed to through college programs. The larger challenge lies in finding the experts in the field of solar installation, which is where a large majority of expected jobs will be. We currently do not have the experts in manufacturing cell technologies. Some industry stakeholders believe we need these manufacturing experts in order to have the most advanced technology in Toronto and stay ahead of the curve.

<sup>18</sup> Electricity Sector Council (2009). “2009 Labour force survey of the Canadian Solar Industry”.

## 7 Local procurement opportunities

As the employment estimation model results suggest over 40% of the total number of jobs in the Solar PV industry lie in manufacturing of components. As a result, local procurement of manufactured components can significantly impact the number of local jobs. The Ontario FiT program requires that at least 60% of content (materials and labour) of a solar project be locally sourced from within Ontario. This has resulted in increased interest from both major and start up Solar PV component manufacturers in setting up in Ontario in order to take advantage of the market.

However uncertainty in government program and political climate is resulting in lack of security and hampering investments. In addition, as suggested by a report by Clean Edge<sup>19</sup> "manufacturers won't commit to increasing capacity, thereby driving down prices, without an assurance of an increase in demand. And buyers, especially large institutional buyers, won't commit to purchases without the assurance of lower prices."

The major manufactured components involved in the Solar PV industry include modules, inverters, racking, wiring and electrical in addition to monitoring softwares and refining of raw materials such as silicon. Table 10 provides a list of local solar component manufactures with sales offices located within the city of Toronto. It is evident that there are only two module manufacturers in Toronto, with Morgan Solar, the smaller of the two, currently in the process of relocating. It is also evident that expansion potential for local manufactures are mostly unknown, which is partially associated with uncertainties with the future of FiT in Ontario.

**Table 10 Solar PV Component Manufacturers with Sales Offices in Toronto<sup>20</sup>**

Company	Manufactured Component	Location of Manufacturing Plant	Production Capacity (MW)	Potential Expansion (MW)
Advanced Energy	Inverters	Toronto	N/A	N/A
Celestica	Inverters	Toronto	N/A	N/A
power One	Inverters	Scarborough	500	tbd
SAE Power	Inverters	Scarborough	500	tbd
Santerno (Carraro Group)	Inverters	TBA	500	N/A
Schneider Electric (Xantrex)	Inverters	Mississauga	N/A	N/A
Solarbridge Technologies	Inverters	Toronto	N/A	N/A
Sustainable Energy Technologies	Inverters	Cambridge	350	N/A
Canasia SolarCorp.	Modules	London	50	200
Celestica	Modules	Toronto	100	200
Eclipsall Energy Corp.	Modules	Looking for a facility in T	64	128
Morgan Solar Inc.	Modules	Toronto	5	N/A
Opel Solar International Inc.	Modules	Unknown	N/A	N/A
Opsun Panels Inc	Modules	Markham	50	N/A
Siliken	Modules	Windsor	50	N/A
SunEdison	Modules	New Market	50	200
Advanced Solar Investments Ltd.	Racking	Cobourg	N/A	N/A
Opsun Panels Inc	Racking	Markham	N/A	N/A
Samco Solar	Racking	Toronto	N/A	N/A
Sasco Strut	Racking	North York	N/A	N/A
Invotronics	Wiring and electrical	Scarborough	N/A	N/A
Protectolite Inc.	Wiring and electrical	Toronto	N/A	N/A

<sup>19</sup> Clean Edge (2002). "bringing Solar to Scale - A Proposal to Enhance California's Energy, Environmental, and Economic Security"

<sup>20</sup> Briz, Sylvie (2010). *Solar Supply Chain in the City of Toronto*. Prepared for Strategic Growth & Sector Development, Economic Development & Culture City of Toronto.

Table 11 provides an overview of the magnitude of solar component manufacturing activity in Toronto and municipalities in vicinity of Toronto. It is evident that activity outside of Toronto is also quite strong.

**Table 11 Solar PV Component Manufacturing Activity in Toronto and Vicinity<sup>21</sup>**

Manufactured Component	Number of manufacturing plants in vicinity of Toronto	Number of manufacturing plants in Toronto	Total
Inverters	18	5	23
Laboratory Testing	1		1
Modules	17	2	19
Monitoring Software	5		5
Racking	11	2	13
Silicon, Ingots & Wafers, Cells	1		1
Wiring & Electrical	5	2	7

The data presented above is based on a recent study on the state of solar supply chain in the city of Toronto<sup>21</sup>. The following are some of the main findings of the study.

- A number of module manufacturers have identified low iron tempered glass as a shortcoming in the supply chain, both locally and globally. While glass is not explicitly listed under the Ontario content requirements, it is a key input in manufacturing a cost effective module in Ontario.
- There are only two inverter manufacturers located in Toronto – Celestica and SAE Power, both contract manufacturers. Subcontracting appears to be a growing trend in Toronto and the industry in general.
- Many racking manufacturers have re-tooled their core operation to supply the solar PV industry. There are a few racking companies based in Toronto but the majority are located in more industrialized zones in the Toronto vicinity, directly north of the city.
- There are many wiring and electrical companies located in more industrialized areas in the Toronto vicinity but there appears to be a shortage of companies based within the city borders. Only a couple of companies were identified as having the potential to supply the solar industry.

It is evident that a number of opportunities exist for local procurement of solar PV component. In addition, there is currently existing demand for additional activity in manufacturing of a number of direct and indirect components. The decision to start a new business or to relocate an existing business to Toronto depends both on the future of the FiT program and how well Toronto is able to attract and foster new businesses.

<sup>21</sup> Briz, Sylvie (2010). *Solar Supply Chain in the City of Toronto*. Prepared for Strategic Growth & Sector Development, Economic Development & Culture City of Toronto.

## 8 Summary of Major Findings

The following summarizes the significant findings resulting from this study based on the research, surveys and interviews conducted.

- The potential economic benefits in employment generation and local business development associated with solar PV industry in Toronto are significant.
- Over 70 person-years of employment are expected to be generated through installation of 2 MW of solar PV on City facilities, 53 of which are expected to be local jobs. Increasing percentage of locally procured modules from 50% to 100% would increase local employment estimates by almost 25%.
- Close to 100,000 local jobs can be expected to be generated in the solar industry if under city wide coverage of solar PV panels at suitable locations.
- About half the estimated local employment is expected to be in system installation, and about one third in component manufacturing, with the remaining 15% in operation and maintenance.
- Almost half of the estimated local employment is expected to be in professional occupations, while the remaining are factory workers, field workers and sales and marketing representatives
- Lack of qualified and experienced installation technicians, project managers and engineers with knowledge and background in the solar industry is posing a great challenge in workforce recruitment, not just in Toronto, but across the province and the country,
- There is a need for a provincial or national certificate programs in solar installations. Without a certificate program individuals are not guaranteed that they would have the required skills they need in order to enter the workforce, even after going through a college/training program
- The need for a study on structural suitability of Toronto's building stock for solar PV installations is apparent. Lack of this data limits us from making accurate estimations on potential power and employment generation capacities.

## Appendix A

### City of Toronto Solar Workforce Survey

The City of Toronto Economic Development and Culture Division along with the Toronto Environment Office are undertaking a study to identify gaps in supply of skilled labour in the solar PV industry. This study will also identify gaps in university and college training program. The study will ultimately identify ways in which the City of Toronto can help with the uptake of the solar PV industry.

To help us reach these goals we ask that you take about 5 minutes to complete this online survey. We assure you that any information you provide is entirely confidential and the source of the data will not be reported. Only aggregate data from several sources will be analyzed.

If there are any questions or comments please feel free to call Sheyda Saneinejad at 416-397-4831 or e-mail her at [ssanein@toronto.ca](mailto:ssanein@toronto.ca).

Thank you!

#### 1. Please enter the name of your firm.

Please enter the name of your firm. .

Is your business located in the Greater Toronto Area and Hamilton?

#### 2. At what capacity is your business involved in the Solar PV industry?

- Design and manufacturing of components
- Installation
- Maintenance and monitoring

Others (please specify)

#### 3. What is your current production/installation volume (e.g. 10 to 15 MW/year, 1000 converters / year, etc.)?

Do you have existing capacity to produce/install more or would you need to hire more staff if demand were to increase?

What could the City of Toronto do to help the growth of the solar Industry?

#### 4. What are the top 4 skill areas that are most challenging to recruit?

- Electrician/Electrical technician
- Roofer
- Foreman
- General labourer

- Electrical Engineer
- Mechanical Engineer
- Structural engineer
- Manufacturing engineer
- Quality assurance engineer/technician
- Chemical/Process engineer

Others (please specify)

**5. What are the primary sources for finding labour in your field today?**

- head hunters
- on-line postings
- united way programs
- high school recruitment fairs
- OYAP
- union calls
- colleges
- father and son industry,
- inter-generational recruitment
- engineers through universities

Others (please specify)

**6. What partnerships are working to help you recruit and/or source labour?**

- Colleges
- co-ops
- OYAP/YMCA
- Friends and family
- Unions

Other (please specify)

**7. What are the top 3 - 5 barriers/obstacles for recruitment and selection today in GTA?**

- Perception of the trades not viewed as a career
- Nepotism

- Low salary for apprenticeship
- Shortage of qualified engineers
- Many youth don't have the Grade 12 Physics and Math
- Non English speaking people need CIC Enhanced Language Training

Others (please specify)

**8. What are the primary sources for training and workforce development today?**

- Union training centres
- Co-op in high schools
- Universities for Engineers
- Colleges and universities for green technology
- Colleges for construction trades
- INGO associations e.g. Canada Green Building Council
- On-job training
- Government training centres
- Associations e.g. Kortrigh Centre for conservation, Infiti Solar, CanSIA

Others (please specify)

**9. What partnerships exist in training and development?**

- Apprenticeships monitored by local Apprenticeship Councils
- Construction association and Ministry of Training, Colleges and Universities and Apprenticeship Council
- LEED training
- Home Builders Association and Carpenters Union
- Colleges of the Trades
- Co-ordination between locals and companies
- Unions working with universities and colleges

Others (please specify)

**10. What are some of the gaps in quality and quantity of training programs available through colleges and universities?**

## Appendix B

Table 12 Base job component-occupation type matrix<sup>22, 23</sup>

		Prof. Tech & Management	Clerical and sales	Services	Processing	Mach. Trades	Bench. Work	Structural Work	Misc.	Total
Manufacturing	Glass	50			50	50			50	200
	Plastics	50				250				300
	Silicon	1550	200	200	3300	200	200			5650
	Cell Manufacturer	800			1600		600	50	150	3200
	Module Assembly	3500			1600		8250	750	6850	20950
	Wires	150				1700				1850
	Inverters	750			1000	1000	1000	1000		4750
	Mounting frame	500	500			150	100	150	100	1500
Installation	System integration	8900	2850							11750
	Distributor Contractor	1500	1500						1000	4000
	Installer	2500						8000		10500
O&M	Operation and Maintenance <sup>24</sup>	10000								10000
<b>Total Hours</b>		<b>30250</b>	<b>5050</b>	<b>200</b>	<b>7550</b>	<b>3350</b>	<b>10150</b>	<b>9950</b>	<b>8150</b>	<b>74650</b>
<b>Total Jobs</b>		<b>15.43</b>	<b>2.58</b>	<b>0.10</b>	<b>3.85</b>	<b>1.71</b>	<b>5.18</b>	<b>5.08</b>	<b>4.16</b>	<b>38.09</b>

<sup>22</sup> Singh, Virinder and Jeffrey Fehrs (2001). "the work that goes into renewable energy" Research report: Renewable Energy Policy Projects, Washington, DC.

<sup>23</sup> All hourly values are adjusted from 2080 work hours to 1960 work hours per person-year of employment

<sup>24</sup> Value has been adjusted from original study to reflect 20 years' worth of operation and maintenance work

**Table 13 - Characteristics of Future Solar PV projections on flat roofs (systems greater than 10kW)**

Field	Source
Available roof area [m <sup>2</sup> ]	Weis, T., Haines, G. and Bell, J (2008) "Solar Opportunities for the City of Toronto" Pembina Institute
% of suitable structures	Anecdotal evidence and personal conversations
% of roof cover	Weis, T., Haines, G. and Bell, J (2008) "Solar Opportunities for the City of Toronto" Pembina Institute
Total PV covered area [m <sup>2</sup> ]	Calculated
Installed MW	Calculated
Annual output [MWh]	Calculated
System cost [\$/W]	Wiser, Ryan; Galen Barbose & Carla Peterman (2009). "Tracking the sun, the installed cost of Photovoltaics in the US from 1998-2007". Lawrence Berkeley National Laboratory
Total System cost [\$ Million]	calculated

**Table 14 - Characteristics of Future Solar PV projections on sloped roofs (systems smaller than 10kW)**

Field	Source
Available number of units	Weis, T., Haines, G. and Bell, J (2008) "Solar Opportunities for the City of Toronto" Pembina Institute
% suitable structures	Anecdotal evidence and personal conversations
Power output [kW/unit]	Weis, T., Haines, G. and Bell, J (2008) "Solar Opportunities for the City of Toronto" Pembina Institute
Installed MW	Calculated
Annual output [kWh per kW installed]	Calculated
Total annual output [MWh]	Calculated
System cost [\$/W]	Wiser, Ryan; Galen Barbose & Carla Peterman (2009). "Tracking the sun, the installed cost of Photovoltaics in the US from 1998-2007". Lawrence Berkeley National Laboratory
Total System cost [\$ Million]	Calculated

## Appendix C

### **Solar PV training initiatives in addition to those identified in the “Solar Training Initiatives Reference Guide”<sup>25</sup>**

#### **Energy Systems Engineering – Conestoga College**

This three year program offers an advanced diploma degree in energy systems engineering, by providing students theoretical and practical knowledge and experience for working in a wide variety of alternative energy fields. Areas of study include power systems, alternative energy sources such as wind, geothermal and solar, industrial solid state controls, instrumentation, programmable logic controllers and motor-generator controls. The program also has a co-op option, where well performing students get the opportunity to work as a paid employee in the industry for a year prior to graduation.

#### **Bridging to green careers – Seneca College**

This 8 month certificate program is designed to help internationally trained immigrants succeed in Canada’s environmental sector through intensive environmental training, job-specific language classes and employment counselling. The program focuses on two streams of built environment and the natural environment. Graduates of the BGC program will be able to examine building structures and systems, create operating strategies for energy demand and supply, minimize operating costs and environment/energy impacts, and work within a building sciences engineering team to achieve new levels of energy efficiency and environmental sustainability.

The following is a list of eligibility requirements:

- Be able to work in Canada
- Be a skilled immigrant living in Canada for less than five years
- Be unemployed and lacking in professional Canadian experience in your field of training
- Have a language level CLB 8+ or higher
- Have a professional and academic background in engineering or life sciences
- Have your international academic and professional credentials evaluated
- Complete an application and submit a current resume
- Attend an information session
- Successfully complete a panel interview

#### **IBEX - Industrial and Building Energy eXpertise Training – Centennial College**

The Centennial Energy Institute offers a self-paced independent study program meant for internationally trained professionals, career retrainers, and technology students/graduates to develop competency in facility energy management, energy conservation and energy retrofit projects. The IBEX program which is funded by the Ontario Power Authority (OPA) and is composed of 16 on-line modules, and 6 workshops that can either be attended in person, or viewed at a later date via a video archive. The on-line modules cover topics such as fuel combustion, combustion equipment, electrical energy, heat transfer and flow, energy measurement, water efficiency, energy auditing, energy costs, rate structures and scheduling, and energy efficiency.

---

<sup>25</sup> Toronto Renewable Energy Co-Operative (2011) "Solar Training Initiatives Reference Guide - City of Toronto and GTA". Prepared for Strategic Growth and Sector Development, Economic Development and Culture, City of Toronto