Situational Analysis of the Canadian Renewable Energy Sector with a Focus on Human Resource Issues

Final Report

Prepared by:

The Delphi Group

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Acknowledgements

This project was guided by an advisory committee of members from the following organizations:

Sector Councils:

BioTalent Canada
Construction Sector Council
ECO Canada
Electricity Sector Council

Government Agencies:

Environment Canada
Industry Canada
Natural Resources Canada

Industry Associations:

Canadian Bioenergy Association
Canadian GeoExchange Coalition
Canadian Solar Industries Association
Canadian Wind Energy Association

Other Organizations:

Association of Canadian Community Colleges
Canadian Council of Technicians and Technologists
Canadian Council of Professional Engineers

DISCLAIMERS

Interview Result Interpretation

Qualitative research seeks to develop insight and direction rather than quantitatively projectable measures.

Due to the sample size, the special recruitment methods used, and the study objectives themselves, it is clearly understood that the work under discussion in this report is exploratory in nature. The findings are not, nor were they intended to be, definitively projectable to a larger population.

Specifically, it is inappropriate to suggest or to infer that few (or many) industry representatives not interviewed as part of this study would indicate similar views simply because few (or many) participants in this study indicated such views. This kind of projection is strictly the prerogative of broader quantitative research.

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Executive Summary

Renewable energy markets are experiencing explosive growth and experts predict this trend will continue. For example, the global markets for wind and solar energy have been growing at a rate of 49% and 29% per year, respectively. Canada is blessed with vast renewable energy resources and abundant supplies of hydro, solar, wind, biomass, earth and ocean energy. The development of these renewable energy resources is expected to contribute to Canada's economic prosperity by providing diversified energy supply to industrial buyers, generating direct economic advantages and employment to local communities and indirect benefits such as improved air quality and lower greenhouse gas emissions. As of 2004, 2% of Canada's total electricity generation capacity was provided from emerging renewable technologies (excluding large scale hydro which represents a further 56% of Canada's electricity generation capacity).

Human Resources and Social Development Canada (HRSDC) is interested in assisting the renewable energy sector and its stakeholders to develop a human resource strategy that will ensure the sector has the right people with the right skills at the right time, now and into the future. As a result of this interest, HRSDC contracted the Delphi Group and Decima Research to provide information on the labour market for the renewable energy sector in Canada, gleaned from what is currently known in order to identify the next steps needed to assist the sector in developing a human resource strategy.

More specifically, HRSDC requested the Delphi Group and Decima Research to provide the following:

- An overview of the key characteristics defining the renewable energy (wind, photovoltaics, active solar thermal, etc.) sub-sectors in Canada and what is expected to change in the near term ;
- A reliable estimate of the labour demand in these sub-sectors over the next 5 and 10 year intervals;
- An overview of what the human resource issues affecting the sector are; and
- An overview of what the gaps in information are - gaps that would need to be filled via primary research in order to develop a comprehensive human resource strategy for the renewable energy sector.

The study focused on the following technologies:

- Wind turbines
- Photovoltaics
- Active solar thermal technologies
- Geoexchange/earth energy technologies
- Small scale hydropower
- Bioenergy technologies (heat and power applications only)
- Ocean energy technologies.

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The following tables summarize the key findings for each of the technologies reviewed.

Table ES1 – Key Findings for the Wind Energy Sub-sector

Key Statistics		Main Drivers	Main Human Resource Issues	Information Gaps	Recommended Actions
Wind					
Estimated Cumulative Installed Capacity	1341 $MW_{electric}$ (2006)	***Positive*** ▪ Provincial renewable electricity policies ▪ Consumer demand for clean energy which drives federal and provincial policies ***Negative*** ▪ Uncertainty around the future of the Wind Power Production Incentive, or the creation of a new	▪ The industry is competing with the oil and gas sector for most kinds of skilled labour ▪ Comfort with heights is a major issue for recruiting for service and maintenance positions ▪ Ability to import desired skills that are not available within Canada is a problem ▪ Availability of skilled labour may become a bottleneck for the industry if it continues to grow as rapidly and a focused recruitment strategy is not in place	▪ A clear picture of the present Canadian large wind turbine manufacturing capacity and its expected growth	▪ Address the apparent disconnect between industry, trade unions and wind technician training program developers ▪ Investigate the possibility of integrating wind energy related curricula into standard engineering and trades programs ▪ Encourage enrolment into related trades or engineering programs ▪ Develop a targeted public information program similar to that presently being executed by the Canadian nuclear industry to
Near Term Annual Market Growth Outlook	44% [1]				
Estimated Present Labour Force (Full-time Equivalent)	1,200 [2] (2005)				
Projected Future Labour Force in 2012 (Full-time Equivalent)	9,671 [3]				

Key Statistics		Main Drivers	Main Human Resource Issues	Information Gaps	Recommended Actions
Projected Future Labour Force in 2017 (Full-time Equivalent)	23,627 [4]	incentive, and the targets of such an incentive ▪ Consumer attitudes, e.g. "Not in My Back Yard" (NIMBY) phenomenon ▪ Transmission constraints: new transmission capacity is required to access, and tie into the grid, sites with strong wind resources	▪ Recruitment into the industry and into engineering and trades programs relevant to power or turbine systems is insufficient ▪ The addition of a few wind turbine system related courses or credits to existing trades programs and engineering degrees may be desirable ▪ For the manufacturing sector, there is a need for traditional trade skills with some additional training or experience with specific materials used in various components (e.g. composites, steel) ▪ The most significant issues in the near term that will impact skilled labour retention in the industry is the wear and tear on the bodies of service technicians who have to repeatedly climb 80 to 100 m towers		help overcome recent image problems encountered by the wind industry ▪ Decision-makers in labour market planning should stay up-to-date on Canadian developments in the manufacturing segment of the supply chain ▪ Training institutions and industry stakeholders should monitor the service and maintenance contracts situation as service contracts are approaching completion for many wind farms and new service contract agreements with equipment suppliers are becoming shorter and more cost prohibitive meaning that significant additional servicing options may be required in the near term ▪ Investigate the issues around immigration and the ability to import skill sets not available in Canada

[1] Growth rate of 44% corresponds to the average Canadian growth rate over the past 5 years. Growth projections stated by Industry informants ranged from 20% to 100% annually.

[2] Source: CanWEA, *Economic Contribution of the Wind Energy Industry in Canada – Results of the 2006 Annual Survey of CanWEA Members*, Insightrix Research, 2006.

[3] Assumes an average annual labour force growth rate equivalent to the market growth rate of 44% from 2006-2012 and an annual labour productivity gain of 2%.

Key Statistics	Main Drivers	Main Human Resource Issues	Information Gaps	Recommended Actions

[4] Assumes an average annual labour force growth rate equivalent to half of the market growth rate of 44% (22%) from 2012-2017 and an annual labour productivity gain of 2%.

Table ES2 – Key Findings for the Photovoltaic Sub-sector

Key Statistics		Main Drivers	Main Human Resource Issues	Information Gaps	Recommended Actions
Photovoltaics					
Estimated Cumulative Installed Capacity	2.1 $MW_{electric}$ (2004)	***Positive*** ▪ The Ontario Standard Offer Program ▪ Net Zero Energy Home (NZEH) initiative (by CMHC) ***Negative*** ▪ In Canada the price of traditional electricity is very low, making it difficult to bridge the cost gap between PV	▪ People with solar design and systems experience are difficult to find in Canada ▪ Immigration issues in efforts to import skills ▪ International business development and sales roles are a challenge to fill ▪ Market is not established enough to support broader development of training programs ▪ Turnover in PV installation firms is significant	▪ More exact and recent data on the size and characteristics of the photovoltaic sub-sector labour force are required ▪ The disparity between growth projections for Ontario and the rest of the country should be monitored and quantified to provide an	▪ Focus should initially be on recruitment into existing training programs once the market starts to grow significantly ▪ Need to integrate PV related curriculum into engineering programs, specifically electrical engineering. ▪ Investigate the issues around immigration and the ability to import desired PV skills that are not available within Canada
Near Term Annual Market Growth Outlook	M: 50% [1] I: 25%				
Estimated Present Labour Force (Full-time Equivalent)	800 [2] (2006)				
Projected Future Labour Force in 2012 (Full-time Equivalent)	4,408 [3]				

Key Statistics		Main Drivers	Main Human Resource Issues	Information Gaps	Recommended Actions
Projected Future Labour Force in 2017 (Full-time Equivalent)	10,857 [4]	technologies and grid electricity ▪ Lack of policies and economic incentives for stimulating PV market growth ▪ Lack of standardization of installation practices ▪ Restrictive building codes and municipal by-laws ▪ Shortage of solar grade silicon feedstock		indication of the impacts of standard offer program type initiatives on PV related labour demand ▪ Need to evaluate differences between labour requirements for off-grid versus grid connected PV applications	

[1] Annual growth rate of 50% for the manufacturing (M) activity sector and 25% for the installation and maintenance (I) activity sector. The differing rates are based on differences between responses from manufacturing type and systems installation type industry informants interviewed as part of this study. The actual range of growth rates cited by informants ranged from 20% to >100%.

[2] Based on time and industry development adjusted 2005 labour force data projected to 2006 from labour force estimate from:
Ayoub, Josef and Lisa Dignard Bailey, *Photovoltaic Technology Status and Prospects – Canadian Annual Report 2004*, Natural Resources Canada, CANMET Energy Technology Center – Varennes, 2005.

[3] Assumes an average annual labour force growth rate equivalent to the market growth rate of 50% for the manufacturing operations and 25% for installation and maintenance related operations from 2006-2012. This also assumes that 50% of manufacturing operations growth and 100% of installation and maintenance related operations growth are met domestically from 2006-2017.

[4] Assumes an average annual labour force growth rate of 25% for the manufacturing operations and 20% for installation and maintenance related

Key Statistics	Main Drivers	Main Human Resource Issues	Information Gaps	Recommended Actions
operations from 2012-2017 and a decrease of labour requirements of 40% for manufacturing operations and 15% for installation and maintenance related operations after 2012.				

Table ES3 – Key Findings for the Active Solar Thermal Sub-sector

Key Statistics		Main Drivers	Main Human Resource Issues	Information Gaps	Recommended Actions
Active Solar Thermal					
Estimated Cumulative Installed Capacity	495 $MW_{thermal}$ (2003)	***Positive*** ▪ Consumer attitudes and demand ▪ Cost of traditional energy sources ▪ Increased manufacturing throughputs are reducing the cost of technology ***Negative*** ▪ Lack of strong policies to promote the use of solar thermal technologies ▪ Building codes are not compatible with solar thermal installation ▪ Little access to low cost (low interest) capital on the consumer side	▪ Hiring was stated as a significant challenge for smaller firms, which represent most firms in the active solar field, due to the investment required to bring new staff up to speed ▪ Lack of training available for solar thermal at both the college and university levels ▪ Lack of resources (qualified trainers) to adequately roll out training programs is expected ▪ Retention has been a significant issue across the sub-sector, especially with respect to technicians and general labour	▪ No major strategic information gaps were identified for this sub-sector.	▪ Growth of this sector should be monitored closely to ensure timely response to its needs ▪ Explore the possibility of adding a solar water heating course to standard plumbing trade courses or solar air heating courses to standard HVAC training to prepare for expected increase demand for these skill sets. ▪ Explore certification requirements and issues for active solar thermal systems installers
Near Term Annual Market Growth Outlook	35% [1]				
Estimated Present Labour Force (Full-time Equivalent)	180 [2] (2003)				
Projected Future Labour Force in 2012 (Full-time Equivalent)	927 [3]				
Projected Future Labour Force in 2017 (Full-time Equivalent)	2,678 [4]				

Key Statistics	Main Drivers	Main Human Resource Issues	Information Gaps	Recommended Actions

[1] The near term growth rate of 35% is a conservative estimate based on projected growth rates stated by industry informants which ranged from 30% to 100% annually.

[2] Source: Industry Canada, *Renewable Energy – Solar Energy*, http://strategis.ic.gc.ca/epic/internet/inrei-ier.nsf/en/h_nz00007e.html, viewed 11/22/2006

[3] Assumes an average annual labour force growth rate equivalent of 35% from 2003-2012 and an annual labour productivity gain of 2%.

[4] Assumes an average annual labour force growth rate of 25% for the solar air heating activity sector and 20% for solar water heating activity sector from 2012-2017 and an annual labour productivity gain of 2%.

Table ES4 – Key Findings for the Geoexchange/Earth Energy Sub-sector

Key Statistics		Main Drivers	Main Human Resource Issues	Information Gaps	Recommended Actions
Geoexchange/Earth Energy					
Estimated Cumulative Installed Capacity	>435 $MW_{thermal}$ (2005)	***Positive*** ▪ Consumer attitudes/demand ▪ New applications for technologies ***Negative*** ▪ Little access to low cost (low interest) capital on the consumer side ▪ Municipal level policies can have a negative impact on the net cost of geoexchange installations	▪ Training courses are being developed without first clearly defining occupational standards ▪ There is a shortage of people with geoexchange/earth energy experience and the market for such people is very competitive	▪ Developing better data on the size of the geoexchange/ earth energy sub-sector and labour force should be a priority ▪ Clear definition of required occupational standards ▪ Precise description of types of skills that require specialized training for geoexchange specific certification	▪ Establishment of a clear definition of the required occupational standards ▪ Assisting the CGC in their efforts to develop training programs would benefit the sub-sector ▪ Develop geoexchange related curriculum for integration into existing programs
Near Term Annual Market Growth Outlook	20% [1]				
Estimated Present Labour Force (Full-time Equivalent)	150 [2] (2006)				
Projected Future Labour Force in 2012 (Full-time Equivalent)	337 [3]				
Projected Future Labour Force in 2017 (Full-time Equivalent)	1,096 [4]				

[1] The near term growth rate of 20% is a conservative estimate based on projected growth rates stated by industry informants which ranged from 20% to 40% annually.

[2] This estimate is based on an annual geoexchange system installation rate of 1,000 units (Source: Industry Canada) and an estimated labour requirement of 150 full time job years (Source: Government of Manitoba) per 1000 systems installed annually.

[3] Assumes an average annual labour force growth rate equivalent of 20% from 2006-2012 and an annual labour productivity gain of 2%.

[4] Assumes an average annual labour force growth rate of 20% from 2012-2017 and an annual labour productivity gain of 2%.

Key Statistics	Main Drivers	Main Human Resource Issues	Information Gaps	Recommended Actions

Table ES5 – Key Findings for the Small Hydropower Sub-sector

Key Statistics		Main Drivers	Main Human Resource Issues	Information Gaps	Recommended Actions
Small Hydropower					
Estimated Cumulative Installed Capacity	2,000 $MW_{electric}$ (2005)	***Positive*** ▪ Provincial renewable energy RFPs and the Ontario Standard Offer Program (SOP) ▪ Anticipated support for green power procurement ***Negative*** ▪ Transmission constraints ▪ Potential bottleneck in supply of hydro turbine manufacturing capacity	▪ Access to skilled construction workers is a challenge as a result of competing demand from housing and oil and gas industries ▪ New people with small hydropower experience simply are not being developed ▪ Ageing workforce poses a major turnover concern in the near term ▪ There does not appear to be a single small hydropower specific course or education program available to the industry ▪ Tradespeople need more computer and electronics skills ▪ Lack of new graduates with power engineering expertise ▪ The industry has not been effectively promoting itself with the future labour force	▪ A review of the courses and education programs available for conventional (large scale) hydropower projects should be conducted ▪ There is conflicting data on the size of the existing small hydropower subsector labour sector which could be clarified through additional primary research ▪ There is a need to explore specific training requirements for hydro turbine manufacturing labour	▪ Need to focus on recruitment into the industry ▪ Need to develop trades programs with an added element of systems/electronics training (e.g. for pipefitters) ▪ Need to monitor turbine manufacturing situation and prepare to respond to increased demand for related skills resulting from potential supply bottleneck
Near Term Annual Market Growth Outlook	10% [1]				
Estimated Present Labour Force (Full-time Equivalent)	2,000 [2] (2006)				
Projected Future Labour Force in 2012 (Full-time Equivalent)	2, 912 [3]				
Projected Future Labour Force in 2017 (Full-time Equivalent)	7,150 [4]				

[1] The near term growth rate of 10% is a conservative estimate based on projected growth rates stated by industry informants which ranged from 10% to

Key Statistics	Main Drivers	Main Human Resource Issues	Information Gaps	Recommended Actions

20% annually.

[2] Source: Natural Resources Canada – CANREN, *Small-Scale Hydro*, http://www.canren.gc.ca/tech_appl/index.asp?CaID=4&PgID=27, viewed 11/22/2006.

[3] Assumes an average annual labour force growth rate equivalent of 10% from 2006-2012, an annual labour productivity gain of 2% and that 100% of the growth is met through domestic operations.

[4] Assumes an average annual labour force growth rate of 10% from 2012-2017 , an annual labour productivity gain of 2% and that 100% of the growth is met through domestic operations.

Table ES6 – Key Findings for the Bioenergy Sub-sector

Key Statistics		Main Drivers	Main Human Resource Issues	Information Gaps	Recommended Actions
Bioenergy					
Estimated Cumulative Installed Capacity	>285 $MW_{electric}$ Thermal capacity data were not found	***Positive*** ▪ Cost of traditional energy sources ▪ Changes in current technology and introduction of new technologies ***Negative*** ▪ The broad range of approaches for harnessing bioenergy is limiting development of a focused industry strategy ▪ Lack of a clear policy framework to promote bioenergy	▪ There is a skills gap in the area of technical sales ▪ There is an expected shortage of general skilled labour that may impact industry growth ▪ Competition with other high paying sectors such as oil and gas is a concern for retention of skilled labour ▪ Competition for skilled people is also expected within the sub-sector with the projected rapid growth in some areas of the sub-sector	▪ There is presently a lack of clear data on the exact size, both in terms of generation capacity and labour force, of the Canadian bioenergy industry ▪ Data on specific potential growth for specific bioenergy applications is lacking.	▪ There is a need to bring the sub-sector's stakeholders together in a more focused way to develop a long term policy and human resource roadmap. ▪ Some effort in recruiting people into the industry will likely have to be made in the near term as the sub-sector is expected to experience significant and rapid growth in several application areas
Near Term Annual Market Growth Outlook	E: 62.5% and C: 20% [1]				
Estimated Present Labour Force (Full-time Equivalent)	2,500 [2]				
Projected Future Labour Force in 2012 (Full-time Equivalent) (Low End to High End)	10,809 [3]				
Projected Future Labour Force in 2017 (Full-time Equivalent) (Low End to High End)	19,373 [4]				

[1] Annual growth rate of 62.5% for emerging technologies (E) sector and 20% for the conventional technologies (C) sector. These growth rates are

Key Statistics	Main Drivers	Main Human Resource Issues	Information Gaps	Recommended Actions
conservative estimates based on interviews with industry informants and industry trends. [2] Estimate based on 6.5% of the total labour force for the overall bioproducts sector. [3] Assumes an average annual labour force growth rate equivalent to 62.5% (the mid-point of the range of estimated growth rates cited by industry informants involved in the emerging technologies sector) for the emerging technologies portion and 20% for the conventional technologies portion of the market from 2006-2012. This also assumes an annual labour productivity gain of 2% and that 70% of the emerging technologies activities and 100% conventional technology activities are conducted through domestic operations. [4] Assumes an average annual labour force growth rate equivalent to 31.3% for the emerging technologies portion and 10% for the conventional technologies portion of the market from 2012-2017. This also assumes an annual labour productivity gain of 2% and that 70% of the emerging technologies activities and 100% conventional technology activities are conducted through domestic operations.				

Table ES7 – Key Findings for the Ocean Energy Sub-sector

Key Statistics		Main Drivers	Main Human Resource Issues	Information Gaps	Recommended Actions
Ocean Energy					
Estimated Cumulative Installed Capacity	>20 $MW_{electric}$	▪ Detailed site analysis and characterization has not yet been completed for Canada's shores ▪ Once ocean energy technologies have completed the development cycle, it is foreseeable that grid access and transmission limitations will have a major impact on their potential market penetration ▪ Changes and improvements in technology and related intellectual property are expected to drive the market for individual technology developers and marketers	▪ Most firms presently active in the field are focused on research, development and demonstration activities ▪ Competition for key experienced staff will be a major concern for the sub-sector when it grows since the industry is small now and there are very few people with expertise	Not assessed	Not assessed
Near Term Annual Market Growth Outlook	Not available				
Estimated Present Labour Force (Full-time Equivalent)	Not available				
Projected Future Labour Force in 2012 (Full-time Equivalent) (Low End to High End)	Not available				
Projected Future Labour Force in 2017 (Full-time Equivalent) (Low End to High End)	Not available				

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1.0 Purpose of Study

Human Resources and Social Development Canada (HRSDC) is interested in assisting the renewable energy sector and its stakeholders to develop a human resources strategy that will ensure that the sector has the right people with the right skills at the right time, now and in the future. HRSDC was of the view that the first step in developing such a human resources strategy was to gather the facts and information upon which to base decisions. HRSDC therefore hired the Delphi Group and Decima Research to provide this information on the renewable energy sector in Canada, gleaned from what is currently known at sufficient depth to identify the next steps needed to assist the sector in developing a human resource strategy.

More specifically, HRSDC contracted the Delphi Group and Decima Research to provide the following:

- What the renewable energy (wind, photovoltaics, active solar thermal, etc.) sub-sectors in Canada look like now and what they are expected to look like in the near term future;
- A reliable estimate of the labour demand in these sub-sectors over the next 5 and 10 year intervals;
- What the human resources issues affecting the sector are; and
- What the gaps in information are, gaps that would need to be filled via primary research in order to develop a comprehensive human resource strategy for the renewable energy sector.

2.0 Renewable Energy and Canada

As the Canadian economy continues to grow, access to affordable sources of energy is central to sustaining this growth. Intensifying demand for energy in Canada and worldwide will continue well into the foreseeable future. In fact, world energy consumption is projected to expand by 54% by 2025 [**RE1**]. Meanwhile, however, traditional energy supplies are becoming increasingly constrained and their use is becoming a global environmental concern.

Many factors are steering world energy supplies away from traditional fossil fuel sources and toward renewable energy technologies, factors such as:

- International action on climate change
- Preoccupation with energy security
- Demand for improved air quality
- Technological advances making non-traditional sources of energy more economical, and
- Energy deregulation.

Consequently, renewable energy markets are experiencing explosive growth and experts predict this trend will continue. For example, the global markets for wind and solar energy have been growing at a rate 49% and 29% per year, respectively [**RE2**]. *Figure RE1* provides an overview of the average annual growth rate of capacity for each of the major renewable energy resources.

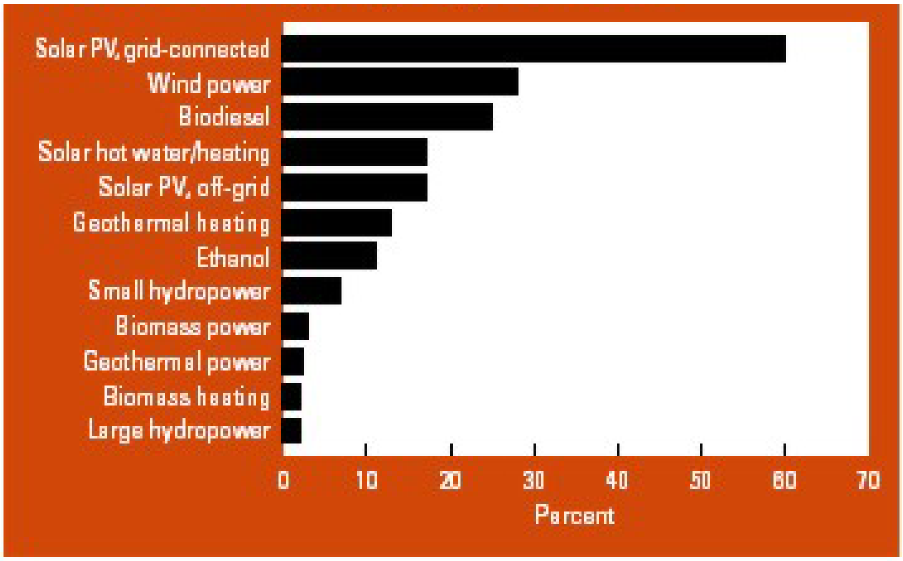

Figure RE1 – Average annual growth rates of global renewable energy capacity from 2000 to 2004 [RE3]

Canada is blessed with vast natural resources and abundant supplies of hydro, solar, wind, biomass, earth and ocean energy. The development of these renewable energy resources is expected to contribute to Canada's economic prosperity by providing diversified energy supply to industrial buyers, generating direct economic advantages and employment to local communities and indirect benefits such as improved air quality and lower health costs. As of 2004, 2% of Canada's total electricity generation capacity was provided from emerging renewable technologies (excluding large scale hydro which represents a further 56% of Canada's electricity generation capacity) [**RE4**].

Most renewable energy industries (except hydropower which is very well developed) are in their infancy in Canada, but they are extremely well positioned to expand their technology offerings, manufacturing capacity, product supply and services. In particular, Canada has or is developing significant capabilities in:

- Large and small scale wind generation
- Solar photovoltaic technology manufacturing and systems installation
- Active solar thermal technologies for space, process and water heating
- Earth energy
- Small scale hydropower generation
- Conversion of biomass into useful forms of energy
- Ocean energy resource assessment and generation technologies

3.0 Definition of Renewable Energy and Scope of this Study

3.1 Definition of Renewable Energy

"Renewable energy" refers to a number of energy resources that can be converted to useful electrical, thermal or mechanical energy without depleting natural resources. In other words, renewable energy resources, if properly managed, can be replaced by natural processes at a rate that is equal to or faster than the rate at which they are consumed [**DS1, DS2**]. Furthermore, renewables can avoid or reduce air emissions such as greenhouse gases and criteria air contaminants, as well as reduce water consumption, thermal pollution, waste, noise, and adverse land-use impacts. Perhaps most importantly, renewables result in virtually no net carbon dioxide (the most commonly emitted greenhouse gas) emissions to the atmosphere and are therefore an integral tool in climate change mitigation. It is expected that the broad and appropriately managed dissemination zero-emitting renewables could help to significantly reduce most of the environmental impacts of energy use in the years to come.

Renewable energy resources include the following:

- **Solar energy:** Energy from the sun's rays can be used to generate thermal energy for direct space, water or process heating or to produce steam through the use of solar concentrator systems to drive electric generators. Solar energy can also be directly converted to electricity through the use of photovoltaic devices, which generate electricity through the excitation of electrons in large surface area semiconductor devices.

- **Wind energy:** Wind is caused by uneven heating of the earth's surface by the sun. It is a globally abundant and free kinetic energy resource that can be converted into useful mechanical energy or electricity using wind turbine technologies. Wind turbine technologies can range in size from small scale single residence or remote power systems to towering multi-megawatt systems that can be grouped in wind farms to produce electricity on a utility scale.

- **Bioenergy:** Bioenergy is essentially the conversion of biomass, mainly organic plant materials which are produced by the process of photosynthesis, into useful forms of energy, such as heat, electricity and fuels. Useful bioenergy feedstocks include wood and wood waste, process waste, agricultural crop wastes, energy crops, the organic fraction of municipal garbage, construction and demolition waste and sewage or manure. There are several approaches to converting biomass into bioenergy and they include:

  - *Direct combustion:* Burning biomass directly to produce heat for space or water heating or to produce steam to drive a turbine for electricity generation.
  - *Anaerobic Digestion:* Decomposition of waste streams such as manure or municipal solid waste in the absence of oxygen to produce a combustible gas similar to natural gas which can be used to drive an electric generator or to generate heat.
  - *Pyrolysis:* Thermo-chemical process used to convert solid biomass to liquid and solid fuels that can be more easily stored, transported and burned than solid wood wastes.
  - *Gasification:* Conversion of forestry, agricultural and municipal residues into syngas (similar to natural gas, but lower in energy content), which once cleaned and

conditioned, can be burned in gas turbines and gas-powered engines or used as a feedstock for the production of methanol and ethanol.

- *Production of Biofuels:* Conversion of biomass feedstocks such as sugars, starches and oils into useful fuels such as ethanol, mainly used for transportation applications, and biodiesel which can be used in transportation or heat and power applications [**DS3-DS8**].

- **Geothermal:** Geothermal energy refers to a source of steam or hot water trapped in the Earth's crust that can be used to power turbines to generate electricity or provide process and space heat.

- **Earth energy:** Earth energy is used by ground source heat pumps (GSHP) to heat or cool buildings. They work by extracting heat from underground soil, deep water bodies or other thermal sources to heat a building in the winter, or by channeling heat back below ground or under water to cool a building in the summer.

- **Hydropower:** Hydropower converts the natural flow of water into electricity. The energy is produced by the fall or flow of water turning the blades of a turbine [**DS9**]. Small (<50 MW) hydroelectric plants can be developed as entirely new projects or at existing dams and have been constructed in connection with water level control of rivers, lakes and irrigation schemes.

- **Ocean energy:** There are many forms of ocean energy, including wave energy, tidal energy, ocean current energy, offshore wind, salinity gradient energy and ocean thermal gradient energy. The two most promising forms of ocean energy in the near term are tidal and wave energy. Tides and tidal currents are generated by gravitational forces of the sun and moon on ocean waters of the rotating earth and can be captured using modern underwater turbine technologies. Ocean waves are generated by wind blowing over ocean surfaces and wave energy is generated by the use of the kinetic energy in these waves to mechanically power generation equipment [**DS10**].

Most renewable forms of energy, other than geothermal and tidal power, ultimately derive from solar energy. For example:

- Wind energy derives from winds, which are generated by the sun's uneven heating of the atmosphere.

- Hydropower depends on precipitation which again depends on sunlight's power to evaporate water.

- Energy from biomass derives from plant material produced by photosynthesis using the power of the sun [**DS2**]

3.2 Study Boundaries

For the purpose of keeping the scope of this study manageable while avoiding overlap with other research initiatives, it focuses on technologies used for renewable electricity generation and renewable thermal applications (heating and cooling) that are emerging as Canada's renewable energy resources. Technologies used in mechanical energy applications, such as transportation or water pumping, have been excluded from the scope of this study. Furthermore, it was decided by the committee steering the project that the most useful and realistic forecast period for this study would be 5-10 years. Consequently, any renewable energy technologies that are not expected to reach commercialization within this forecast period will only be addressed in a cursory manner to provide preliminary technical and market status information.

Three categories of technology can potentially be used in renewable electricity projects: (1) generating technologies; (2) power conditioning technologies; and (3) storage technologies.

Generating technologies are those which convert a renewable energy resource to electricity. Examples include photovoltaic cells, wind turbines, hydroelectric turbines and biomass fueled turbine generators. There are two broad categories of renewable electricity generating technologies, intermittent and baseload (dispatchable). Intermittent technologies include solar and wind, which due to the nature of their energy resources, cannot generate electricity continuously. Conversely, baseload technologies such as small hydro (with storage) and biomass combustion can often generate electricity continuously as long as the energy resource is effectively managed [**DS11**]. Hydropower plants with storage capacity can also be used to support intermittent renewables.

Power conditioning technologies are those, exclusive of generation, which condition the electricity generated so that it can be put to use in standard applications or transported through power transmission infrastructure. These include inverters for converting DC into AC power and transformers for converting voltages.

Storage technologies are those which allow electricity generated from renewable energy sources at one time to be used at a later time. The most prominent technologies for storage are battery technologies.

As previously stated, the emphasis of this study will be on generating technologies. That said, it is important to note that power conditioning technologies, in particular, and storage technologies play a significant role in renewable electricity projects. Power conditioning technologies are essential in grid-connected projects while storage technologies are essential for off-grid projects. For this reason, this study will aim to include these technologies in the market and labor demand forecasts as much as possible with the available data [**DS12**].

It is also important to note that large scale storage battery technologies, such as Vanadium Redox-Flow technology, may play an increasing role in grid-connected applications as the share of intermittent renewable electricity technologies increases within electricity portfolios. Conversion of renewable electricity into hydrogen may also be a viable option for energy storage. However, these are expected to be much longer term (>10 years) developments and are consequently <u>not included in the scope</u> of analysis of this study.

In addition to the exclusions listed above, the following energy technologies are <u>excluded from the scope</u> of this study:

- **Energy efficient generating technologies (fuel cells and microturbines) -** These technologies are generally not expected to be used within the forecast period to generate electricity directly from renewable energy sources.

- **Geothermal power generation -** Canada's geothermal resources are limited, located mainly in British Columbia and western Alberta, and very little development of these resources is projected within the forecast period.

- **Solar thermal concentrating electricity generation technologies -** These technologies are only suitable for areas of the world with the highest rates of solar radiation. Canada, being a northern country does not have such rates, thus making it uneconomic to use these technologies within the Canadian territory.

- **Ethanol and biodiesel:** Both of these fuels are primarily targeted at transportation applications. Where separate data exist for the application of biodiesel to heat and power applications it has been included in this study.

- **Ocean energy technologies:** Most ocean energy technologies still require significant development to achieve commercialization. As previously stated, the two most promising ocean energy technologies are tidal and wave power. However, significant commercialization is expected to occur beyond the study's forecast period. Therefore, only a brief review of the market status of these two technologies has been provided along with any labor demand forecasts and human resource commentary possible with existing information.

- **Small-scale residential wood pellet and wood stove technologies:** These are well established technologies and their market is not expected to grow on the scale of other renewable technologies. It was therefore deemed of limited value to include these technologies in the scope of this study.

- **Large-scale hydropower:** Large-scale hydropower (>50 MW) was not included within the scope of this study. It was felt that the large hydropower industry is very well established in Canada and that it did not require the same level of attention as the smaller, less developed small-scale hydropower sub- sector.

The study therefore focused on the following technologies:

- Wind turbines
- Photovoltaics
- Active solar thermal technologies
- Geoexchange/earth energy technologies
- Small scale hydropower
- Bioenergy technologies (heat and power applications only)
- Ocean energy technologies

4.0 Wind

4.1 Overview of the Industry

Wind energy is the fastest growing energy source on the planet in terms of annual installed capacity [**W1**]. Worldwide, the wind energy industry market was estimated to be worth $25 billion in 2005 and the total installed wind generation capacity has now surpassed 59,000 megawatts (MW); roughly twice the electricity demand of Ontario [**W2**]. Growth has been especially rapid in recent years where the global wind power capacity has expanded at rates greater than 20% annually. In 2004 alone, the global wind industry installed more than 8,000 MW of wind capacity. With this growth, the industry has been doubling in size every three years. As a result, several major energy multinationals have become increasingly active in wind generation projects in recent years, such as GE, Siemens, TransCanada and Shell. They recognize the tremendous potential of the industry [**W1**].

Development of this renewable energy resource has been most significant in Europe where several countries count on wind energy to provide more than 5% of their electricity. The United States and Denmark essentially pioneered the industry. The US abandoned most of its efforts in this field from the 1970s and 1980s as a result of changes in energy policy and reduced pressures on the cost of traditional fossil fuel resources. In contrast, Denmark strategically maintained focus on wind energy resource development and now produces 20% of its electricity from wind, corresponding to roughly 3200 MW. As a result of their early development of wind technology, Danish wind technology manufacturers have dominated the world market, and today account for 38% of global sales [**W2, W3**].

In more recent years, Germany has become the market leader for installations, with a cumulative installed wind generation capacity of 15,688 MW by the end of 2004, enough to supply 6.2 % of the domestic demand. The wind industry in Germany generates more than CA$5.9 billion annually and employs in excess of 45,000 people [**W3**].

Spain is also becoming a major player with a total installed capacity of 6420 MW (5% of demand) by 2004. Not surprisingly, roughly 80% of the wind turbines sold worldwide are manufactured by European companies [**W3**]. According to Wind Force 12, published by the European Wind Energy Association (EWEA) and Greenpeace, wind power can deliver 12% of the world's electricity by 2020 creating 2.3 million jobs[(6]) [**W1**].

Due to the traditionally low cost of electricity in Canada and a lack of economic instruments to promote its use until recent years, wind energy had not been an economically competitive option despite the country's very strong national wind resource. Consequently, Canada has lagged behind other countries in the development of its corresponding wind energy industry; however this is changing rapidly. Canada surpassed 1300 MW of installed capacity of wind power production in 2006 [**W4**]. In contrast, the total installed wind capacity was less than 200 MW in 2001 [**W5**], meaning that Canada has experienced an average annual growth rate of greater than 44% over the past five years [**W6, W2**].

Canada's wind energy growth can be put into perspective by comparing it with that of other nations. By the end of 2004, Canada had 444 MW of installed wind power capacity. The same capacity was reached by Germany in 1994 and by Spain in 1997 [**W1**]. *Table W1* provides an overview of the progress of various countries in wind energy resource development and contrasts them with Canada's progress.

Table W1 – Progress of countries in wind energy capacity installation [W1]

Country	Year Total Installed Capacity Equalled 444 MW	MW installed in 2004	Cumulative Installed Capacity at end of 2004 (MW)
United States	1984	370 MW	6,740 MW
Denmark	1991	7 MW	3,117 MW
Germany	1994	2,020 MW	16,629 MW
Spain	1997	2,061MW	8,263 MW
India	1999	875 MW	3,000 MW
Canada	2004	122 MW	444 MW

4.2 Profile of the Wind Energy Sub-sector in Canada

4.2.1 Size

The total cumulative Canadian installed wind generation capacity reached 1,341 MW [**W4, W12**] in 2006**.** As of November, the growth in installed wind capacity for the year 2006 alone was 657, representing an increase in capacity of nearly 100% over the year 2005. Installed capacity as of the end of the year 2005 was 684 MW [**W12**]. In Canada, the wind energy industry includes roughly 210 companies [**W13**]. Before the multiplier effect created through indirect jobs, this corresponds to approximately 1200 full time equivalent jobs nationwide [**W13**].

4.2.2 Structure

The Canadian wind energy industry includes many specialized firms and skill sets. Specifically, the Canadian wind energy industry is made up of:

- Wind resource assessment and feasibility study firms
- Wind farm design firms
- Wind project developers
- Financing firms
- Specialized legal firms
- Small to medium sized turbine manufacturers
- Turbine sales and marketing firms
- Component subcontractors for medium to large scale turbines
    - Blade manufacturers
    - Tower manufacturers
    - Foundation design and construction firms
    - Power conditioning equipment manufacturers
- Scientists (geologists, marine biologists) for environmental assessments
- Transportation logistics firms

- Installation logistics firms
- Mechanical engineering and construction firms (e.g. transmission, infrastructure development and installation)
- Electrical engineering firms (generators, wiring, grid connection)
- Service, maintenance and repair Firms
- Wind farm operators
- Regulatory specialist consultant
- Electricity sales firms
- Government research and policy
- Industry promotion

Roughly one third of the Canadian firms involved in the wind sector are technical consultants [**W7**]. Canada has very little large turbine manufacturing capacity in the form of component manufacturers and does not have a single established large turbine manufacturing operation. Canada's wind industry related manufacturing base is primarily limited to tower, blade, small turbine and power conditioning equipment (inverters) manufacturers [**W7-W9, W1**]. Wind farm developers and operators range from large multinationals to recent start-up firms. Although there is activity occurring in the wind energy sub-sector across Canada, the two near term leaders in wind development are Quebec and Ontario.

4.2.3 Economic Performance

For the year 2005, the total sale of all firms active in the wind energy sub-sector in Canada was estimated at roughly $1.3 billion. The total annual payroll expenditure within the wind sub-sector in the same year was estimated at $216 million per year. Total annual expenditures for the Canadian industry were estimated to be roughly $480 million, while total annual revenues were estimated at $550 million. On average, approximately 82% of these revenues were derived from domestic firms [**W2, W13]**.

4.2.4 Trends and Factors Impacting the Sector

In order to supplement information available in the literature reviewed for this report, seven key industry informants from the wind industry sub-sector were interviewed to gain further insight into the trends and the factors impacting the wind energy sub-sector. These informants included representatives from organizations involved in large turbine sales, service and maintenance, project development and operation, education, component manufacturing and industry promotion. Results from these interviews are reflected in the sections. Since these results are solely based on the input from just seven informants, the following should not be interpreted as a comprehensive list; nor should it be assumed that these trends and factors are having an impact on all firms presently involved in the Canadian wind energy sub-sector.

The recent rapid growth of wind energy in Canada can be attributed to the following key factors:

- Wind turbine technology improvements and increasing costs for fossil fuels have created an atmosphere where the cost of electricity generation from large scale wind farms has reached the point of being increasingly competitive with traditional sources of electricity in the Canadian marketplace.

- The signing of the Kyoto accord, and the consequent creation of policies and economic instruments, such as the Wind Power Production Incentive (WPPI), to encourage the development of domestic renewable energy generation capacity are bridging the remaining cost gap between large scale wind electricity generation and traditional sources of electricity.
- The creation of provincial renewable energy portfolio standards, have led to several requests for proposals (RFPs) for long term renewable electricity supply contracts with premium rates focused on large scale wind development.

Federal Government Policy

At the time of preparing this report, government policy was cited by industry informants as the most significant impacting factor for the wind industry sub-sector. On the federal level, uncertainty around the future of the Wind Power Production Incentive, or the creation of a new incentive, and the targets of such an incentive was cited as the most significant impacting factor on the growth of the domestic industry in the near term. Success of the first phase of the WPPI program originally led to the increase of the production incentive (WPPI) from 1,000 MW to 4,000 MW as part of Budget 2005, providing the industry with a clear signal of long term support needed to ensure continued growth. However, due to a change in government the WPPI program was suspended until further evaluation and no replacement program had yet been announced at the time of conducting interviews with industry informants (a replacement program, entitled the ecoENERGY for Renewable Power program and similar to the initial WPPI incentive was announced on January 19th, 2007). In addition to the uncertainty around the production incentive, the lack of a market for the environmental attributes of wind power, in the form of a carbon credit system, was also cited as a major limitation to more rapid growth for the sub-sector.

Provincial Government Policy

On the provincial level, industry informants cited renewable electricity RFPs as the most important driver for the industry. To a lesser extent, the Ontario Standard Offer program is expected by some informants to have an impact on growing the small scale wind market in Canada.

Costs

Informants generally felt that the impact of the cost of traditional sources of energy is presently less significant for wind power projects, especially large scale wind farms which make up the bulk of the Canadian wind market. This is mainly due to the fact that the difference in cost between traditional sources of electricity and wind generated electricity is becoming marginal for these applications. One respondent cited that the availability of major low cost hydropower resources in Quebec has made wind projects more difficult to justify in the province. Nevertheless the province has committed to nationally leading wind power development.

Supply Chain Issues

In addition to these factors, access to raw materials, mainly steel, and a shortage of large scale turbines in general were cited by informants as minor factors at present. The importance of the turbine supply issue is expected to diminish as supply catches up with demand in the next few years.

Human Resource Issues

Human resource issues were also only considered to be a minor impacting factor on the industry at present by the industry informants. Specific issues around labour included:

- The lack of experience on the part of wind project developers, which is leading to projects encountering unforeseen problems and costs in the development cycle;
- Concern over the future of service and maintenance options - service contracts with original equipment providers are growing increasingly short and many such contracts will be expiring in the next few years. There is a concern that renewal of such contracts with original equipment suppliers will be prohibitively costly and that there will be a shortage of adequate economic service and maintenance providers; and
- In the long term, the lack of wind related training programs in Canada may lead to a bottleneck in the achievement of wind industry growth expectations.

Siting

The majority of informants cited that consumer attitudes are having an increasingly negative impact on the growth of the wind industry. The "Not in My Back Yard" (NIMBY) phenomenon and other forms of opposition to large scale wind farm development have halted or prevented the completion of several large scale wind projects in Canada in recent years. It is important to note however, that these projects have typically been near populated areas or close to communities of summer homes or resort areas where the disruption of the landscape with large wind turbines has been perceived as unwanted visual pollution of the environment. Residents near proposed wind farms have also raised concerns over noise from turbine blades and the potential for harm to migratory bird populations. Several informants stated that the increasingly arduous nature of environmental impact assessments are leading to longer project completion cycles and affecting the economics of projects. Consumer attitudes are also considered to be important by informants because they drive federal and provincial policies.

Transmission Constraints

Transmission constraints were cited by several informants as a significant impediment to further growth. New transmission capacity is required to access, and tie into the grid, sites with strong wind resources. It was felt by these informants that if constrained by the existing transmission infrastructure, growth will only occur in a few geographic areas close to adequate transmission and not necessarily in more remote areas with strong wind regimes.

4.2.5 Changes in Technology

The most significant changes in technology in the global wind industry are related to the ever increasing size of individual turbines (see *Figure W1* below). The size of new installed turbines has increased 100 fold from 50 kW in the early 1980s to 5 MW today [**W14**]. This increase in size has led to increased economies of scale as siting and engineering costs are proportionately reduced for every unit of wind power capacity installed. However, most industry informants did not feel that changes in technology were playing a significant role in the present wind market and that they played a more significant role in the market over the last 10 years. One informant stated that the 1.5 MW turbine was presently the most desirable, despite the availability of larger units. Similarly, intellectual property issues and new applications for wind technology were also not considered to be a major factor in the present domestic wind industry.

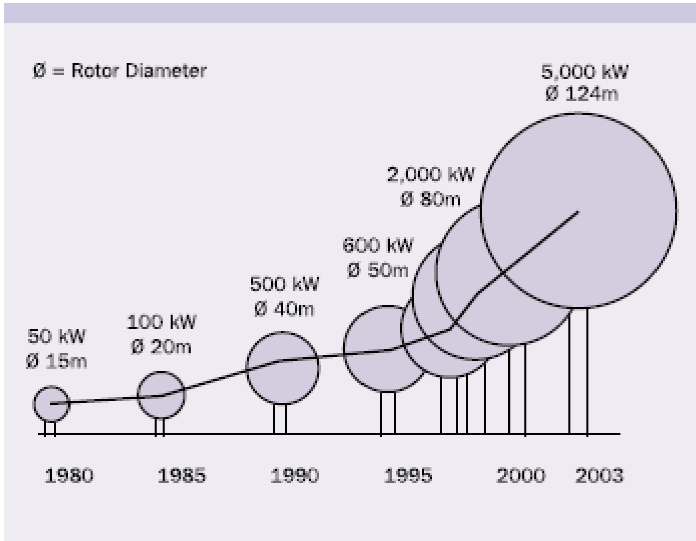

Figure W1 – Evolution of large wind turbine scale [W14]

4.3 Key Players and Stakeholders in the Canadian Wind Industry

For a detailed listing of the Canadian wind industry's main stakeholders please refer to the Canadian Wind Energy Association's member directory (http://www.canwea.ca/members_directory.cfm).

4.4 Estimated Labour Demand in the Canadian Wind Industry

As part of the interviews, key wind industry informants were asked about projected growth of revenues and number of employees for their individual firms and the industry overall. All respondents expected growth in revenues for their specific operations and the industry as a whole over the next 5 years. The most significant driver for this growth was generally stated as being provincial RFPs for renewable energy generation capacity. One key informant suggested that the market for new annual installations in Canada will likely plateau within the next 5 years but that the level at which the market stabilizes will depend on a variety of factors such of government policies and transmission constraints. The bulk of the projected growth is expected to be in utility scale wind farms.

Actual revenue growth expectations ranged from 20% to 100% annually. In parallel, all respondents also expected growth in the demand for skilled labour over the next five years as a result of projected industry growth. However, all respondents found it difficult to project how much growth in staffing in the various areas of the project chain would actually occur.

The following table (*Table W2*) estimates the total labour requirement by the year 2012 based on three scenarios. The first scenario assumes an annual growth rate of 20% over the next 5 years corresponding to the low end of the projected growth rate range stated by informants.

The second scenario assumes a growth rate of 44% corresponding to the average Canadian growth rate over the past 5 years. Finally, the third scenario assumes a very strong growth over the next 5 years of 70%, which approaches the upper end of the range stated by informants.

All three scenarios assume labour growth will be proportional to revenue growth[1],as was done in a employment study conducted by the European Wind Energy Association (EWEA), and that the profile of the Canadian wind industry does not change significantly, i.e. the proportion (~10-20%) of the large wind turbine manufacturing supply chain filled by Canadian operations remains constant. This also assumes that the bulk of the remainder of activities required for large turbine wind farm projects, such as project planning, construction and installation, operation and maintenance, continue to be provided by Canadian operations. This is supported by the results of the interviews with the key industry informants who generally agreed that the majority of the Canadian job creation benefits over the short term are expected to stem from design, development, construction, operation and maintenance activities. These calculations also assume an annual labour efficiency gain of 2%, based on a similar assumption made in the previously mentioned EWEA employment study[1].

Table W2 – Estimates of the long term labour requirement in the wind energy subsector

	Scenario 1	Scenario 2	Scenario 3
Average Annual Growth Rate in Installed Capacity from 2006-2012	20%	44%	70%
Annual Increase in Labour Efficiency	2%	2%	2%
Labour Force at the End of 2005 (# of Full-time Equivalent Employees)	1200	1200	1200
Installed Capacity at the End of 2005 (MW)	684	684	684
Labour Force at the Start of 2012 (# of Full-time Equivalent Employees)	***3239***	***9671***	***26182***
Corresponding Installed Capacity at the Start of 2012 (MW)	2042	6099	16510
Average Annual Growth Rate in Installed Capacity from 2012-2017	10%	22%	35%
Labour Force at the Start of 2017 (# of Full-time Equivalent Employees)	***4715***	***23627***	***106122***
Corresponding Installed Capacity at the Start of 2017 (MW)	3289	16483	74032

To put the above labour projections further into perspective, a study conducted in 2005 for Industry Canada by SYNOVA on the future human resources needs in the Canadian wind industry estimated that with concerted efforts by Canada's industry and governments, the wind energy sector could require a domestic labour force equivalent to more than 13,000 jobs by 2012. This labour requirement corresponded to a total installed capacity of over 5600 megawatts (MW) of wind energy by 2012 with an annual installed capacity of 831 MW for the same year [**W1, W7**]. This study assumed that a Canadian content of 60% of the

[1] Taken from: Wind Energy – The Facts, *Volume 3 - Industry and Employment*, European Wind Energy Association, December 2003, p.137, http://www.ewea.org/fileadmin/ewea_documents/documents/publications/WETF/Facts_Volume_3.pdf.

manufacturing requirements for large wind turbines installed in Canada, 100 percent domestic wind farm service and maintenance and the development of a strong export market can be achieved over the study's projection time frame [**W1**]. Industry developments to date have not supported these assumptions and a significant increase in the Canadian large wind turbine component manufacturing and export capacity will have to occur to meet the SYNOVA projection.

In contrast to the installed capacity projections outlined in the table above and the projection by the SYNOVA study, the Canadian Wind Energy Association is projecting a total installed wind capacity of 10,000 MW by 2010. To further contrast these projections, the provinces of Quebec and Ontario alone will be contracting more than 5,000 MW of wind power by 2012 through RFPs.

The issue that will have the most significant impact on the requirement for labour in the wind sub-sector is the rate of development of the domestic large wind turbine manufacturing capacity, as can be evidenced by the difference in labour projections between the SYNOVA study and the present study. Informants interviewed as part of the present study found it difficult to project whether the Canadian content in manufacturing would increase since development in this area will depend heavily on yet to be announced long term federal policy for wind development.

The European Wind Energy Association estimates that for every MW of large scale wind capacity installed, 10 job/years in manufacturing activities and 2 job/years in planning, installation and construction are required. 2 permanent jobs in service and maintenance are created for every MW of installed wind generation capacity. Today, Canada imports nearly all of its large turbines and components. The only components for which Canada has a significant manufacturing base are the towers and rotor blades. The typical cost breakdown for a large wind turbine is as follows: nacelle assembly (60 percent), rotor blades (16 percent), tower (15 percent), and foundation (9 percent). Considering this and the fact that in large, networked wind farms, wind turbines represent up to 70 percent of the total capital investment, and consequently the majority of the related employment opportunities, it is clear that employment will be heavily tied to this issue. Any development of domestic large turbine manufacturing capacity will translate to a significant change in the labour demand for the sub-sector [**W7**]. It is important to note, however, that Canadian firms have little intellectual property in the large scale wind technology field and will have to rely on technology and manufacturing licenses with foreign firms should they seek to increase the domestic economic benefits of large scale wind development. Beyond the 70 percent of the capital that goes into the development of large wind farms, the balance of the costs are for land, interconnection, foundations, road construction, installation and development-related services. As previously stated, the majority of Canadian wind firms are presently focused in these areas [**W7, W10**].

4.5 Profile of the Workforce

Based on interviews with industry informants, the following demographic details for the Canadian wind industry were gathered:

- The average age for service technicians in the industry is between 20-30 years old.
- The average age for administrative, project development and management staff in the industry is between 35-40 years old.
- The average level of education for service and maintenance staff is trade certificates.

- The average level of education for administrative, project development and management staff is an engineering degree or a graduate level business degree.
- The industry is roughly made up of 90% males and 10% females.

Occupations in the wind energy sub-sector include:

- Wind resource assessment specialists
- Electrical engineers with power specialization or experience
- Mechanical engineers with turbine system, gear box system, composite materials and large-scale construction and design experience
- Wind farm design specialist/engineers
- Mechanical tradespeople with turbine system, gear box system, composite materials and large-scale construction experience
- Geologist/civil engineers with foundation experience
- Electrical tradespeople with power, transmission and control systems experience
- Construction tradespeople
- Business and finance specialists
- Civil engineers with large-scale power system construction experience
- General construction labor
- Heavy equipment operators
- Large scale transportation specialists
- Habitat biologists and ornithologists
- Environmental impact assessment specialists
- Operations managers
- Technical sales staff
- Electricity sales and marketing staff [**W1**]

4.6 Available Training

4.6.1 College Programs

Cégep de Gaspésie et des Iles de la Madeleine is currently the only Canadian training facility offering a 6 month, 1,395 hour, wind energy technician course (www.cgaspesie.qc.ca) entitled “Mechanical and Electronics Industrial Maintenance”. The program covers both maintenance and installation of wind turbines. Presently, the program is available in French only although the college has plans to expand its offering in English. There is also a plan to transfer the curriculum to St. Lawrence College in Kingston to start a second program there. The program’s curriculum is mainly divided between three areas: electronics, mechanics and wind energy. To date, this program has been primarily targeted at skilled labour recently layed-off by other sectors in the region that require a skills upgrade to access new job opportunities.

Several other colleges offer general courses on building integrated renewable energy applications which include some small scale wind technology course material. However, it is expected that the transferability of such training to large scale wind technologies and projects, which make up the majority of the Canadian wind market, would be limited. These include programs offered by St. Lawrence College, Lambton College in Sarnia, Centennial College, in Toronto and New Brunswick Community College.

4.6.2 University Courses

Some universities have introduced or are planning to introduce wind and general renewable energy material into their programs. These include:

- The University of New Brunswick (UNB), in Fredericton, which is the leading university in Canada in the area of wind energy research through its Sustainable Power R&D Group which focuses on the development of innovative power electronic converters and advanced control strategies for variable speed wind turbine systems. The current group includes one associate professor, one research associate, one post doctoral fellow, eight doctorate candidates and twelve master's of science students.

- The recently founded University of Ontario Institute of Technology (UOIT), in Oshawa, is offering a four year BSc. program in Energy and the Environment which is expected to include access to an emerging energy systems lab for wind, solar and hydrogen technologies [**W1, W9, W15,W17**].

- L'Université du Québec a Rimouski offers a master's program in wind energy with a focus on electrical engineering. The program offers courses, such as project management, storage of wind energy and wind resource assessment.

- Dalhousie University, in Halifax, offers courses in wind energy resource assessment and small wind turbines.

- L'Université de Montréal, École Polytechnique, Montreal, offers courses in vertical axis wind turbines, aerodynamics and icing through its mechanical engineering department

- L'Ecole de Technologie Supérieure, in Montreal, offers courses in wind turbine aerodynamics, wind turbines in cold climate, wind flow inside wind parks [**W1, W15-W17**].

4.7 Human Resource Issues

The following human resource issues were identified for the Canadian wind energy sub-sector through the interviews with seven key industry informants. Issues are broken down into three broad categories, recruitment, training and retention.

4.7.1 Recruitment

Interviewed firms had all hired skilled labour in the past 3 years and were all generally satisfied with this labour. They felt that the industry is competing with the oil and gas sector for most kinds of skilled labour. On the electrical technician side specifically, informants felt that most technicians are pursuing jobs in the computer and high-tech sectors and are not being attracted to the power sector.

When recruiting, large wind farm service and maintenance firms generally look for journeypersons with several years of related experience and less experienced recent trades graduates to fill labour needs. For more experienced labour they look for electricians with power generation and transmission experience, with wind related experience is ideal but rare, or mechanical experience working with turbine and gear box systems. For less experienced labour they look for trades people with electrical and mechanical certificates. A major issue for recruiting for service and maintenance activities is comfort with heights. Due to the nature of the work, which involves working on top of wind towers of up to 100 m high, this is an essential attribute for recruits for these jobs.

Issues around immigration and the ability to import desired skills that are not available within Canada were cited by several respondents as an area of concern. These respondents felt that the burden of demonstrating that certain specialized skill sets were not available within Canada represented a major cost and required a significant investment of time. For these respondents, the ability to import these skills is essential to meet recruiting requirements for domestic operation. Beyond these issues, wind industry informants did not appear to have any concerns over recruitment at present. Several respondents did feel that access to skilled labour may become a bottleneck for the industry if it continues to grow as rapidly and a focused recruitment strategy is not in place.

4.7.2 Training

Industry respondents generally felt that the present level of training available to the industry was adequate, taking into consideration the fact that most companies do their own internal training once staff are hired and that the focus needs to be on recruitment into the industry and into engineering and trades programs relevant to power or turbine systems. Informants generally felt that the qualifications of new graduates could be improved by the addition of a few wind turbine system related courses or credits to existing trades programs and engineering degrees to reduce the training burden associated with new hires in the industry.

Industry informants generally stated that when wind service, maintenance and operation technicians are hired, some training is generally required, regardless of the level of experience, to deal with specific turbine types from different manufacturers. The major players in the service industry, such as GE and Vestas, offer their own structured internal training for their equipment servicing. In addition to technical training, large turbine service and maintenance jobs also require safety and heights training (rappelling, harness etc.). Software training for monitoring facility operation is also required but is also generally provided by employers after hiring. Intellectual property was cited by one respondent as the reason that most turbine manufacturers provide service training internally. It was generally felt by respondents that it would be useful to have a wind technician certification established as a trade.

It was generally agreed upon by informants that any training programs developed must have input from industry stakeholders to be useful and successful. However, based on interviews with informants, there appears to be a disconnect between the wind technician course(s) offered in Canada outside industry and the actual wind industry. Specific large scale wind technician courses are being offered or are being developed but industry stakeholders do not appear to be actively seeking graduates from such programs.

This situation is in part evidenced by the fact that a significant barrier to offering appropriate training to technicians through academic institutions is access to large scale turbines for lab work and hands-on training. Systems presently used are small (~50 kW). It is difficult for academic institutions to get access to large turbines for the following reasons:

- MW scale turbines represent a major capital investment.
- There is presently a shortage in the large turbine supply and demand for turbines is very competitive with large orders taking priority.
- MW scale turbines have only been in use for a relatively short period of time so access to end of life or used and discounted turbines is not possible.
- Because turbine manufacturers are providing there own training there is little incentive for them to provide turbines to academic institutions for further training programs.

For the manufacturing sector, there is a need for traditional trade skills with some additional training or experience with specific materials used in various components (e.g. composites, steel). In many training programs, these training requirements are likely already being addressed.

Several informants felt that training would be helpful for community consultation skills and communicating the benefits of wind to community and land owners to avoid costly opposition cycles when developing large scale wind projects. Also, there do not appear to be any training programs for site identification, wind farm design or project planning available in Canada at present. As the market expands a shortage of all skills and skills development capacity is projected in the wind industry ranging from business development, wind farm design, community consultation, construction labour and service and maintenance.

4.7.3 Retention

Some informants stated that in the early days of the Canadian industry, retention was an issue, but that it is less so now. The most significant issues in the near term that will impact skilled labour retention in the industry is the wear and tear on the bodies of service technicians who have to repeatedly climb 80 to 100 m towers. In order to address this issue, the industry is working on integrating elevators into towers. Beyond this height issue for technicians, retention is not considered to be a concern by informants, although it was acknowledged by several that the labour market is very competitive and migration within the wind and power industry does occur. In general, training, competitive salaries and the establishment of a standard certification for technicians were identified as avenues for dealing with retention. In addition, some effort is being focused on recruiting and hiring local people to promote better retention of skilled labour at the places it is needed. This is especially a factor for wind operations in more remote or less populated areas.

4.8 Information Gaps, Recommend Actions and Key Observations

The following is a high level summary of the information gaps and issues that need to be addressed in the near term within the Canadian wind energy sub-sector in order to contribute to the development of an effective human resource strategy for the industry:

4.8.1 Information Gaps

- A clear picture of the present Canadian large wind turbine manufacturing capacity and its expected growth is presently lacking. Primary research should be conducted to establish such a picture. This contribute significantly to clarifying the expected long term labour force requirements for the sector.

4.8.2 Recommended Actions and Key Observations

- Address the apparent disconnect between industry, trade unions and wind technician training program developers. Key issues that need to be resolved are:
  - Whether the industry wants training institutions to provide training for wind technicians, since most service providers presently provide their own training to hires;
  - Getting buy-in from industry in the development of these programs in terms of curriculum design and access to appropriate equipment for training (mainly large scale turbines); and
  - Determining whether the establishment of a new national certification category for wind turbine technicians is required or whether related certification requirements are already covered through existing certification programs. The development of clear occupational descriptions for wind turbine technicians would contribute significantly to clarifying this issue. In the event that a new certification category is required, industry, trade unions and training program developers will have to work together to establish related training and certification programs.

- Investigate the possibility of integrating wind energy related curricula into standard engineering and trades programs. Industry informants generally felt that fully dedicated wind training was not required for many positions in the industry but that some exposure to wind energy issues and technologies would be beneficial in reducing the burden of initial training of recruits. Addition of a few optional targeted courses or credits or integration of some wind material into existing courses within existing trades and engineering programs are expected to be sufficient to meet most industry needs.

- The sub-sector needs to encourage and participate in recruitment of future students and workforce into related trades or engineering programs, mainly electrical systems and power systems programs to ensure adequate availability of human resources as the market grows. Recruitment programs focused at communities where wind projects are being built are expected to be especially effective.

- Develop a targeted public information program similar to that presently being executed by the Canadian nuclear industry to help overcome recent image problems the wind industry is encountering (such as allegations of high levels of noise from turbines and visual pollution of landscapes) and make potential recruits into the industry more aware of its promise.

- Stay up-to-date on the Canadian developments in the manufacturing segment of the supply chain. Any increase in domestic large wind turbine manufacturing activities will have a major impact on the labour demand within the sub-sector.

- Monitor the service and maintenance contracts situation. Service contracts with original equipment providers are growing increasingly short and many such contracts will be expiring in the next few years. There is a concern that renewal of such contracts with original equipment suppliers will be prohibitively costly and that there will be a shortage of adequate economic service and maintenance providers.

- Investigate the issues around immigration and the ability to import desired skills that are not available within Canada. In some cases, importing of skills may contribute to growing the market and increasing the economic benefits of wind development for domestic firms.

5.0 Photovoltaics

5.1 Overview of the Industry

The global solar electricity industry is now worth more than EURO 3 billion (~CA$4.5 billion) annually. Consequently, competition among major manufacturers has become increasingly intense, and new major players continue to enter the market as the potential for photovoltaic technology continues to expand. Europe, in particular Germany, and Japan lead the world in both manufacturing capacity and installed PV electricity generation capacity. Leading firms in both of these regions continue to invest heavily in new production capacity expansion and new technologies in response to strong domestic and international political support. This support is taking the form of promotional frameworks and economic incentives for the development of solar electricity [**PV1**].

World photovoltaic cell and module production has increased rapidly over the past decade. In 2004, the total global production for PV reached 1195 MW, representing a 57% increase over 2003. Global production capacity in 2003 was 716 MW. Japan led the way in 2004 producing 602 MW, while Europe as a whole produced 314 MW. In contrast, the United States produced 139 MW [**PV2**]. In addition to the strong incentive programs that are driving demand for PV technology in many parts of the world, the continuing trend of cost decreases for the technology has also played a major role in growing the global PV market. The following figure (*Figure PV1*) illustrates the trend of cost decrease and global production since the early 1970s [**PV3**].

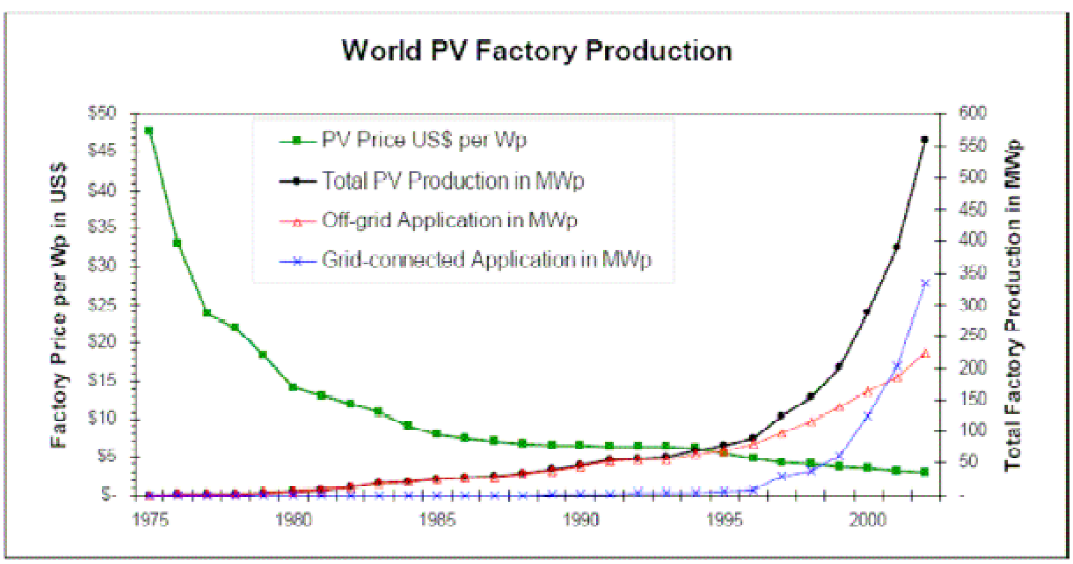

Figure PV1 – Global PV production and cost profile since 1975

Nearly 85% of the world PV cell and module production in 2004 was based on sliced mono- and polycrystalline silicon cells. Despite the start up of several new plants focused on thin film (non-crystalline silicon) technologies, only 47MW of amorphous silicon (3.9% of the total global production capacity) was produced. The balance (~11%) is primarily made up of other none-silicon compound semiconductor solar cells. Regardless of the notable increase in activity in thin film technology production, crystalline silicon technologies are expected to continue to make up the majority of the PV market over the next 5 to 10 years. As a result of PV technology improvement, manufacturing economies of scale and reduced silicon use, the cost of PV technologies has decreased significantly over the past decade [**PV1, PV2**].

The most significant factor limiting the growth of the global PV market at present is a shortage of solar grade silicon feedstock which has resulted in increased silicon costs, and consequently increased solar module prices over the past 2-3 years. As a result, the next few years will be pivotal for some players in the industry and securing of long term silicon supply contracts will be essential for their survival. Silicon supply issues are expected to continue until 2008-2009 when significant new solar grade silicon facilities are expected to come online internationally [**PV2**].

Applications for PV technology can be categorized in three broad segments: grid-connected, off-grid and consumer products. Grid connected systems, which typically do not involve any power storage, feed electricity directly into the utility grids where they are connected. Grid-connected systems can range from small roof mounted residential systems ranging from roughly 100 W to 4 kW to multi-megawatt utility scale PV power generation plants. The off-grid segment is made up of “stand-alone” applications, which are generally made up of both PV generation equipment and power storage equipment, mainly batteries. Off-grid applications include power for remote telecommunications towers, remote research stations, summer homes or cottages without access to the utility grid, electrification of rural villages in developing countries or remote villages, etc. The consumer products segment includes the use of PV technology as power sources for calculators, portable cell phone or laptop chargers, portable power for recreational vehicles, etc. The consumer products segment of the PV market represents a very small share. The following figure (*Figure PV2*) illustrates the global growth in various segments of the PV market over the past decade [**PV3**].

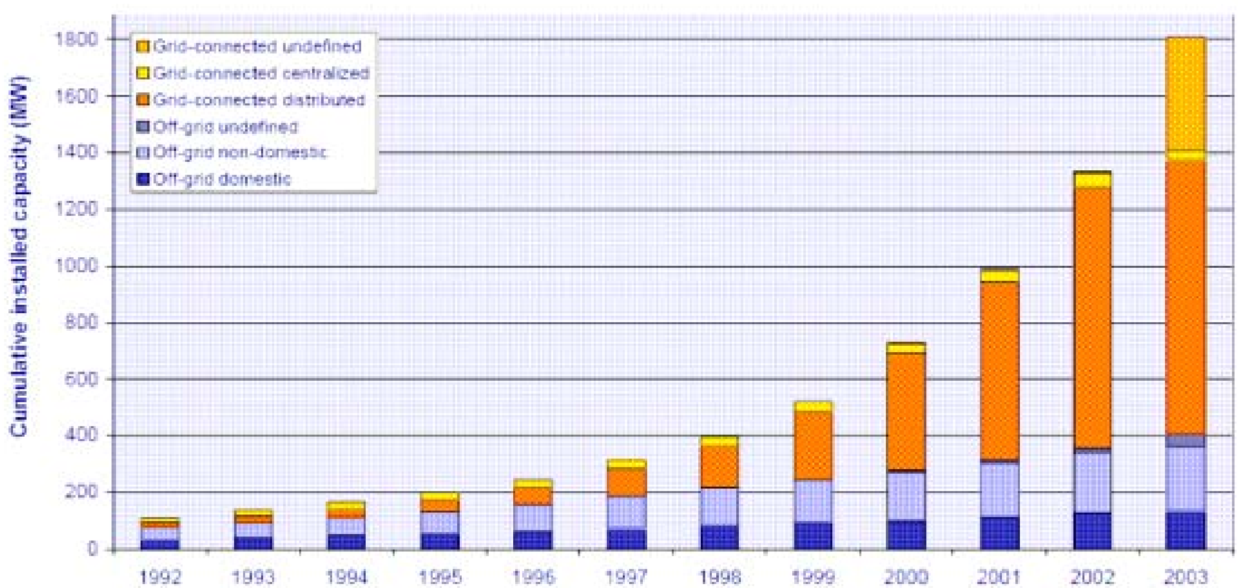

Figure PV2 – Evolution of global cumulative installed PV capacity by market segment

The markets for solar PV have undergone a dramatic shift in the last 5 years. Prior to 1999, the primary market for PV was in off-grid applications. However, now over 78% of the global market is for grid-connected applications. This growth and the overall growth of the industry have primarily been driven by strategic political initiatives to respond to climate change. It is estimated that the global grid-connected residential/commercial sector grew from 360 MW in 2003 to over 610 MW in 2004 [**PV1-PV2**].

In contrast to international growth, the Canadian market for PV products has not grown as rapidly because of the very low cost of conventional electricity sources. At the end of 2004, the estimated cumulative installed capacity for PV electricity production in Canada was 14 MW, compared to 1.86 MW in 1995. To put this in perspective with respect to activities in other countries, a 2003 report from the International Energy Agency (IEA) ranked Canada 13th out of 20 IEA nations in installed PV capacity with only 26% of the international average. It also ranked 12th in annual sales with only 17% of the international average [**PV3**]. Despite the relatively low price of conventional energy and the resulting slow market for PV products in Canada, many Canadian firms are contributing to the growth of the international PV market.

Domestically, a sustained market for remote and off-grid applications has developed over the last 11 years. This has been an unsubsidized market to date that has grown because PV can meet the remote power needs for applications such as transport route signaling, navigational aids, remote homes, telecommunication and remote sensing and monitoring [**PV4**]. Where Canada has lagged significantly is in the grid-connected market segment which accounts for less than 3.5% of the Canadian installed capacity [**PV3-PV5**]. *Figure PV3* provides a breakdown of the Canadian PV market evolution over the past decade by market segment [**PV3**].

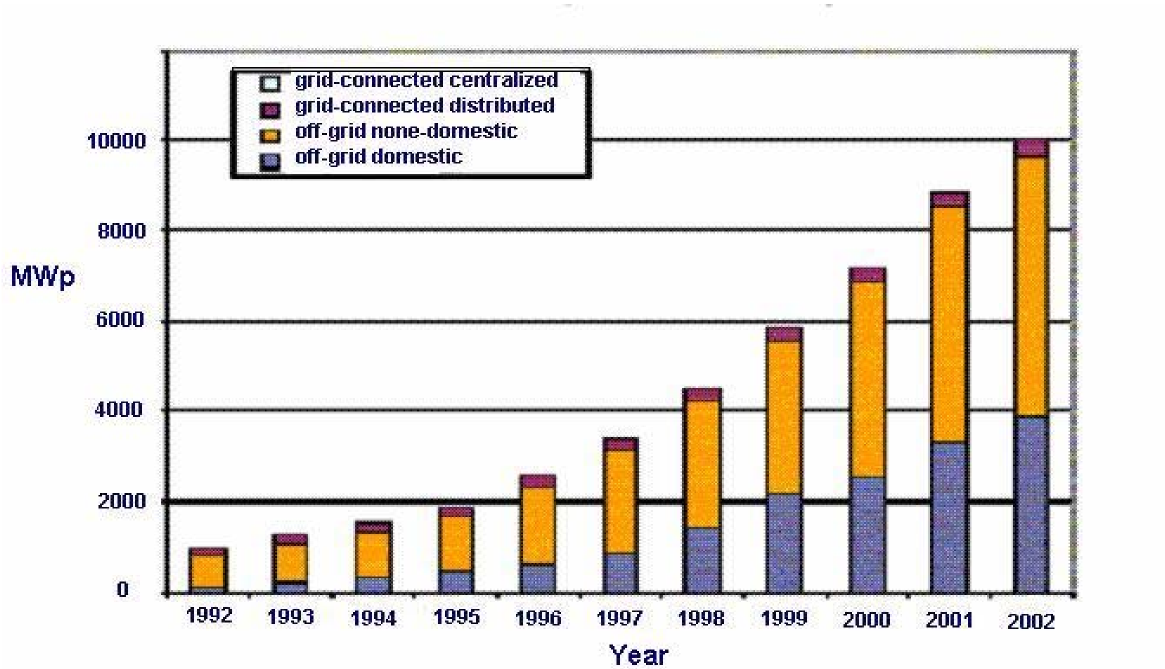

Figure PV3 – Evolution of Canadian cumulative installed PV capacity in MWp by market segment

5.2 Profile of the Photovoltaic Sub-sector in Canada

5.2.1 Size

The annual Canadian PV module market, in terms of installed capacity, was roughly 2.1 MW and the total installed PV generation capacity was estimated at 14 MW in 2004. Since 1992, the average domestic PV market growth has been approximately 23% [**PV3-PV4**]. The CANMET Energy Technology Center (CETC) in Varennes estimated that roughly 150 companies and organizations promoting PV power existed in Canada in 2004. The majority (90-95%) of the firms working in the Canadian PV industry are designers or installers of systems. CETC also estimated that PV firms and organizations employed roughly 765 people as of the end of 2004 [**PV4**].

In June 2004, Spheral Solar, a subsidiary activity of ATS Automation Tooling Systems Inc., opened Canada's first fully integrated 20 MW solar cell manufacturing plant based on a novel technology platform in Cambridge, Ontario. This and growth from 11 other firms involved in PV module and balance of system component manufacturing led to the addition of an estimated 150 Canadian manufacturing jobs in 2004. Spheral Solar is estimated to have employed approximately 200 people at its peak [**PV4**], but the company has since restructured and refocused its activities, suggesting that a significant portion of the employment growth in the manufacturing sector from the year 2004 may no longer be a factor [**PV4**]. However, several other firms have expanded operations significantly over the 2005-2006 time frame and this is expected to have made up for any losses in the total employment figure in the industry. It is therefore estimated, taking into consideration growth in other activities, that the total number of people working in the Canadian PV industry today is roughly 800 (full-time equivalent).

5.2.2 Structure

The Canadian photovoltaic industry includes many specialized firms and skill sets. Specifically, the Canadian photovoltaic sub-sector is made up of:

- PV manufacturers
  - Silicon feedstock
  - Solar cells
  - PV modules and systems
  - Balance of system components
- PV distributors and retailers
- PV consultants
- PV systems designers and installers
- PV researchers and technology developers
- PV manufacturing equipment manufacturers
- Industry promotion and advocacy groups

The larger players in the industry, mainly those involved in manufacturing are located in British Columbia, Ontario and Quebec. Companies involved in other areas of activity are typically small and distributed throughout the country.

5.2.3 Economic Performance

CETC estimated that the total PV business including sales and investment in Canada was valued at $125 million for the year 2004. For the same period, twelve manufactures reported revenues from manufacturing operations related to PV modules and balance of system components of roughly $84 million [**PV4**].

5.2.4 Trends and Factors Impacting the Sector

In order to supplement information available in the literature reviewed for this report, six key industry informants form the Canadian PV industry sub-sector were interviewed to gain further insight into the trends and the factors impacting the PV sub-sector. These informants included representatives from organizations involved in manufacturing, project development and installation, and education related to PV systems. Results from these interviews are summarized below. Since these results are solely based on the input from just six informants, the following should not be interpreted as a comprehensive list; nor should it be assumed that these trends and factors are having an impact on all firms presently involved in the Canadian photovoltaic sub-sector.

Government Policy

All key informants felt that the most important factor impacting the sector globally and domestically is government policy at both the national and regional levels. In foreign jurisdictions, such as Germany and Japan, strong government incentives and policies are driving the market. In Canada, the lack of federal government policies and economic incentives for encouraging PV are considered a major factor impacting or inhibiting the sector. A lack of standardization of installation practices, restrictive building codes and municipal by-laws were also cited as major barriers for installers in Canada.

In the near term, the Ontario Standard Offer program is expected by most informants to be a key driver in the stimulation of the PV market in Canada. Significant participation in this program is expected from “early adopter”-type consumers. CanSIA projects that this program could lead to a grid-connected residential market growth of up to 40 MW (15,000 homes) over the next 5 to 10 years [**PV3**].

Another initiative which may help stimulate the Canadian PV sub-sector in the near term is the Net Zero Energy Home (NZEH) initiative led by the Canadian Mortgage and Housing Corporation (CMHC). In the summer of 2005, CMHC announced a national program to encourage the demonstration of the NZEH concept and stimulate the construction of 1500 NZEHs within 5 years. The program has a long-term vision of shifting all new home construction to net-zero energy by 2030. Based on modeling of sustainable growth, it is expected that this combined with the favorable conditions established by the Standard Offer Program could lead to the construction of nearly 400,000 new homes powered by 3 kW PV systems (1200MW total) in Ontario by 2025 [**PV3**].

Costs

The cost of traditional sources of energy is also cited as a significant factor impacting the sub-sector. In Canada the price of traditional electricity is very low, making it especially difficult to bridge the cost gap between PV technologies and grid electricity.

Supply Chain Issues
Several informants stated that in recent years, access to silicon based solar cells and panels has been a moderate constraint domestically on the industry. This has been caused by the aforementioned shortage in the solar grade silicon raw material used in the production of solar cells which was brought on by the very rapid growth of the PV industry and the parallel increasing silicon demand from a re-strengthening semiconductor sector. The shortage issue is expected to become less significant in the near term as silicon supply issues are resolved by new silicon production capacity being brought online in the next few years. With the resolution of this supply issue, PV prices, which have consequently risen in recent years, are expected to start decreasing again as they have over the past 25 years [**PV2**].

Human Resource Issues
Human resource issues were currently not considered to be significant for the domestic PV industry by industry informants, although there is a perceived shortage of people with strong technical PV skills for both installation and manufacturing roles. It was generally felt that the market has not grown to the point of this being a major concern for the industry but that this is expected to become a more significant factor as the market grows, especially if the growth is rapid.

Intellectual Property
Intellectual property was considered to be a significant market factor for organizations who have developed proprietary PV products or PV manufacturing processes. This has allowed them to achieve strong market penetration and in some cases prevent direct competition. New applications for technologies were considered to be a significant market factor for firms developing PV products that are not directly tied to conventional power generation applications.

Consumer Interest
Consumer attitudes are also seen as a significant factor by industry informants in that they create demand for products and drive government policy. Domestically, the demand for PV products in the past has generally been in applications where PV is the most economical and practical power solution, such as in off-grid and remote power applications. More recently, early adopters of the technology who purchase it regardless of cost, have also been increasingly contributing to the market growth of grid tied PV applications.

5.2.5 Changes in Technology

Changes in technology were seen by industry informants as being a potentially significant impacting factor for the global PV market. This is because any improvement in the cost of the technology, either from increases in electricity generation efficiency, or from more efficient use of silicon or the advent of lower cost substrate materials such as compound semiconductor thin films, will lead to a reduction of the cost gap between PV and conventional sources of electricity. This will, in turn, lead to increased market penetration and even more rapid growth for the PV technology industry.

5.3 Key Players and Stakeholders in the Canadian Photovoltaic Industry

For a detailed listing of the Canadian photovoltaic industry's main stakeholders please refer to the Canadian Solar Industries Association member directory (http://www.cansia.ca/directory/).

5.4 Estimated Labour Demand in the Canadian Photovoltaic Industry

As part of the interviews, key PV industry informants were asked about projected growth of revenues and number of employees for their individual firms and the industry overall. All respondents expected growth in revenues for their specific operations and the industry as a whole over the next 5 years. Growth projections ranged from 20%-25% to 1000% over the next 5 years depending on the organization and its activities.

Manufacturers of solar cells and panels expect the largest growth, with projections of 800% to 1000% increases over the next 5 years. Some manufacturing firms are dedicated to meeting a large portion of their growth through Canadian operations, while others will be expanding their operations internationally to meet growth projections. Firms focused on developing international operations expected to keep ~20-25% of their operation within Canada. At present, Canadian manufacturing firms are focused almost entirely on the international market, so their growth projections do not reflect general sales growth within Canada. For manufacturers of PV products, the largest areas of growth are in key markets such as Europe (Germany and Spain), Asia (India, China and Japan) and the United States. One informant indicated that the Canadian market represents 10% of its sales to the state of California alone.

Generally, industry informants expected the domestic market for PV sales and installations to grow at a rate of 20 – 25%. One respondent who operated in Ontario expected a growth in sales and installations of roughly 1000% in the next 5 years. Domestically, the lack of skilled/qualified installers and its potential impact on achieving actual growth projections are considered serious factors in the development of the market. There is a concern that poorly installed systems early on in the market growth cycle could tarnish the image of PV as an attractive option for consumers. The strongest areas of growth domestically, according to respondents, are in distributed and residential projects and off-grid projects. Utility scale projects were only considered to be a significant potential market by one respondent.

Consequently, all informants foresaw an increased labour requirement in their operations or for the industry as a whole over the near term. The growth rate of the labour force was not expected to be as high as the projected sales growth for reasons such as productivity economies, increased experience base and automation. Expansion of international operations by manufacturing firms to meet growth expectations will also limit the domestic job creation benefits of the projected corporate growth.

Types of labour required will be:

- design, process and research engineers and scientists,
- production technicians and labour,
- systems designers,
- installers and maintenance people,
- technical sales specialists,
- technologists, and
- human resource staff and administration staff.

On the marketing side specifically, there will be a need for people with experience in international sales to allow manufacturers to continue to penetrate European and Asian markets.

To give perspective to the projected specific labour demand with reference to potential installed capacity the following figures are useful. Globally, more jobs are created in the installation and servicing of PV systems than in their manufacture. One study by the European Photovoltaic Industry Association (EPIA) and Greenpeace from 2004 estimates that 17 production/manufacturing job/years are created per MW of PV production capacity installed (this is expected to decrease to 15 in 2010 and 10 by 2020). Conversely, the study estimated that 30 jobs are created for design, installation, retailing and providing other local services per MW (26 jobs by 2020). Maintenance is estimated to contribute to 1 to 2 jobs per MW of installed capacity [**PV1**].

Based on the previously stated data for the Canadian market in 2004, the annual PV installations totaled 2.136 MW and the total installed PV generation capacity was roughly 14 MW in Canada. Based on the above employment figures, this would suggest that roughly 65 people were employed in the design installation, retailing, service and maintenance fields in 2004. Using the average growth rate of the domestic PV installations over the past of roughly 23%, the present (2006) number of people working in these areas is roughly 100. Using the previously made estimate of the total number of 800 (full time equivalent) people presently employed in the Canadian PV industry, this would leave roughly 700 people employed in research, technology development, education, industry promotion and manufacturing activities. It is difficult to estimate the exact number of people employed in each of these activities, but it is likely that the majority would be in manufacturing based on previously stated revenues for manufacturing activities ($84 million out of $123 million for the year 2004). For the purpose of this study it is therefore assumed that the total number of people working in PV manufacturing activities in Canada is roughly 650. Based on these estimates and projected growth rates gathered from industry informants, the labour demand in this sub-sector has been estimated for the future 5 year and 10 year intervals. This table assumes that 50% of growth from Canadian firms operating in the manufacturing sector will be met domestically. It also assumes that 100% of the other activities will continue to be met through domestic operations. To be conservative, the table also assumes that labour requirements per MW manufactured will decrease to 60% of present values by 2012 based on the 2020 figures cited in the EPIA and Greenpeace study discussed above. Similarly, it is assumed that 85% of the installation and maintenance jobs per MW installed will be required post 2012.

Table PV1 – Estimate of future manufacturing and design, installation, service, retail and maintenance in the Canadian PV sub-sector

Manufacturing	Scenario 1	Scenario 2	Scenario 3
Present (2006) Labour Force	650	650	650
Projected Growth Rate 2006-2012	30%	50%	100%
Projected Growth 2012-2017	15%	25%	50%
Decrease in Labour Due to Efficiency Gains post 2012	60%	60%	60%
Percentage of Growth Met through Domestic Operations	50%	50%	50%
Labour Force by 2012	1894	4027	21125
Labour Force by 2017	3240	9384	105987
Design, Installation, Service, Retail and Maintenance	**Scenario 1**	**Scenario 2**	**Scenario 3**
Present (2006) Labour Force	100	100	100
Projected Growth Rate 2006-2012	15%	25%	35%
Projected Growth 2012-2017	10%	20%	30%
Decrease in Labour Due to Efficiency Gains post 2012	85%	85%	85%
Percentage of Growth Met through Domestic Operations	100%	100%	100%
Labour Force by 2012	231	381	605
Labour Force by 2017	523	1473	3628

5.5 Profile of the Workforce

Based on interviews with industry informants, the following demographic details for the Canadian photovoltaic industry were gathered:

- People working in PV systems design and installation activities can be separated into two age categories, the older generation which is roughly 50 years of age on average (this generation started working in the industry during the late seventies when the first significant uptake of PV activities occurred in response to energy security), and the younger generation which typically ranges in age from 25 to 30 years old.
- The average age of people working in PV manufacturing activities, depending on the organization, is between 30 to 40 years old.
- The average level of education for people working in both PV systems design and installation and manufacturing is trade certificates and engineering degrees.
- Some general, none-specialised labour is used in the manufacturing of PV products.
- The industry is roughly made up of 85 to 95% males depending on the area of activities.

Occupations in the photovoltaic sub-sector include:

- Process engineers (manufacturing)
- Assemblers
- Technologists

- Electrical/Materials/Chemical Engineers for process development and R&D
- Electrical engineers for system design and integration
- Mechanical engineers for equipment design
- Electrical tradespeople for system installation and integration
- Technical salespeople
- Marketing specialists
- Business and finance specialists
- Plant and operations managers

5.6 Available Training

5.6.1 British Columbia Institute of Technology (BCIT), BC

BCIT provides two courses on PV systems. The first is an introductory course that deals with equipment and design of solar electric systems. The second course is more advanced and meets the needs of electricians and engineers. In addition, the Institute will soon be offering an installation course developed specifically for electricians which will be incorporated into an existing training program for standard electricians [**PV7**].

5.6.2 Seneca College, Toronto, ON

CanSIA currently offers a PV technicians training program through Seneca College. The program provides a comprehensive understanding of related electric theory and the fundamentals of photovoltaic systems [**PV8**].

5.6.3 St. Lawrence College, Kingston, ON

St. Lawrence College offers a 2-year Energy Systems Engineering Technician and a 3-year Energy Systems Engineering Technologist course. These are certificate programs approved by the Ontario Ministry of Training Colleges and Universities. The programs cover all elements of the building energy systems including heating, ventilation and air-conditioning systems, energy efficiency and alternative energy systems such as photovoltaics [**PV9**].

5.6.4 Seven Generations Education Institute and Lampton College, Fort Francis, ON

With special funding from Indian and Northerm Affairs Canada (INAC), Seven Generations Education Institute and Lambton College have developed a 180-hour Renewable Energy Certificate Program. This program includes courses on solar energy and has received a donation of 40 solar panels from George Brown College from a renewable energy program that was discontinued due to lack of enrolment [**PV7**].

5.6.5 Solar Buildings Network, Montreal, QC

The Solar Buidlings Network comprises 24 top Canadian researchers in solar energy and buildings from 10 Canadian universities (Concordia, Queen's, Waterloo, University of Toronto, Ecole Polytechnique de Montreal etc.) who have joined forces to develop solar-optimized homes and commercial buildings for the future.

The Network also includes researchers and experts from partners organizations at Natural Resources Canada, the Canada Housing and Mortgage Corporation, Hydro Quebec, the Royal Architectural Institute of Canada and the Building Owners and Managers Association.

The budget of the Network is about $6 million which is being used to promote innovative research and development in solar energy utilization. Several doctorate and master's level students are completing degrees through the network and a solar related curriculum has been integrated into the standard curricula of the engineering programs of several universities involved with the network [**PV6**].

5.6.6 University of Toronto, Toronto, ON

The Advanced Photovoltaics and Devices group in the Faculty of Applied Science and Engineering at the University of Toronto has a range of PV manufacturing process related education opportunities for undergraduate students, in the form of summer internships and undergraduate theses projects and graduate students in the form of Masters and Doctorate degrees and post doctoral fellowships. The group focuses on high efficiency heterojunction silicon photovoltaics and thin film nanocrystalline-amorphous silicon materials and devices research [**PV10**].

5.7 Human Resource Issues

The following human resource issues were identified for the Canadian PV sub-sector through the interviews with six key industry informants. Issues are broken down into three broad categories, recruitment, training and retention.

5.7.1 Recruitment

All informants had hired skilled labour in the last 3 years. The level of satisfaction with these hires appears to be high. Certificates and degrees were generally considered to be of importance in assessing new hires for most informants, while specific work experience was only important to some. A personality fit and a demonstrated ability to learn were also cited as key requirements by some informants.

Informants generally felt that people with solar design and systems experience are difficult to find in Canada and some firms have had to look abroad to fill these needs. In efforts to import skills, immigration issues were cited as a major burden by some informants. The main issue being that it is difficult to demonstrate that skills are not available within Canada. Some informants stated that international business development and sales roles are also a challenge to fill.

5.7.2 Training

Based on the interviews with key industry informant, most firms rely on on-the-job training to develop needed skills. Most hire technical trades (electrical or mechanical) or engineering graduates with fundamental skills and then train them in more PV-specific areas. Some firms focused on design and installation activities send staff on solar certification courses while some manufacturers send staff for other forms of training such as software and design. One respondent involved in installation activities indicated the intention of developing an internal certification program for new hires as the market grows. Manufacturers of solar cells and modules indicated the need to integrate some optional PV course material into electrical engineering curricula especially because of the strong overlap between integrated circuit technology and photovoltaic technology.

Overall, informants felt that there are very few PV related training programs in Canada, likely because few people have viewed PV as a viable career option until recently. Although the limited availability of training programs is identified as a problem, respondents were generally of the opinion that the market was not established enough to support broader development of programs. One respondent felt that there was a need for engineering level solar system design courses, but acknowledged that the market may not be large enough to absorb all the graduates from such a program in the near term.

5.7.3 Retention

The average turnover for manufacturers was in the range of 10%. Several respondents stated mergers, acquisitions and restructuring played a role in these rates. Adequate training and salary were cited as the best solutions for dealing with retention in the manufacturing field.

Turnover on the installation side was thought to be significant, although an exact estimate was generally not available. The seasonal, ebb and flow nature of the work was cited as the main cause for this turnover. Diversification of business into other energy efficiency and renewables technology applications for buildings was cited as a potential solution to the turnover issue encountered by installers. It was generally felt that the issue of retention would be resolved once the Canadian industry becomes more established and grows a steady market.

5.8 Information Gaps, Recommend Actions and Key Observations

The following is a high level summary of the information gaps and issues that need to be addressed in the near term within the Canadian PV sub-sector in order to contribute to the development of an effective human resource strategy for the industry:

5.8.1 Information Gaps

- More exact and recent data on the size and characteristics of the photovoltaic sub-sector labour force is required.

- The disparity between growth projections for Ontario and the rest of the country should be monitored and quantified to provide an indication of the impacts of standard offer program type initiatives on PV related labour demand. This will be useful in adjusting PV labour forecasts if and when such programs are created in other jurisdictions.

- The is a need to evaluate differences between labour requirements for off-grid versus grid connected PV applications to better understand the Canadian situation since the bulk of the market to date has be for off-grid projects.

5.8.2 Recommended Actions and Key Observations

- The lack of skilled/qualified installers and the potential impact of this on achieving actual growth projections are considered serious factors in the development of the market. Significant training capacity appears to be in place in Canada suggesting the focus should initially be on recruitment into existing training programs once the market starts to grow significantly. It is essential that installers be certified to ensure quality installations and avoid negative perception in the marketplace.

- On the manufacturing side, integration of PV related curriculum into engineering programs, specifically electrical engineering, is perceived as being a good starting point for developing required skills.

- Investigate the issues around immigration and the ability to import desired PV skills that are not available within Canada. In some cases, importing of skills may contribute to growing the market and increasing the economic benefits of photovoltaic market development for domestic firms.

- Monitor market developments resulting from the standard offer program in Ontario. This program could potentially create a major demand increase for PV systems and result in a qualified installer shortage across the country.

6.0 Active Solar Thermal

6.1 Overview of the Industry

In 2004, the European Solar Thermal Industry Federation projected that the European solar thermal market, which includes the EU-25 and Switzerland, grew by 12% compared to 2003. In total 1,110 MWth (1,586,184 m2) of new capacity was installed in Europe. Germany is the European leader in terms of market volume, representing 47% of the European market. It is followed by Greece (14%), Austria (12%) and Spain (6%) [**ST1, ST2**]. *Figure ST1* provides a break-down of the European solar thermal market [**ST2**].

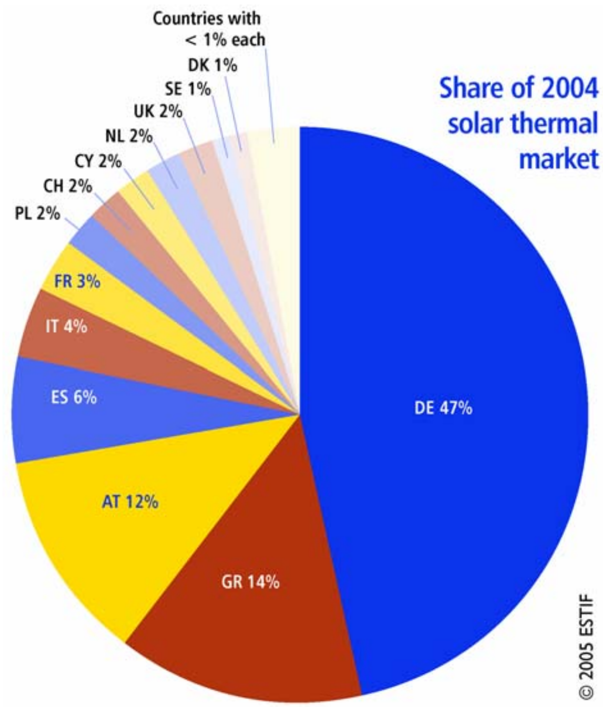

Figure ST1 – Break-down of European solar thermal (air and water) market by country [ST1]

In terms of capacity in operation per capita, the European leader is Cyprus, with 431 kWth/1000 inhabitants, followed by Greece and Austria, both with 179 kWth/1000 inhabitants. The EU average is roughly 21 kWth/1000 inhabitants. Europe, and most notably Germany, is the global leader in the development of solar thermal technology, but represents only 9% of the total market. China alone represents 78% of the total world market [**ST1**]. In China, annual sales and installation of solar water heating systems (SWH) grew to 13 million m^2 in 2004 (equivalent to ~CA$1.6 billion) and has grown at an average rate of 29% since 1991. At the end of 2001, China's cumulative installed SWH capacity reached 60 million m2 [**ST4**]. Japan, Israel, India, Turkey and Egypt also represent significant markets for solar thermal technologies [**ST2, ST3**]. The bulk of the solar thermal market is for solar water heating applications but solar air space heating applications are seeing increasing market penetration.

The Canadian active solar thermal market is composed of three main segments, (1) domestic or process solar water heating systems, which are typically evacuated or liquid glazed systems, (2) solar pool heating systems, which are generally unglazed liquid collectors, and (3) solar air heating systems. The market for solar air heating in Canada is proportionately larger than in other areas of the world, representing one third of the market on a revenue basis, due to the domestic development of a novel solar air collector technology, SolarWall. The vast majority, 90%, of these air collectors are sold in the industry, commercial or institutional sectors for space heating applications. Solar pool heating is also not as prominent outside North America. These systems also represent roughly a third of the domestic market on a revenue basis. The remainder of the market is represented by glazed and evacuated systems. Cumulative installed solar thermal capacity in Canada reached 706,564 m^2, or roughly 495 MWth, by the end of 2003. It is important to note that the majority, 68%, of installed capacity on an area basis is made up of the lower efficiency unglazed pool heating systems [**ST5**].

6.2 Profile of the Active Solar Thermal Sub-sector in Canada

6.2.1 Size

In order to simplify reporting of the size of the active solar thermal sub-sector in Canada, the industry can be broken down into two broad categories, solar water heating, which includes both the domestic hot water and swimming pool market segments, and solar air heating. At the end of 2003, a total capacity of 641,408 m^2 of SWH collector area, corresponding to an installed capacity of 449.5 MWth was installed in Canada. The equivalent of 19.2 MWth was installed in 2003, alone. Based on Industry Canada data, there were approximately 70 companies working in the solar water heating market segment in 2003. These were primarily firms involved in sales, design and installation. Many of these firms also design and install PV systems. Industry Canada estimated that roughly 120 people were directly employed by the solar water heating industry in 2003. Typical employment (with the exception of administrative positions) in this market segment is as designers and installers or research and development staff [**ST6**]. Some manufacturing positions also exist. The estimated annual growth rate of the SWH market segment was 20% over the past 3 years [**ST5**].

At the end of 2003, a total capacity of 65,156 m^2 of solar air heating collector area, corresponding to an installed capacity of 45.6 MWth, was installed in Canada. The equivalent of 7.3 MWth was installed in 2003 alone. Canadian solar air heating technology is very good by international standards and up to one half of manufacturing sales are estimated to be outside Canada. Solar systems for heating air are the principal sector of activity for six Canadian companies, employing approximately 60 persons. The majority of these companies are the manufacturers and distributors of the Canadian Conserval SolarWall technology. Typical employment (with the exception of administrative positions) within this market segment is as technical salespeople, designers and installers or as researchers and consultants [**ST6**]. Approximately 10% of all Canadian active solar sales are to international customers.

6.2.2 Structure

The Canadian active solar thermal industry includes many specialized firms and skill sets. Specifically, the Canadian active solar thermal sub-sector is made up of:

- Distributors and suppliers
- Manufacturers of collectors
- Manufacturers of balance of system components
- Designers and installers
- Consultants
- Industry promotion

6.2.3 Economic Performance

Total Canadian active solar thermal collector sales revenues for the year 2003 were roughly $5.1 million. In 2004, the annual revenues grew to $7.2 million, an increase of over 40% [**ST5**].

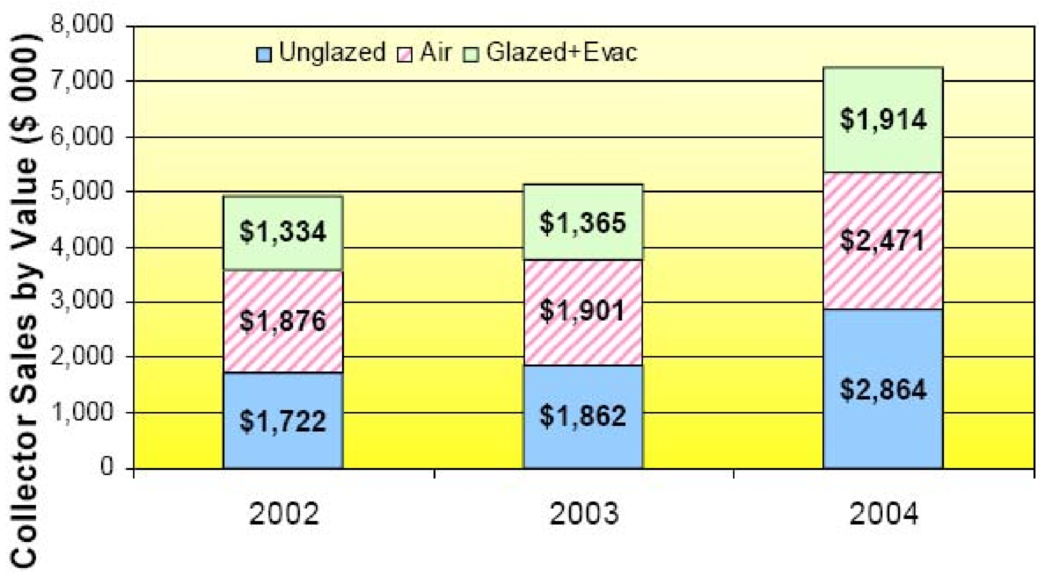

Figure ST2 – Canadian solar thermal collector sales by type from 2002-2004 [ST5]

6.2.4 Trends and Factors Impacting the Sector

In order to supplement information available in the literature reviewed for this report, four key industry informants form the Canadian active solar thermal industry sub-sector were interviewed to gain further insight into the trends and the factors impacting this sub-sector. These informants included representatives from organizations involved in manufacturing, project development and installation and research. Results from these interviews are summarized below. Since these results are solely based on the input from just four informants, the following should not be interpreted as a comprehensive list; nor should it be assumed that these trends and factors are having an impact on all firms presently involved in the Canadian active solar thermal sub-sector.

Government Policy
All informants stated that government policy at all levels was the most significant factor impacting the sector. Specifically the lack of strong policies to promote the use of solar thermal technologies and issues related to building codes that are not compatible with solar thermal installation are seen as major impacting factors restricting growth for the industry.

Costs
The cost of traditional energy sources, specifically fuels such as natural gas, was also stated as a major factor impacting the sector. It has had a negative impact in that large fluctuations in natural gas costs, in particular, have made it difficult to establish a clear economic case for some thermal technologies and impeded market penetration. However, overall it has had a positive impact in that consumers are looking for ways to save money on heating bills and are looking to active solar thermal technologies as a solution. Consequently, consumer attitudes and demand were also stated as being a significant factor by informants. It was felt that people are becoming more aware that active solar thermal can be an economic alternative for hedging against heating costs and can contribute to individual energy security. Informants felt that promotion, education and information dissemination will therefore play a large role in building the market.

Access to Capital
Cash flow and access to low cost (low interest) capital on the consumer side were stated as the most significant limitation to growth.

Human Resource Issues
Access to experienced labour was also stated as an area that could impact growth.

Supply Chain and Intellectual Property Issues
Access to raw materials was generally not considered by informants to be a factor for the industry at present. Intellectual property was a very important factor for some informants but not for others. The same was true for new applications for technologies.

6.2.5 Changes in Technology

Changes in technology specifically related to increased manufacturing throughputs are expected by informants to have an impact on the cost of technology, and hence the market for technologies, through economies of scale over the near term.

6.3 Key Players and Stakeholders in the Canadian Active Solar Thermal Industry

For a detailed listing of the Canadian active solar thermal industry's main stakeholders please refer to the Canadian Solar Industries Association member directory (http://www.cansia.ca/directory/).

6.4 Estimated Labour Demand in the Canadian Active Solar Thermal Industry

All interview respondents felt that their organizations will be growing over the next 5 years. Ranges of growth expectations (domestic and international) were from 30% to over 100% annually over the next few years, depending on the informant. For some firms the largest market for their products was international, with up to 90% of their product being exported. However, most firms expect to meet growth mainly through Canadian operations, despite the fact that several are more heavily focused on strong international markets.

For solar water heating technology firms the largest area of growth is expected to be within the residential sector followed by the commercial sector. The residential sector is perceived as being very close to the tipping point in terms of cost competitiveness with traditional heating sources. Pool heating applications are also expected to remain a steady market in the near term. For solar air heating, industrial and commercial applications are expected to be a strong area of growth. The residential market is also expected to be a strong area of growth, though more so in the US market.

Utility scale projects are expected to be an important market for some technologies in terms of using utility providers as distribution channels for product. Another specific client type that is promising over the next few years is energy service companies (ESCOs). Applications in the field of aquaculture are also seen as promising for solar water heating technologies.

Informants generally expected labour requirements to grow proportionally with sales for most manufacturers but to a lesser extent for technology licensing and project developers/installers. *Table ST1* provides a range of estimated labour force growths over the 5 and 10 year time period for both the solar air heating and solar water heating segments of the market. For the purpose of this study it was assumed that Industry Canada’s estimates of the number of people presently working in the active solar thermal sub-sector represented full-time equivalent quantities.

Table ST1 – Estimate of future Canadian solar air heating and solar water heating labour demand

Solar Air Heating	Scenario 1	Scenario 2	Scenario 3
Present (2003) Labour Force	60	60	60
Projected Growth Rate from 2003-2012	20%	35%	50%
Projected Growth from 2012-2017	15%	25%	50%
Annual Increase in Labour Efficiency	2%	2%	2%
Percentage of Growth Met through Domestic Operations	100%	100%	100%
Labour force by 2012	152	309	581
Labour force by 2017	386	1018	4403
Solar Water Heating	**Scenario 1**	**Scenario 2**	**Scenario 3**
Present (2003) Labour Force	120	120	120
Projected Growth Rate from 2003-2012	20%	35%	50%
Projected Growth from 2012-2017	10%	20%	30%
Annual Increase in Labour Efficiency	2%	2%	2%
Percentage of Growth Met through Domestic Operations	100%	100%	100%
Labour force by 2012	305	618	1163
Labour force by 2017	618	1660	4306

6.5 Profile of the Workforce

Based on interviews with industry informants, the following demographic details for the Canadian active solar thermal industry were gathered:

- The average age of people working in the industry is roughly 30 years;
- The average level of education for people working in active solar thermal manufacturing operations is college graduates and high school graduates;
- The average level of education for people working in active solar system design is engineering graduates;
- The average level of education for people working in active solar system installation is tradespeople;
- The industry is roughly made up of 90% males.

Occupations in the active solar thermal energy sub-sector include:

- Plumbers
- Pipefitters
- Drillers
- HVAC specialists
- Construction trades
- Design engineers with heat transfer expertise (typically mechanical or chemical)
- General manufacturing labour
- Process engineers (for manufacturing)
- Technical salespeople
- Researchers

6.6 Available Training

6.6.1 Canadian Solar Industries Association (CanSIA), Ottawa, ON

CanSIA offers the Canadian Solar Hot Water System Installer Certification Program. Becoming certified is a voluntary process and is not presently an explicit requirement for solar hot water system installations. The certificate grants recognition to an individual who has met predetermined qualifications as set out by CanSIA and met the skill requirements to install Solar Domestic Hot Water (SDHW) systems according to CSA F383-87 Installation Code for SDHW Systems. As part of this program CanSIA offers regular training workshops across Canada for solar installers. CanSIA also administers the certification exam as well as accredits education institutes who offer courses on the installation of SDHW systems [**ST7**]. CanSIA is also developing a course for solar air heating.

6.6.2 St. Lawrence College, Kingston, ON

St. Lawrence College offers a 2-year Energy Systems Engineering Technician and a 3-year Energy Systems Engineering Technologist course. These are certificate programs approved by the Ontario Ministry of Training Colleges and Universities. The programs cover all elements of the building energy systems including heating, ventilation and air-conditioning systems, energy efficiency and alternative energy systems such as solar air and water systems [**ST8**].

6.7 Human Resource Issues

The following human resource issues were identified for the Canadian active solar sub-sector through the interviews with four key industry informants. Issues are broken down into three broad categories, recruitment, training and retention.

6.7.1 Recruitment

The firms interviewed had all hired skilled labour within the last 3 years. The level of satisfaction with this labour ranged from high to medium. Hiring was stated as a significant challenge for smaller firms, which represent most firms in the active solar field, due to the investment required to bring new staff up to speed. Engineers and trades people are generally sought when filling labour requirements.

The skill sets required by the industry are cross cutting (e.g. plumbing, roof work, heat transfer) for installation work, therefore need versatile/adaptable people. Several informants stated that it has been a challenge to get people who fit this profile and who are reliable. In assessing potential hires, informants stated that relevant work experience was most important.

6.7.2 Training

According to industry informants, most training is currently provided internally by firms. The biggest barriers to providing internal training are cost and time burdens. This is especially true for smaller organizations.

The main reason firms have to do their own training appears to be that there is a definite lack of training available for solar thermal at both the college and university levels. It was stated that there is presently no training available, outside that offered through CanSIA, for solar water heating and active solar thermal technology design and installation. It was generally felt by respondents that this is mainly because the market has not yet sufficiently established itself to give a clear signal to academic institutions and potential students that this is a viable field to find work in. Consequently, it is a challenge to find people who understand even the basic concepts of the technology. Some respondents indicated that the lack of adequately trained people with substantial expertise in the industry means that there is a lack of resources (qualified trainers) to adequately roll out training programs even when the demand is high enough to justify them.

Respondents generally agreed that the addition of a solar water heating course to standard plumbing trades courses or solar air heating courses to standard HVAC training would suffice to cover near term installation training requirements. It was also felt that the ability to certify installers was needed in the near term as performance of systems is dependent on quality installation and uniformity of installation quality are expected to help drive the market.

6.7.3 Retention

Informants indicated that the competition for skilled trades is very high in Canada right now making it difficult to retain good people. As such, turnover has been a significant issue across the sub-sector, especially with respect to technicians and general labour. The seasonal nature of solar thermal installation work, salary issues and the small and unstable nature of some of the organizations involved in the industry are the main cited causes for retention issues, especially with competition from much higher paying sectors. Respondents generally felt that the key to addressing the issue of retention in the industry is the achievement of better market penetration and steadier work flow. This is, in turn, expected to allow for better compensation and work conditions for employees. Creating a certification program for the industry is generally perceived as a potential factor in achieving better retention in the industry. Overall, turnover was cited as a major concern by industry informants in terms of risk of investing time and resources in training people who are unlikely to remain on a job very long.

6.8 Information Gaps, Recommend Actions and Key Observations

The following is a high level summary of the information gaps and issues that need to be addressed in the near term within the Canadian active solar thermal sub-sector in order to contribute to the development of an effective human resource strategy for the industry:

6.8.1 Information Gaps

The active solar thermal sub-sector is in its infancy in Canada and represents a relatively small labour market at present. Although the available data on the size of the labour force in this subsector is limited to estimates, these estimates likely provide enough of an idea of the size of this sector for the time being. Furthermore, the factors impacting the sub-sector are well understood. In the near term, the main priority for the active solar thermal sub-sector should be to grow the market domestically for its products and services, as this in itself is expected to contribute significantly to resolving many of the current human resources issues being experienced. As such, no strategic information gaps could be identified for the development of a human resource strategy for this sub-sector.

6.8.2 Recommended Actions and Key Observations

- The growth of this sector should be monitored closely to ensure timely response to its needs. Given a few more years to mature, it is expected that the active solar thermal sub-sector will have grown to the point of requiring significant development of training programs and a more focused overall human resource strategy.

- Turnover has been a significant issue across the sub-sector, especially with respect to technicians and general labour. This is mostly thought to be the result of several factors, which include:
    - Most of the firms operating in the sub-sector are small
    - Active solar thermal technologies have not yet achieved sufficient market penetration to allow for sustained stability for many firms active in the sub-sector
    - The seasonal nature (winter is typically an off season for the industry) of system installation work
    - The present strong competition for tradespeople has made it difficult for the sub-sector to compete with other sectors for skilled labour.

- There is a lack of training available for solar thermal at both the college and university levels. There is also expected to be a lack of resources, in the form of qualified trainers, to adequately roll out training programs even when the demand is high enough to justify them.

- Respondents generally agreed that the addition of a solar water heating course to standard plumbing trade courses or solar air heating courses to standard HVAC training would suffice to cover near term installation training requirements.

- The ability to certify installers is needed in the near term as performance of systems is dependent on quality installation and uniformity of installation quality are expected to help drive the market. The requirements for the creation of a broadly recognized certification program should therefore be explored.

7.0 Geoexchange/Earth Energy

7.1 Overview of the Industry

´GeoExchange™´is the industry term for the technology also known as 'earth energy', 'ground source' or 'geothermal heat pump' technology. Geoexchange applications specifically include a ground source heat pump, but may also involve other technologies such as solar thermal, thermal storage, thermal balancing etc.

Out of a total of 71 IEA reporting countries, total installed earth energy capacity reported in 2005 reached 28 269 MWth, representing an almost 2-fold increase since 2000. Straightforward ground source heat pump (GSHP) applications represent the majority of this capacity and are one of the fastest growing applications of renewable energy in the world. GSHP systems have now been installed in roughly 31 countries, with annual increases of installations of 10% over the past ten years. GSHP specific growth over the past ten years is illustrated in *Figure GE1* [**GE1**]. Global leaders in installed GSHP capacity are Sweden, the United States, Norway and Switzerland. Sweden and Norway have the highest per capita rate of installation of GSHPs. Globally, the number of new GSHP installations is expected to continue to increase in countries where such systems are already known.

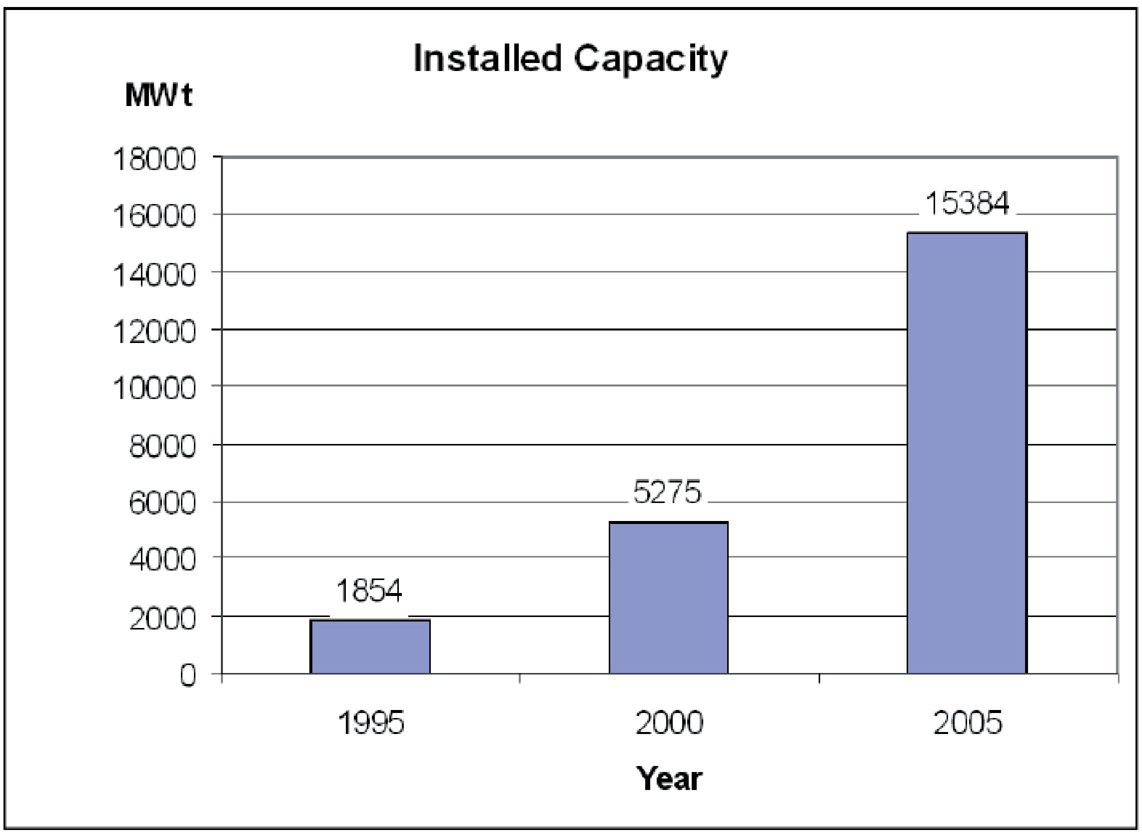

Figure GE1 – Total global installed GSHP capacity from 1995-2005 [GE1]

In addition to space heating, geoexchange systems may be used for cooling, greenhouse heating, aquaculture pond heating, snow melting, agricultural drying and various industrial uses. *Table GE1* illustrates the evolution of the installed capacity for ground geothermal heat pumps and other common applications of geoexchange systems.

Table GE1 – Evolution of global installed capacity for all common applications of geothermal/earth energy direct use [GE1]

Usage type	Capacity (MW_{th})			Utilization (TJ/yr)		
	2005	2000	1995	2005	2000	1995
Geothermal heat pumps	15 384	5 275	1 854	87 503	23 275	14 617
Space heating	4 366	3 263	2 579	55 256	42 926	38 230
Greenhouse heating	1 404	1 246	1 085	20 661	17 864	15 742
Aquaculture pond heating	616	605	1 097	10 976	11 733	13 493
Agricultural drying	157	74	67	2 013	1 038	1 124
Industrial uses	484	474	544	10 868	10 220	10 120
Bathing and swimming	5 401	3 957	1 085	75 289	79 546	15 742
Cooling/snow melting	371	114	115	2 032	1 063	1 124
Others	86	137	238	1 045	3 034	2 249
Total	**28 269**	**15 145**	**8 664**	**273 372**	**190 699**	**112 441**

The Canadian market for geoexchange/earth energy technology is currently underdeveloped, but many key factors are in place which will contribute to its growth. These include regulatory support, efficiency/emissions pressure, budding consumer interest, and increasing costs of traditional fuels [**GE2**]. Canada's federal and some provincial governments offer incentives and tax benefits for companies installing GSHPs in commercial facilities [**GE3**]. A list of and information about these incentives and tax benefits are provided in Section 11.0.

As of 2005, Canada had an installed GSHP capacity of approximately 435 MWth, ranking it 10th in the world [**GE1**]. In addition to experience with more conventional GSHP applications of earth energy, Canadian firms have also designed, developed and built an open loop geoexchange system that runs 4.7 kilometres into Lake Ontario to cool up to 4.6 million square metres of downtown Toronto office space, including over 130 office buildings from Queen's Park to the Waterfront [**GE2**]. Canadian firms have also been active in custom designed geoexchange systems for everything from schools, recreation arenas, and large university campuses, to wineries, pools and fish farms [**GE2, GE3**].

7.2 Profile of the Geoexchange/Earth energy Sub-sector in Canada

7.2.1 Size

There are more than an estimated 35,000 geoexchange installations in Canada, used for residential, commercial, institutional and industrial applications [**GE1**] and approximately 1,000 units are added each year [**GE5**]. Canada has four well established heat pump manufacturers, and approximately 15 regional distributorships [**GE2**]. In recent years there has been an increase in the number of installers specializing in geothermal heat pumps. The Government of Manitoba estimates that for every 1,000 GSHP units installed roughly 150 jobs are created [**GE4**]. Based on the present annual installation rate stated above, it is therefore estimated that roughly 150 full-time equivalent people are working in the geoexchange/earth energy subsector.

7.2.2 Structure

The Canadian geoexchange/earth energy industry includes many specialized firms and skill sets. Specifically, this Canadian sub-sector is made up of:

- Designers and installers
- Manufacturers
- Distributors
- Drillers
- Retailers
- Consultants [**GE5**]

7.2.3 Economic Performance

The Government of Manitoba estimates that for every 1,000 GSHP systems installed in Canada, the estimated annual installed capacity in recent years, roughly $15 million in construction related activities are created [**GE4**]. This is expected to grow dramatically, as further market penetration of geoexchange technology is achieved. A Canadian Electricity Association (CEA) market study in 2002 conservatively identified a $1.6 billion annual potential market for GSHPs – $619 million in the province of Ontario alone [**GE3**].

7.2.4 Trends and Factors Impacting the Sector

In order to supplement information available in the literature reviewed for this report, four key industry informants from the Canadian geoexchange/earth energy industry sub-sector were interviewed to gain further insight into the trends and the factors impacting this sub-sector. These informants included representatives from organizations involved in manufacturing, sales, project design, development and installation and industry promotion. Results from these interviews are summarized below. Since these results are solely based on the input from just four informants, the following should not be interpreted as a comprehensive list; nor should it be assumed that these trends and factors are having an impact on all firms presently involved in the Canadian geoexchange/earth energy sub-sector.

Consumer Attitudes
The primary positive factor impacting the geoexchange subsector cited by the study informants was consumer attitudes/demand. The main reason this factor is positive is that customers are generally getting good value for their investment in geoexchange technology and consequently, the technology is establishing a strong reputation despite the absence of government incentives or organized promotion activities.

Government Policy
It is generally felt by the informants that the industry has made its market inroads on its own merits without any significant government intervention in recent years. However, it is also felt that any government policy for promoting geoexchange uptake domestically would have a significant impact on the market demand. Municipal level policies are also seen by informants as a significant factor potentially impacting the market on two fronts. Firstly, municipalities have the authority to outlaw the technology or make it very difficult for it to integrate with building codes. Secondly, municipal taxation of geoexchange systems as a result of increased property valuations might significantly impact the payback period, and as such the business case, for geoexchange systems.

Costs
Cost of traditional sources of energy is only considered to be a factor impacting demand by some informants.

Human Resource Issues
Human resource issues were also considered to be an impacting factor by some of the informants. There is a general awareness that the market for skilled, experienced people in the sub-sector is very competitive and that this is impacting some firms more than others.

Access to Capital
Access to good capital on the customer side was also cited as a major factor affecting growth in the subsector. Securing investment for business growth was also cited as a challenge by some respondents.

7.2.5 Changes in Technology

Changes in technology and new applications for technologies were sited as factors impacting demand by some of the key informants. New applications include wineries and fish aquaculture. No specific changes in technology were cited by informants.

7.3 Key Players and Stakeholders in the Canadian Geoexchange/Earth Energy Industry

For a detailed listing of the Canadian geoexchange industry's main stakeholders please refer to the Canadian Geoexchange Coalition's member directory (http://www.geo-exchange.ca/en/about/members.htm).

7.4 Estimated Labour Demand in the Canadian Geoexchange/Earth Energy Industry

All four informants expected growth in sales and installations in the next 5 years. Growth projections ranged from 20-40% annually. The three most significant factors limiting this expected growth in the sector are access to low cost capital on the customer side, standardized certifications for installers and a lack of consistent standards and codes. Growth is mainly expected in distributed commercial, municipal and residential applications. Specialized applications such as wineries and arenas are also expected to be an area of growth. The majority of growth expectation projected by the study's informants will be met through domestic operations, though the clear majority of heat pump equipment will be imported from the United States.

In parallel to this, all four respondents felt that their labour force growth would be less than their sales growth. Labour force growth rate projections ranged from 10-30%. It is expected that this demand will be for engineers, plumbers, pipe fitters and drillers. The following table (*Table GE2*) provides labour force growth projections for three scenarios, a high scenario corresponding to 30% annual growth of the sub-sector labour force, a moderate scenario corresponding to 20% annual growth in the labour force and a low scenario corresponding to 10% annual growth in the labour force.

Table GE2 – Estimate of the future labour demand in the geoexchange/earth energy sub-sector

	Scenario 1	Scenario 2	Scenario 3
Present (2006) Labour Force	150	150	150
Projected Growth Rate from 2006-2012	10%	20%	30%
Projected Growth from 2012-2017	10%	20%	30%
Annual Increase in Labour Efficiency	2%	2%	2%
Percentage of Growth Met through Domestic Operations	100%	100%	100%
Labour force by 2012	218	337	503
Labour force by 2017	536	1096	2193

7.5 Profile of the Workforce

Based on interviews with industry informants, the following demographic details for the Canadian geoexchange/earth energy industry were gathered:

- The average age of people working in the industry is roughly 40 years;
- The average level of education for people working in geoexchange/earth energy manufacturing operations is tradespeople and high school graduates;
- The average level of education for people working in geoexchange system installation are trades program graduates;
- The average level of education for people working in geoexchange system design are engineering graduates and professional engineers;
- The industry is roughly made up of 90-95% males.

Occupations in the geoexchange/earth energy sub-sector include:

- System designers
- Drillers
- Installers
- Dealers
- Distributors
- Manufacturing technicians
- Assemblers
- Technical salespeople
- Managers
- Process engineers [**GE6**]

7.6 Available Training

Four geoexchange – specific courses are being developed by the Canadian GeoExchange Coalition (CGC) as of this writing. Courses will be conducted under CGC auspices for:

- Installers (three and a half days)
- Residential designers (two days; installation course is prerequisite)
- Commercial designers (for registered / licensed engineers only)
- Drillers

Course materials, examinations, and an installer´s manual are being finalized for 31 January 2007 in most cases, and successful completion of the course will result in an Attestation of Study issued by CGC. The course has been developed with the assistance of Natural Resources Canada´s Renewable Energy Deployment Initiative.

Having passed the courses, graduates (or those demonstrating equivalent experience and knowledge) may then apply for CGC accreditation in their respective field. Several provincial and territorial utilities and governments have indicated that they are actively considering requiring CGC accreditation for industry participation in future incentive programs.

After successfully gaining accreditation, participants may apply to have their future projects certified as compliant with CGC training and general practices such as CSA standard 448-02. Requirements for accreditation may be certificates in gas fitting, pipefitting or drilling or an engineering degree.

CGC further envisions development of new courses for:

- maintenance and service
- advanced commercial installations
- advanced commercial design.

Finally, CGC is working with the Association of Canadian Community Colleges to develop a link and eventual transfer of training functions to the college sector. Likewise, CGC envisions a university engineering course as part of future course development activities [**GE3**]. In addition to the CGC initiatives, the Centre for Energy Systems Applications (CESA) has recently been established at BCIT. CESA is expected to have some geoexchange related curricula [**GE10**].

One industry stakeholder indicated concern that training courses are being developed without first clearly defining what occupational standards should be. In other words training is being developed without defining what is being "trained to". This potential disconnect can be avoided by the establishment of a clear definition of the required occupational standards and a more precise description of types of skills that require specialized training.

7.7 Human Resource Issues

The following human resource issues were identified for the Canadian geoexchange/earth energy sub-sector through the four interviews with key industry informants. Issues are broken down into three broad categories, recruitment, training and retention.

7.7.1 Recruitment

All firms interviewed had recently hired skilled labour and were fairly satisfied with recent hires. When assessing potential hires, employers mainly look for related work experience and transferable skills. Informants generally felt that there is a definite shortage of people with GSHP/geoexchange experience and that the market for such people is very competitive. Key informants felt that the biggest competition for people with related skills is the traditional HVAC industry.

7.7.2 Training

Informants stated that there is presently no training program for geoexchange/GHSP systems in Canada. Consequently, all firms interviewed presently provide their own internal geoexchange training. Some industry respondents felt that even some general renewable energy or a 'Geothermal 101' course would be helpful in reducing the training burden for companies taking on new recruits. Some respondents felt that a fully dedicated geoexchange curriculum was not necessary for skills development requirements and that a few extra technology specific credits or courses added to existing relevant trades programs, such as plumbing or pipefitting, would suffice to meet the entry needs of the industry. Material such as heat transfer, ground thermal dynamics, GSHP-specific HVAC and building design would be most suitable for such extra credits. Most organizations did not see any barriers to training of staff beyond the availability of training programs.

Respondents expected that some form of certification will be required for geoexchange installations in most regions in the near term. One respondent suggested that an international forum for exchange of best practices would be useful to the industry. In addition, one respondent felt that education on renewable energy technologies and GSHP specifically has to be integrated into all levels of education and various programs to ensure that these technologies are being considered as viable and sustainable options for meeting energy needs.

7.7.3 Retention

Retention was only identified as a problem by one respondent. The cited reason for this was competition for skilled people in the industry and the fact that once an employee was properly trained it is a challenge to retain them.

7.8 Information Gaps, Recommend Actions and Key Observations

The following is a high level summary of the information gaps and issues that need to be addressed in the near term within the Canadian geoexchange/earth energy sub-sector in order to contribute to the development of an effective human resource strategy for the industry:

7.8.1 Information Gaps

- Developing better data on the size of the geoexchange/earth energy sub-sector and labour force should be a priority. Existing data appear to be very rough estimates with little justification. Sound data will be required to develop an effective human resource strategy for the sub-sector.

- There presently appears to be a lack of a clear definition of required occupational standards and precise description of types of skills that require specialized training for geoexchange specific certification. The capacity to meet geoexchange related certification requirements through existing trade certification programs should be explored.

7.8.2 Recommended Actions and Key Observations

- There are clear signs that this sub-sector is positioned for significant growth in the near term and that there is a definite shortage of people with GSHP and geoexchange experience. Furthermore, the market for such people is very competitive. This suggests that a concerted effort must be put into recruitment into the industry.

- There is presently no training program for geoexchange/GHSP systems in Canada. Training programs are being developed by the Canadian Geoexchange Coalition. Assisting the CGC in these efforts would benefit the sub-sector.

- Some respondents felt that a fully dedicated geoexchange curriculum was not necessary for skills development requirements and that a few extra technology specific credits or courses added to existing relevant trades programs, such as plumbing or pipefitting, would suffice to meet the entry needs of the industry. Development of relevant curricula for integration into existing programs should be made a priority. In order to ensure that training courses meet their mark, a clear definition of the required occupational standards and a more precise description of types of skills that require specialized training should be established.

8.0 Small Hydropower

8.1 Overview of the Industry

Small hydropower (< 50 MW) has been developed worldwide for more than a century. The total global installed small hydropower capacity was estimated at 61,000 MW in 2004 [**SH1**]. More than half of the world's small hydropower capacity exists in China, where an ongoing boom in small hydro construction added nearly 4 GW of capacity in 2004 alone. Other countries with substantial ongoing efforts in small hydropower development include Australia, India, Nepal, and New Zealand. Internationally, small hydro is often used in autonomous (not grid-connected) village-power applications to replace diesel generators or other small-scale power plants or to provide electricity for the first time to rural populations. In the last few years, more emphasis has been put on the environmental integration of small hydro plants into river systems in order to minimize environmental impacts, incorporating new technology and operating methods. [**SH1, SH2**].

Small hydropower, being a more established and mature technology than other emerging renewable technologies, such as solar PV and wind, is growing at a slower rate, roughly 4-5% annually. However, this represents a significant market since the existing installed small hydropower capacity is greater than any other emerging renewable technology. *Table SH1* provides a comparison of the installed capacity for various renewable energy electricity generation technologies [**SH2**].

Table SH1 – Existing global cumulative installed capacity by renewable energy type at the end of 2004 [SH1]

Existing capacity end-2004	Power generation
Small hydropower	61 GW
Wind power turbines	48 GW
Biomass power	39 GW
Geothermal power	8.9 GW
Solar PV, off-grid	2.2 GW
Solar PV, grid-connected	1.8 GW
Solar thermal power	0.4 GW
Ocean (tidal) power	0.3 GW
Total renewable power capacity	160 GW

In Canada small hydroelectric facilities are typically defined as those sites with a capacity of 30 MW or less (this defers somewhat from the international definition of small hydropower which is <50 MW as stated in the Section 3.0). In Canada, there are slightly more than 300 of these facilities which account for approximately 3 percent (or 2,000 MW) of the country's total 69,000 MW of hydroelectric facilities. According to Natural Resources Canada, an additional capacity of 2000 MW of small hydropower is economically viable [**SH3**].

8.2 Profile of the Small Hydropower Sub-sector in Canada

8.2.1 Size

Conflicting data are available on the size of the Canadian small hydropower industry. Natural Resources Canada estimates that the Canadian small-hydro industry includes more than 20 equipment manufacturers and about 70 engineering firms employing a total of approximately 2,000 people. This number does not appear to include small hydropower plant operators. Natural Resources Canada estimates that roughly 100 to 150 MW of small hydropower capacity are added yearly to Canada's power supply. Canada's small hydroelectric manufacturers and service providers, such as consultants and financiers, also export to overseas customers [**SH4**].

Conversely, Industry Canada estimates that the industry is composed of fewer than 50 businesses, approximately a quarter of which are large public electricity providers equipped with small hydroelectric plants. Industry Canada estimates that these businesses directly employ roughly 750 to 1000 people in small hydropower related activities. Industry Canada also estimates that the industry adds roughly 30 MW to 50 MW of capacity annually. The largest cause of deviation between these two sources of estimates is projected to be the range in scale for the definition of small hydropower from different groups and jurisdictions [**SH3**].

8.2.2 Structure

The Canadian small hydropower industry includes many specialized firms and skill sets. Specifically, this Canadian sub-sector is made up of:

- Small hydroelectric plant developers
- Plant construction contractors
- Research engineers or design consultants
- Small hydroelectric plant operators
- Maintenance engineering technicians
- Component manufacturers
- Hydrology assessment firms
- Environmental impact assessment firms
- Civil engineering firms[**SH3**]

8.2.3 Economic Performance

Natural Resources Canada estimates that over the last decade, the small-scale hydropower industry has contributed about $150M per year to the Canadian economy in manufacturing and services [**SH4**]. In Comparison, Industry Canada estimates that over the 1990s, some $100 million annually were injected into the Canadian economy through small hydroelectric plants in the areas of manufacturing and services [**SH3**].

8.2.4 Trends and Factors Impacting the Sector

In order to supplement information available in the literature reviewed for this report, five key industry informants from the Canadian small hydropower industry sub-sector were interviewed to gain further insight into the trends and the factors impacting this sub-sector. These informants included representatives from organizations involved in small hydropower project consulting, project development and operation, government research and industry promotion. Results from these interviews are summarized below. Since these results are solely based on the input from just five informants, the following should not be interpreted as a comprehensive list; nor should it be assumed that these trends and factors are having an impact on all firms presently involved in the Canadian small hydropower sub-sector.

Government Policy
Government policy was cited by key industry informants as the most significant impacting factor for the small hydropower industry sub-sector. At the federal level, the expectation that the government will take a leadership role in green power procurement is expected to have an impact on the small hydropower market in the years to come. Any announcement of federal incentives for small hydropower development would also be expected to further drive the market.

At the provincial level, and perhaps most significantly, renewable energy RFPs and the Ontario Standard Offer Program (SOP) are expected to have the largest impact on the market. Renewable RFPs and the SOP provide the opportunity for long term (up to 20 years) guaranteed contracts, which makes financing of projects significantly easier.

Costs
The cost of traditional sources of energy was considered by informants to be less significant for small hydropower projects mainly because the difference in cost between small hydropower and power from fossil fuel sources often tends to be small to nonexistent, depending on the project.

Supply Chain Issues
Access to raw materials, beyond flowing water, was also not considered a factor for the small hydropower industry.

Intellectual Property
In addition, informants generally felt that intellectual property and new applications for small hydropower technology were not a significant factor impacting demand within the sub-sector.

Human Resource Issues
Human resource issues were considered to be an impacting factor by some informants, though less significant than other factors cited above. In particular, access to skilled construction workers is a challenge as a result of demand from housing and oil and gas industries. Furthermore, there is a concern that there has been little development of new small hydropower projects in recent years and that new people with experience simply are not being developed. Nonetheless, this does not yet appear to be having a major impact on the growth of the market.

Transmission Constraints

Transmission constraints were cited as a major limiting factor for the growth of the small scale hydropower sub-sector. Many ideal sites for small hydropower development are in areas with poor grid access or access to transmission lines with limited capacity for absorbing additional power, rendering such projects unfeasible to pursue in the near term.

8.2.5 Changes in Technology

Industry informants generally felt that changes in technology are having an impact on the market. In particular, increasing levels of automation are reducing the labor requirement and the cost for operating facilities. Furthermore, advances in hydraulic and turbine modeling are allowing developers to provide better performance warranties. Increased warranty coverage on plants are contributing to making access to financing for projects easier.

8.3 Key Players and Stakeholders in the Canadian Small Hydropower Industry

For a detailed listing of the Canadian small scale hydropower industry's main stakeholders please refer to the Government of Canada's Clean Energy Portal small hydropower company listing (http://www.cleanenergy.gc.ca/tech_dict/index_e.asp?ac=100&sc=195&sc_i=4&ac_i=5).

8.4 Estimated Labour Demand in the Canadian Small Hydropower Industry

All respondents felt that the industry and their organizations will be growing over the next 5 years. Actual growth projections ranged from 50%-100% over the next 5 years (~10-20% annually) with the strongest growth projections coming from firms operating in Ontario. All of the growth expectations are expected to be filled by Canadian operations.

Cited limitations to growth included the long project development cycles (up to 4 years), access to capital, limited number of sites and issues around access to crown land sites. Government policy and environmental regulations were also seen as a limitation, as was access to experienced people. Finally, the supply of hydro turbines is expected to be a potential limitation to the rate of growth, especially as a result of the major growth in Ontario resulting from the requirement to replace a large portion of the generation capacity and the standard offer program. There are few turbine manufacturers and long lead times are becoming the norm.

Utility scale projects will continue to be the primary focus for the industry. International markets could also be a major area of growth in the near term but a significant effort will have to be put into promoting Canada's capabilities abroad to take advantage of this market.

The labour force is expected to grow but not at the same rate as the market. This is mainly due to the increasing levels of automation used in plant operation. There is also a trend within the industry to outsource a lot of the maintenance work in an attempt to minimize overhead. Nonetheless, a significant shortage of experienced labour is foreseeable in the next 5-10 years as the majority of the workforce in hydropower approaches retirement age.
As previously stated, there are presently very few companies in turbine manufacturing. This is already starting to be a bottleneck for the industry and these companies will need to grow to meet demand. This will require developing additional design and construction staff. For consulting, design and construction firms, there will likely be an increase in demand, but not on the same level as the market growth. This is because these types of firms are only involved during planning and construction of projects and is tied to the annual installed capacity, not the total generation capacity. Growth in the annual installed capacity is somewhat smaller than that of total cumulative installed capacity. In light of all of these factors, the actual national labour force growth rate for the industry is expected to be in the range of 5-15%, with firms in Ontario growing most rapidly. The following table (*Table SH2*) provides labour force growth projections for three scenarios, a high scenario corresponding to 15% annual growth of the sub-sector labour force, and moderate scenario corresponding to 10% annual growth in the labour force and a low scenario corresponding to 5% annual growth in the labour force. Projections for these three scenarios are presented assuming the present level of employment within the industry estimated by both Natural Resources Canada and Industry Canada of roughly 2000 and 1000 people respectively. It was assumed for both Natural Resources Canada and Industry Canada data are for full-time equivalent labour. In considering these figures it is very important to remember that a large portion of the present labour force in the sub sector will be reaching retirement age within the next 5-10 years and that the actual requirement for new recruits within the industry could represent as much as 80% or more of the labour force projections.

Table SH2 – Estimate of the future labour demand in the Canadian small hydro sub-sector

Natural Resources Canada	Scenario 1	Scenario 2	Scenario 3
Present (2006) Labour Force	2000	2000	2000
Projected Growth Rate from 2006-2012	5%	10%	15%
Projected Growth from 2012-2017	5%	10%	15%
Annual Increase in Labour Efficiency	2%	2%	2%
Percentage of Growth Met through Domestic Operations	100%	100%	100%
Labour force by 2012	2307	2912	3636
Labour force by 2017	4969	7150	10421
Industry Canada	**Scenario 1**	**Scenario 2**	**Scenario 3**
Present (2006) Labour Force	1000	1000	1000
Projected Growth Rate from 2006-2012	5%	10%	15%
Projected Growth from 2012-2017	5%	10%	15%
Annual Increase in Labour Efficiency	2%	2%	2%
Percentage of Growth Met through Domestic Operations	100%	100%	100%
Labour force by 2012	1154	1456	1818
Labour force by 2017	2485	3575	5124

8.5 Profile of the Workforce

Based on interviews with industry informants, the following demographic details for the Canadian small hydropower industry were gathered:

- The average age of people working in the industry is roughly 45-50 years, consequently a large number of people working in small hydropower firms are expected to retire in the near term;
- The average level of education for people working in manufacturing operations is tradespeople and high school graduates;
- The average level of education for people working in small hydropower industry are engineering and trades program graduates;
- The industry is roughly made up of more than 90% males; this has been identified as an issue by the small hydropower industry.

Occupations in the small hydropower sub-sector include:

- Small hydroelectric plant developer
- Plant construction contractors and labourers
- Hydrogeologists
- Civil engineers
- Research engineers or design consultants
- Small hydroelectric plant operators
- Maintenance engineering technician
- Component manufacturers
- Power system engineers
- Mechanical engineers
- Fish habitat specialists

8.6 Available Training

Based on interviews with key industry informants and a preliminary literature review there presently does not appear to be a single small hydropower specific course or education program. It is expected, however, that any training related to large hydropower project planning, design, construction and operation would be fully transferable to small scale hydropower projects. A review of the courses and education programs available for conventional (large scale) hydropower projects was not conducted as part of this study.

8.7 Human Resource Issues

The following human resource issues were identified for the Canadian small hydropower sub-sector through the interviews with five key industry informants. Issues are broken down into three broad categories, recruitment, training and retention.

8.7.1 Recruitment

Industry informants felt that there is a definite lack of skills and experience under the age of 40 due to the long hydropower plant lifetimes and the limited growth of the industry in recent years. There is a perceived need within the industry for systems people as well as mechanical people. There is also a continued need for mechanical engineers with turbine design experience and civil engineers with stream (damming, fish habitat, ice issues) construction experience. For plant operation specifically, there is a need for people with good communications skills to deal with technical problems remotely. Utilities cannot afford to wait for specialized technicians to get to sites for repairs so there is a definite need for staff to be able to communicate and understand how to handle maintenance requirements. On the construction side, it was felt that labour shortages are affecting everyone, not just the hydropower sub-sector.

When hiring, industry informants generally look for relevant certificates or degrees and work experience. As technology has improved, there has been a problem with tradespeople not having enough computer skills and a lack of inclination towards those skills, which would allow them to do all that is required of them. There is also a perceived lack of new graduates with power engineering expertise, especially with a hydropower focus. It was felt by respondents that most electrical engineering graduates are focused on high tech applications these days, but there is a need within the industry for people with electronics experience and comfort with technology, as well.

Several informants cited that the industry has not been effectively promoting itself with the future labour force. As such, there is a lack of awareness of hydropower as a viable and promising career option. Consequently, there is a perceived need to focus on recruitment in the industry, especially in light of the ageing workforce, a large portion of which will be retiring within the next 5 to 10 years, and the large gap in the industry of experienced people.

8.7.2 Training

According to informants, most training is done on the job in the industry, with some firms providing for extra external specialized training to employees when needed. Several informants felt that there is a need to develop trades programs with an added element of systems/electronics training (e.g. for pipefitters). There is also a concern over the lack of hydropower and power systems training being offered in university curricula.

Small hydropower generation as a cost effective source of electricity is taking on an increasing importance for northern areas, and in particular for aboriginal and remote communities. In these situations, it is expected that local people will have to be trained to handle construction, operation and management requirements for the hydropower stations. This will create a particular set of training issues, especially where projects involve the aboriginal community and community involvement is stipulated in development agreements.

8.7.3 Retention

Turnover has generally not been a problem in the small hydropower sub-sector because most plants operate for more than 50 years and work conditions are typically very stable. Many people have been working in the industry for 30-40 years. However, this ageing workforce poses a major retention concern in the near term.

8.8 Information Gaps, Recommend Actions and Key Observations

The following is a high level summary of the information gaps and issues that need to be addressed in the near term within the Canadian small hydropower sub-sector in order to contribute to the development of an effective human resource strategy for the industry:

8.8.1 Information Gaps

- Training related to large hydropower project planning, design, construction and operation is likely fully transferable to small scale hydropower projects. A review of the courses and education programs available for conventional (large scale) hydropower projects should therefore be conducted.

- There is a need to explore specific training requirements for hydro turbine manufacturing labour.

8.8.2 Recommended Actions and Key Observations

- In considering the labour forecast figures it is very important to remember that a large portion of the present labour force in the sub sector will be reaching retirement age within the next 5-10 years and that the actual requirement for new recruits will be significantly more than that resulting from industry growth alone.

- There is presently a lack of new graduates with power engineering expertise, especially with a hydropower focus. The industry has not been effectively promoting itself with the future labour force. As a result, there is a lack of awareness of hydropower as a viable and promising career option. This should be addressed in any human resource strategy for the sector, especially in light of the imminent retirement of a large portion of the existing labour force.

- There are presently very few companies in the turbine manufacturing domain. This is already starting to be a bottleneck for the industry and these companies will need to grow to meet demand. Therefore recruitment and training issues related to these activities should be looked at in depth.

- There will be a continued need for mechanical engineers with turbine design experience and civil engineers with stream (damming, fish habitat, ice issues) construction experience.

- Several informants felt that there is a need to develop trades programs with an added element of systems/electronics training (e.g. for pipefitters).

9.0 Bioenergy

9.1 Overview of the Industry

Around 12% of the global energy required is generated by combustion of biomass fuels, which vary from wood to animal by-products and black liquor (a recycled byproduct formed during the pulping of wood in the papermaking industry). A wide variety of technologies are used to convert this biomass into useful energy. In developing countries, around 35% of the energy used originates from biomass, but most of this is for non-commercial use in traditional applications (such as cooking). In a country such as Nepal, over 90% of the primary energy is produced from traditional biomass fuels. In industrialized countries, the total contribution of biomass to the primary energy mix is only 3%. This mainly involves the combustion of commercial biomass fuels in modern devices – for example, woodchip-fired co-generation plants for heat and power. Other applications are domestic space heating and cooking, industrial heat supply, and large-scale power generation in coal fired plants [**BE1**].

Electricity production and heat generation from biomass, the two major categories of bioenergy included in the scope of this study, have expanded significantly over the past decade in Europe, driven mainly by developments in Austria, Finland, Sweden, Germany, and the United Kingdom. After significantly rapid growth in recent years in converting waste wood in Germany to energy, the market has started to level off as most of the waste resource streams have now been earmarked for existing energy generation projects. The use of biomass for district heating and combined heat-and-power projects has been a particularly successful approach in Germany and similar activity has also been taking place in Austria. Elsewhere in Europe, the United Kingdom has seen significant recent growth in "co-firing" (burning small shares of biomass in coal-fired power plants). In Sweden, biomass supplies more than 50 percent of district heating needs. Continuing investment in bioenergy is a trend throughout several other OECD countries as well, perhaps most notably in the United States [**BE2**].

Among developing countries, small-scale power and heat production from agricultural waste is becoming increasingly common, for example from rice or coconut husks. The use of bagasses (sugar cane waste) for power and heat production is now very common in countries with large sugar industries, including Brazil, Columbia, Cuba, India, the Philippines, and Thailand. Furthermore, increasing numbers of small-scale biomass gasifiers are finding application in rural areas throughout the world and there have been several larger scale gasifier demonstration projects using high-efficiency combined-cycle power plants to generate electricity in developed countries [**BE2**].

Combustion is the most common way of converting solid biomass fuels to energy. It is well understood, relatively straightforward, and commercially available, and can be regarded as a proven technology. However, the desire to burn uncommon fuels, improve efficiencies, reduce costs, and decrease emission levels continuously results in improved technologies being developed [**BE1**]. Therefore, in addition to the more conventional approaches to converting biomass into bioenergy discussed above, recent technology developments are allowing for the extraction of energy from waste streams that were heretofore uneconomical. An example of such a technology is new large scale anaerobic digesters that can convert biological waste streams from food processing, agriculture or wastewater treatment facilities into a combustible gas for heat and power applications. New biomass conversion technologies are also allowing for the transformation of biomass streams into new, easily transportable and broadly applicable fuels, such as bio-oil and biodiesel, which can be used in heat and power generation applications. Finally, interest in bioenergy "coproduction," in which both energy and non-energy outputs, for example, animal feed or industrial fiber, are produced in an integrated process, is also growing [**BE2, BE3**].

With more biomass resources per capita than any other nation, Canada has a diverse treasure house of crops, trees, animals, marine life, microorganisms, and industrial and municipal organic residues. Annual biomass residues are equivalent in energy content to about a quarter of the fossil fuel used in Canada. Consequently, Canadian companies are exceptionally well positioned to capture strong financial and economic returns from these materials [**BE3**].

Presently, Canada produces roughly 3 percent of its electricity needs from biomass sources. In fact, bioenergy is Canada's second-largest renewable energy source after hydro [**BE4**]. The Canadian bioenergy industry is active in all the technology areas listed above and is developing several new and very promising technologies for the conversion of biomass into useful energy streams. The Canadian bioenergy sub-sector can be broken down to four main sub-industrial clusters which each have different prospects and profiles:

- residential wood stove and wood pellet,
- industrial combustion/digestion,
- municipal and district heat and power, and
- biofuels.

In recent years, Canada has become a world leader in the development of biomass fast pyrolysis and advanced anaerobic digestion (biogas) technologies, especially for large scale applications of such technologies. Companies involved in these fields are aggressively marketing their technologies to the US and European markets [**BE5**]. Canadian firms are also becoming increasingly active in the large scale production of biodiesel [**BE6**].

As indicated in Section 3.0 of this study, residential wood stove and wood pellet related activities and transportation applications of biofuels are not included in the scope of this study [**BE3**]. Both of these application areas represent significant economic activity and consequently significant human resource demand areas. The expected near term growth in biofuels demand resulting from federal and provincial transportation biofuels initiatives in particular will lead to a large demand for specialized skilled labour. These expected developments should be kept in mind when assessing the following situational analysis of the human resource issues in the bioenergy heat and power application areas.

9.2 Profile of the Bioenergy Sub-sector in Canada

9.2.1 Size

It is very difficult to estimate the exact size of the bioenergy sub-sector in Canada due to the broad range of technical approaches to converting biomass to energy, the range of biomass feedstocks that can be economically used, the diversity of markets for each technology and the complexity of the overall bioenergy supply chain. In addition, many of the firms entering the sub-sector are technology developers in the demonstration or early commercialization stages that have only started significant activities within the last 2-3 years. This has meant that their contribution to both the generation capacity in terms of megawatts and to the labour market in terms of number of employees has not been captured in the presently available data. Furthermore, many of the firms involved in the bioenergy sub-sector get lumped in with the overall bioproducts sector.

According to a preliminary study by Statistics Canada based on some partial data for 2001 on the Canadian bioproducts industry, an estimated 133 Canadian firms are involved in making or developing industrial bioproducts. These firms were estimated to employ 39,000 people [**BE3**]. For the purpose of this study, it is estimated that direct employment within the bioenergy sub-sector, as defined in the Section 3.0 of this document, is roughly 2500 (full-time equivalent) (~6.5% of the bioproducts sector total). Within this level of employment, it is estimated that roughly 500 people are employed by firms developing new technologies with potential for rapid domestic and international growth and roughly 2000 people are employed by firms developing and operating more traditional direct combustion, mainly associated with the forestry sector, and landfill gas projects. These numbers should only be taken as estimates until precise data on this sub-sector become available. Typically, bioenergy creates more permanent employment than other energy sources. For the same capital investment, it creates almost twice as many jobs as other types of renewable energy, and three times as many as fossil energy [**BE7**].

Partial data were available from Industry Canada on the installed biomass based electricity generation capacity in Canada. As of 1999, there were 16 landfill sites using landfill gas (LFG) to generate 85.3 MW of electricity in Canada. There are also several independent power producers who generate electricity from the combustion of wood waste obtained from sawmills eager to dispose of it. About 10 such plants exist in Canada representing a total of roughly 200 MW of generation capacity [**BE4, BE5**].

9.2.2 Structure

There is a large diversity of firms operating in the bioenergy sub-sector. This is mainly the result of the broad range of technologies that can be used to convert biomass into electrical and thermal energy and the wide variety of biomass feedstocks that can be used. The Canadian bioenergy industry (as it is defined in the scope of this study) includes many specialized firms and skill sets. Specifically, this Canadian sub-sector is made up of:

- Anaerobic digester technology developers and manufacturers
- Biodiesel production technology developers
- Biodiesel producers
- Pyrolysis technology developers and manufacturers
- Pyrolysis plant operators
- Forestry products manufacturers
- Landfill gas electricity plant developers and operators

- Engineering consultants
- Biomass heat and power plant operators
- Biomass combustion equipment manufacturers
- Industry promotion

9.2.3 Economic Performance

As previously stated, due to the highly diverse and complex nature of the bioenergy sub-sector, no data on the specific economic performance of the industry could be found. Based on the study conducted by Statistics Canada which used partial data for 2001, the Canadian bioproducts industry was estimated to have produced revenues of $15.3 billion. Also in 2001, the bioproducts industry was estimated to have invested $598 million in research and development and had exports worth $564 million [**BE3**]. Assuming again that the economic performance of the bioenergy sub-sector can be estimated as representing roughly 6.5% of that generated by the bioproducts sector, revenues for the bioenergy sub-sector can be estimated at roughly $1 billion.

9.2.4 Trends and Factors Impacting the Sector

In order to supplement information available in the literature reviewed for this report, three key industry informants from the Canadian bioenergy industry sub-sector were interviewed to gain further insight into the trends and the factors impacting this sub-sector. These informants included representatives from organizations involved in manufacturing and project development, technology development and industry promotion. Results from these interviews are summarized below. Since these results are solely based on the input from just three informants, the following should not be interpreted as a comprehensive list; nor should it be assumed that these trends and factors are having an impact on all firms presently involved in the Canadian bioenergy sub-sector.

Costs
The cost of traditional sources of energy was cited by all industry informants as the most significant factor impacting demand in the sector.

Industry Diversity
The broad range of approaches for harnessing bioenergy is seen as an impacting factor on the industry in the sense that individual technology developers are establishing their own niches with less of a focus or dependence on the bioenergy industry situation as a whole. The technologies are competing on their own without assistance and are consequently not focused on contributing to the development of overall development strategies for the sub-sector. Consequently, there is a lack of a clear policy framework to promote bioenergy. This was cited as one of the major impacting factors on the sector by one respondent.

Raw Materials
Access to raw materials was also felt to be a minor impacting factor when dealing with biomass streams tied to crown land.

Human Resource Issues
Access to skilled labour was not perceived by informants as a major factor in the industry at present.

Consumer Interest
Finally, because most bioenergy applications are on a commercial or industrial scale, individual consumer demand was cited as having a very minor impact on the industry.

9.2.5 Changes in Technology

New applications for technologies were cited as being a significant factor by all respondents. Canadian firms are developing highly versatile technologies that are allowing for new uses of biomass streams, mostly waste and residue streams, beyond traditional direct combustion or land fill disposal. Examples of such technologies include pyrolysis systems for conversion of lignocellulosic residues into easily transportable and broadly applicable bio-oil streams and large scale anaerobic digestion systems that are allowing for the economic conversion of streams that were traditionally seen as nuisance waste streams into electricity and heat sources.

9.3 Key Players and Stakeholders in the Canadian Bioenergy Industry

For a detailed listing of firms involved in the Canadian bioenergy sub-sector please refer to the Government of Canada's Clean Energy Portal biomass company listing (http://www.cleanenergy.gc.ca/tech_dict/index_e.asp?ac=100&sc=186&sc_i=0&ac_i=5).

9.4 Estimated Labour Demand in the Canadian Bioenergy Industry

All respondents expected their organizations or their industries to grow within the next 5 years. Due to the relatively small current market penetration of certain emerging technologies, expectations are for significant and rapid growth in the next five years for a portion of the sub-sector, especially for firms focused on international markets. Estimated growth rates of up to 100% annually were suggested by respondents representing such firms. More traditional direct combustion technology applications are expected to grow at a somewhat slower rate of 10-20% annually.

A major limitation to achieving projected growth, especially domestically, cited by informants was the conservatism of potential buyers of new emerging technologies. The ability to put skilled people in place quickly enough to meet explosive growth projections was also stated as a potential bottleneck. The key areas of projected growth for the sub-sector cited by informants included heat and power applications from biomass/forestry residues and most significantly, new, non-transportation related applications for bio-oil and biogas applications for waste water treatment plant and agricultural waste streams. Applications within these fields will mostly be utility scale projects and off-grid/remote projects according to informants. Specific client types such as crop oil producers with large biomass residue streams and forestry product producers were cited as key areas of growth. Industry informants expect to meet a large portion of their projected growth through domestic operations.

All organizations expected equally significant growth in skilled labour requirements to meet the above growth projections. One respondent suggested the potential for growth from 13 employees today to 300 within 6 years. Another informant suggested a 300% increase in skilled labour requirements over the next 5 years. For the purpose of projecting the size of the total bioenergy sub-sector labour force at the 5 and 10 year marks, two separate categories of growth have been used. For the emerging technology category, which includes pyrolysis, biodiesel, anaerobic digestor and gasification technology developers, a range of growth rates from 25% to 100% annually are used for the first 5 years of growth. This range is projected to drop to half over the second 5 years of growth. For the more traditional direct combustion and landfill gas category, a lower growth rate range of 10 to 30% is used for the first 5 years of growth. Once again this range of growth rates is projected to decrease to half for the second 5 year period. The following table (*Table BE1*) provides a breakdown of labour force growth for rapid, medium and low growth rate scenarios.

Table BE1 – Estimate of the future emerging and conventional bioenergy technology labour demand

Emerging Technologies (Pyrolysis, Biodiesel, Anaerobic Digester and Gasification)	Scenario 1	Scenario 2	Scenario 3
Present (2006) Labour Force (Estimate)	650	650	650
Projected Growth Rate from 2006-2012	25.0%	62.5%	100.0%
Projected Growth from 2012-2017	12.5%	31.3%	50.0%
Annual Increase in Labour Efficiency	2%	2%	2%
Percentage of Growth Met through Domestic Operations	70%	70%	70%
Labour force by 2012	1431	4837	13337
Labour force by 2017	2020	13231	67701
Conventional Technologies (Direct Combustion and Landfill Gas)	**Scenario 1**	**Scenario 2**	**Scenario 3**
Present (2006) Labour Force (Estimate)	2000	2000	2000
Projected Growth Rate from 2006-2012	10%	20%	30%
Projected Growth from 2012-2017	5%	10%	15%
Annual Increase in Labour Efficiency	2%	2%	2%
Percentage of Growth Met through Domestic Operations	100%	100%	100%
Labour force by 2012	2912	5972	9654
Labour force by 2017	3359	6142	10085

9.5 Profile of the Workforce

Based on interviews with industry informants, the following demographic details for the Canadian bioenergy industry were gathered:

- The average age of people working in the bioenergy industry, based on the limited number of informants interviewed from within the sub-sector, is roughly 30-40 years;
- The average level of education for people working in research and development roles in the industry is a master's degree or PhD;
- The average level of education for people working in plant design is engineering degrees;
- The average level of education of people working in plant construction and operation activities is trade certificates; and
- The industry is made up of roughly 75-80% males.

Occupations in the bioenergy sub-sector include:

- Process engineers
- Mechanical Engineers
- Research scientists
- Plant design specialists
- Bioenergy plant operators
- Construction tradespeople
- Plumbing and pipefitting tradespeople
- Power system engineers
- Power systems tradespeople
- Maintenance engineering technicians
- Component manufacturers
- Technical salespeople

9.6 Available Training

Based on the interviews with industry informants, there are presently no dedicated training programs specifically targeted to bioenergy. However, the Canadian Bioenergy Association offers periodic training opportunities in conjunction with groups such as the Forest Products Association of Canada and the BIOCAP Canada Foundation on biomass power generation and heating.

Informants generally indicated that the skills developed through traditional engineering (chemical, biotechnology, mechanical, civil and electrical) and trades (plumbing, pipefitting, combustion systems, mechanical etc.) programs suffice for the labour force to be prepared for entry level positions in the sub-sector. Only research and development roles require highly specialized graduate level credentials. However, education and skills training is needed to facilitate scientists and engineers in working with and integrating the capabilities of a range of disciplines that traditionally have not worked together (e.g. biology, chemistry and engineering) [**BE3**].

9.7 Human Resource Issues

The following human resource issues were identified for the Canadian bioenergy sub-sector through the interviews with three key industry informants. Issues are broken down into three broad categories, recruitment, training and retention.

9.7.1 Recruitment

The two industry respondents had recently hired skilled labour and were fairly pleased with these hires. Work experience was the most important factor when assessing the qualifications for potential hires. Both respondents generally did not feel that it was difficult to find quality employees to fill roles. Informants did, however, expect a shortage of general skilled labour that would affect all industries, as their technologies penetrate the market and more construction labour is needed.

9.7.2 Training

The two industry respondents did not feel that there was a lack of training available or that they had difficulty finding people with a particular skill set. These informants felt that most required skills are transferable from existing trades and technical degrees. The informants indicated that any required training is generally done on the job with employees being sent on specific training courses if any additional specialized training is required. The industry informants did not feel that there were any barriers to providing training to employees at the present time. The only skills gap area cited by informants was technical sales. This skill set is considered to be essential for growth domestically and internationally.

9.7.3 Retention

Retention was not considered to be a major issue in the industry at present, although competition for skilled people is expected with the projected rapid growth within some areas of the sub-sector. Competition with other high paying sectors such as oil and gas was also cited as a concern related to retention.

9.8 Information Gaps, Recommend Actions and Key Observations

The following is a high level summary of the information gaps and issues that need to be addressed in the near term within the Canadian bioenergy sub-sector in order to contribute to the development of an effective human resource strategy for the industry:

9.8.1 Information Gaps

- There is presently a lack of clear data on the exact size, both in terms of generation capacity and labour force, of the Canadian bioenergy industry. Some research needs to be conducted in order to determine this information.

- Data on specific potential growth for specific bioenergy applications are lacking. This will be essential for the development of an effective human resource strategy.

9.8.2 Recommended Actions and Key Observations

- The large diversity of interests and activities within the bioenergy industry is seen as a barrier to the development of an overall bioenergy sub-sector strategy in terms of market development, government policy engagement and human resources strategy. There is a need to bring the sub-sector stakeholders together in a more focused way to develop a long term policy and human resource roadmap.

- Some effort in recruiting people into the industry will likely have to be made in the near term as the sub-sector is expected to experience significant and rapid growth in several application areas.

10.0 Ocean Energy

10.1 Overview of the Industry

Offshore wind energy, ocean currents, waves and tidal movements represent a vast source of renewable energy. If successfully exploited, they could contribute a substantial supply of electricity in coastal areas around the world. This could further support economic development and sustainable job creation in these regions [**OE1**]. The international ocean energy industry is nascent and consequently has a very high number of conceptual technologies striving for success, few of which will likely progress through to the ultimate goal of commercialization. The key challenge facing the wave and tidal energy industries is for them to prove themselves as reliable and secure energy sources in the near term. As a result, only a few wave energy and tidal devices will progress to commercialization over the next 5-10 years and those that do will require significant financial help, either through targeted government research and development instruments and economic incentives or private sector financing [**OE2**].

For all ocean energy technologies being developed, large scale demonstration projects are required in order to test survivability and efficiency issues that have not yet been resolved. It is therefore impossible to predict the true potential for market penetration of these technologies until they have been thoroughly tested in their final environment. To date, a number of devices have been successfully installed at shoreline or near shoreline locations but the true potential of wave energy can only be realized in the offshore environment where large developments can take advantage of more significant wave resources. It is expected that wave energy industry will grow on the back of modular offshore wave, and potentially scalable, energy devices that can be deployed quickly and cost effectively in a wide range of conditions [**OE2, OE3**].

The deployment and commercialization of tidal technologies will depend not only on the development of reliable, cost effective and easily site-able equipment but also on the clear characterization of the tidal energy resource to make the business case for their deployment [**OE4**]. Overall, marine renewable energy is generally considered to have the potential to become competitive with other generation forms in future. However, in present market conditions, it is likely to be more expensive than other renewables or conventional generation until at least hundreds of megawatts capacity are installed [**OE3**].

Canadian industry is making significant strides in the ocean energy field and is positioning itself well to take advantage of this potentially large future market through:

- Canadian national wave and tidal resource mapping initiatives undertaken by the National Research Council and Triton Consultants [**OE5**];
- Establishment of tidal energy demonstration projects [**OE6, OE7**]; and
- Development of several small scale novel wave and tidal electricity generation technologies [**OE8-OE12**].

Early assessments of the Canadian wave and tidal current resources have been encouraging. The potential tidal energy resource in Canada has been estimated to exceed a mean power of 42,000 MW [**OE13**] and the annual mean wave power off Canada's Pacific coast is estimated at 37,000 MW, while the annual mean wave power along Canada's Atlantic coast is estimated at 146,500 MW – combined this is more than double current domestic electricity demand [**OE6**]. In addition to these activities, the Ocean Renewable Energy Group, a collaboration between industry, academics & government, has been created to promote research and development in the field of ocean energy technologies in Canada. The group leads an effort to ensure that Canada is a leader in providing ocean energy solutions to a world market [**OE14**]. The design, engineering, project development, implementation and operating capabilities needed for ocean energy are ready in many existing Canadian companies working with the port, marine, fabrication and shipbuilding, shipping, offshore oil, ocean technology and power industries. For them, ocean energy could represent a significant new market opportunity that could provide new jobs and opportunities for the maritime industries that have been experiencing declining growth rates [**OE6**].

10.2 Profile of the Ocean Energy Sub-sector in Canada

10.2.1 Size

Due to the nascent nature of the Canadian ocean energy industry, limited data are available on the size of the industry. Based on the number of firms presently involved in the sub-sector and their relatively small size, it is estimated that the ocean energy industry directly employs under 80 people. The only significant ocean energy project in operation at the time of writing this report was the 20 MW tidal energy plant at Annapolis Royal on the Bay of Fundy in Nova Scotia, which has been in operation since 1984, and is the only one of its kind in North America. The plant is one of the first, and largest, constructed to capture tidal energy [**OE14**]. In addition to the Annapolis Royal project several demonstration projects are presently being developed and are expected to be fully operational within the next few years [**OE9, OE15**].

10.2.2 Structure

As previously stated, the ocean energy industry is in its very early stages in Canada and consequently the present day structure of the industry is expected to change significantly over the next 5-10 years. The extent of this change will depend on the success of firms presently involved in the sub-sector and the increasing involvement of other firms as the market for ocean energy technologies grows. The Canadian ocean energy industry presently includes many specialized firms that are either entirely or partially focused on ocean energy projects. Specifically, this Canadian sub-sector is made up of:

- A tidal power plant project operator
- Tidal power technology developers
- Wave power technology developers
- Testing laboratories
- Government research agencies
- Marine construction and fabrication firms
- Resource characterization and mapping specialists
- Industry promotion

10.2.3 Economic Performance

No data on the economic performance of the Canadian ocean energy subsector are presently available.

10.2.4 Trends and Factors Impacting the Sector

Only one key industry informant from the ocean energy sub-sector was interviewed as part of this study. Based on this interview, the following trends and factors impacting the sector were gleaned. Since these are solely based on the input from a single informant, the following should not be interpreted as a comprehensive list; nor should it be assumed that these trends and factors are having an impact on all firms presently involved in the Canadian ocean energy sub-sector.

Resource Characterization

The informant indicated that one of the most significant limitations to the potential growth of the sub-sector in Canada will be the fact that a detailed site analysis and characterization has not yet been completed for Canada's shores. Some preliminary characterization has been done, but this is not deemed sufficient to justify the development of projects or to allow for access to financing for such projects. Also, because the wave and tidal resources have not been clearly characterized, it is difficult to project what the potential market for ocean energy technologies will be. The informant felt that the federal government will have to sponsor more detailed analysis to determine the best sites for early development. The industry informant indicated that Europe had defined its sights 10 years ago and are presently just waiting for the technologies to come to fruition. The informant felt that if Canada wants to be a leader in ocean energy, the government will have to take steps to encourage its development now. There was also a suggestion that the main areas that federal government support is needed are in characterization of the resources and development of an ocean energy cluster as was done with fuel cells.

Market Penetration

The industry informant did not expect significant roll-out of ocean energy technologies to the market for at least 5-10 years and indicated that most firms presently active in the field are focused on research, development and demonstration activities. The informant also indicated the most likely initial market for ocean energy technologies will be in Europe and Asia, where energy costs are higher and demand for alternative sources of electricity is higher. Applications of ocean energy projects are expected to be mostly in utility scale and off-grid industrial projects.

Grid Access

Once ocean energy technologies have completed the development cycle, it is foreseeable that grid access and transmission limitations will have a major impact on their potential market penetration. Without access to the grid, energy would have to be stored and transported, which is likely not a near term possibility. In the long term, storage of ocean energy in the form of hydrogen may become a viable option for overcoming the grid access issue.

Competition for Key Staff
The industry informant cited that competition for key experienced staff will be a major concern for the sub-sector since the industry is small now and there are very few people with expertise, but demand for experienced people will certainly grow.

10.2.5 Changes in Technology

Changes and improvements in technology and related intellectual property are expected to drive the market for individual technology developers and marketers. The industry informant indicated that it is likely that the first person to develop efficient, cost effective and reliable technology will win the race and secure the largest initial market share.

10.3 Key Players and Stakeholders in the Canadian Ocean Energy Industry

For a detailed listing of firms involved in the Canadian ocean energy sub-sector please refer to the Ocean Renewable Energy Group's members listing (http://oreg.ca/members.html).

10.4 Estimated Labour Demand in the Canadian Ocean Energy Industry

Due to the very limited data available on this emerging renewable energy field and the expectation that this sector will not achieve significant market penetration for at least 5-10 years, labour forecast estimates could not be provided within the scope of this report.

10.5 Profile of the Workforce

Due to the very limited data available on Canadian ocean energy industry, the development of a profile of the workforce working in the sub-sector was not possible at this point in time.

10.6 Available Training

No dedicated training programs are presently being offered within Canada for the ocean energy field.

10.7 Human Resource Issues

Only one informant from the Canadian ocean energy sub-sector was interviewed as part of this study. Therefore it was not possible to definitively establish the human resources issues affecting this sub-sector.

11.0 Overview of Relevant Initiatives in the Renewable Energy Sector

In its efforts to become a world leader in the renewable energy market, Canada is creating a strong domestic market, spurred by several Canadian advantages such as:

- Strong federal support - The Canadian Government is actively investing in the research and development of renewable energy through various funding initiatives, including Sustainable Development Technologies Canada (SDTC), Technology Early Action Measures (TEAM), the Industrial Research Assistance Programs (IRAP) and the recently announced ecoENERGY program.
- Canada has strong R&D capabilities and offers the lowest taxation rate for R&D efforts within the G7 community.
- Canada offers tax benefits, such as accelerated write offs for capital equipment and flowthrough share financing for expenses associated with renewable energy projects
- Ontario, Canada's most populated province now offers premium rates for electricity produced from renewables through its standard offer program and several provinces are expected to initiate similar measures.
- A large and rapidly expanding domestic market for renewable energy with huge untapped resources (wind, small hydro, wave, etc.) and direct access to the world's largest energy consumer, the United States.

Examples of some specific government incentive programs are described below.

11.1 Wind Power Production Incentive (WPPI)

WPPI was designed to provide financial support for the installation of 1,000 megawatts of new capacity between April 2002 and March 2007. Funding for this incentive of $260 million was announced in December 2001. The incentive was intended to cover approximately half of the current cost of the premium for wind energy in Canada compared to conventional sources. As of June 2006 almost 1000MW had been supported by WPPI, signifying that the majority of financial resources designated to the program had been deployed to projects. According to the original incentive rate schedule, the amount of the financial incentive to be received over a ten-year period was 0.8 cents/kWh for any project commissioned after March 31, 2006.

As the program's success became evident and the targets began to appear in reach, interest groups began pressuring the federal government to extend WPPI. Consequently, Budget 2005 provided $200 million over 5 years and a total of $920 million over 15 years to expand the Wind Power Production Incentive target to 4,000 MW. Under the new tranche of the incentive and as with the original terms of the program, an incentive payment of 1 cent per kilowatt-hour of production for the first 10 years of operation would be made to eligible projects commissioned before April 1, 2010. The eligible production per project would be determined by Natural Resources Canada [**I1**].

WPPI Tax Credit Amounts and Schedule

Commissioning Date	**Amount of Financial Incentive for the ten- year period**

April 1, 2002 to March 31, 2003 inclusive	1.2 cents per kilowatt-hour (¢/kWh)
After March 31, 2003 and on or before March 31, 2006	1.0 ¢/kWh
After March 31, 2006 and on or before March 31, 2007	0.8 ¢/kWh
Extension of WPPI	1.0 ¢/kWh

11.1.1 Status of WPPI

- Disbursements for WPPIs first phase approved projects continue.
- Until recently, the funds for the announced extension of WPPI were frozen, which when combined with the fact that the first phase was fully prescribed meant that no new funds for wind projects were available.
- On January 19th, 2007, a replacement program, entitled the ecoENERGY for Renewable Power program and similar to the WPPI program, was announced by the federal government.

11.2 Renewable Power Production Incentive (RPPI)

In Budget 2005, and subsequently in Canada's climate change plan, Project Green, the federal government announced a Renewable Power Production Incentive (RPPI) to stimulate the installation of up to 1,500 MW of new renewable energy electricity generating capacity, other than wind (small hydro, biomass and geothermal). RPPI's application to solar energy was never fully formalized. Similarly to WPPI, an incentive payment of 1 cent per kWh of production would be awarded for the first 10 years of operation of eligible renewable energy projects commissioned after March 31, 2006 and before April 1, 2011. Budget 2005 provided $97 million over five years and a total of $886 million over 15 years for the RPPI. This program was still in its infancy at the time of the recent change in government and its future is uncertain.

11.2.1 Status of RPPI

- The RPPI program was never fully developed and implemented.
- The following activities had taken place prior to the change in government:
  - Assignment of staff at NRCan to develop the program
  - Development of a concept paper on RPPI
  - Solicitation of feedback from stakeholders on the RPPI design concept

Policy Development Related to RPPI

- RPPI is considered a climate change initiative, thus it was being reviewed along with the other programs mentioned above.
- The RPPI has essentially been combined with the wind incentive as the above mentioned ecoENERGY for Renewable Power program, to create an all technology renewable production tax credit.

11.3 Capital Cost Allowance for Investment in Efficient and Renewable Energy Generation

Class 43.1 currently provides an accelerated capital cost allowance rate of 30 per cent per year for investments in equipment that produces heat for an industrial process or electricity by using fossil fuel efficiently or by using renewable energy sources. The two general categories of included equipment are cogeneration and renewable energy technologies.

A variety of renewable energy production assets are also included in Class 43.1, including:

- Wind turbines
- Electrical generating equipment that uses only geothermal energy
- Small hydroelectric facilities
- Stationary fuel cells
- Photovoltaics and "active" solar equipment used to heat a liquid or gas
- Equipment powered by certain waste fuels (e.g. wood waste, municipal waste, biogas from a sewage treatment facility)
- Equipment that recovers biogas from a landfill
- Equipment used to convert biomass into bio-oil.

In addition, where the majority of the tangible property in a project is eligible for Class 43.1, certain project start-up expenses (mostly relating to intangibles) are treated as Canadian Renewable and Conservation Expenses (CRCE). These expenses may be deducted in full in the year incurred, carried forward indefinitely for use in future years, or transferred to investors using flow-through shares. Flow-through shares are particularly beneficial to start-up firms that do not have enough taxable income to benefit from tax deductions themselves.

Eligible expenses typically include engineering and design, site clearing, feasibility studies, contract negotiations and regulatory approvals. In the wind industry, CRCE also includes the capital cost of "test wind turbines," which can constitute up to 20 per cent of the generating capacity in a wind farm.

Budget 2005 proposed to further accelerate the CCA rate from 30 per cent to 50 per cent for the full range of renewable energy generation equipment currently included in Class 43.1 (including wind turbines, small hydro facilities, active solar heating equipment, photovoltaics and geothermal energy equipment). This increased rate was set up to apply to equipment acquired over the next seven years, at the end of which period the effectiveness of the measure will be reviewed [**I3**].

11.3.1 Status of Capital Cost Allowance for Investment in Efficient and Renewable Energy Generation

- The change in 43.1 to 50% was confirmed by the federal government in Budget 2006.

11.4 Renewable Energy Deployment Initiative REDI

REDI was announced in December 1997, and came into effect on April 1, 1998. REDI is a 9-year, $51 million program designed to stimulate the demand for renewable energy systems for water heating, space heating and industrial process heating. These systems include:

- active solar water heating systems;
- active solar air heating systems; or
- high efficiency/low emissions biomass combustion systems of between 75kW and 2MW capacity.

Under REDI, Natural Resources Canada undertakes market development activities and provides an incentive to encourage the private sector, federal departments and public institutions to gain experience with active solar and efficient biomass combustion systems. Corporations are eligible for a refund of 25 percent of the purchase, installation and certain other costs of a qualifying system, to a maximum refund of $80,000 per installation and a maximum of $250,000 per corporate entity. Some incentives are also provided on a pilot project basis.

In remote communities, business, institutions and other organisations may be eligible for a refund of 40 percent of the purchase and installation of a qualifying system, up to a maximum refund of $80,000. Under REDI, remote communities are classified using the following criteria:

- neither connected to the North American electrical grid nor to the piped natural gas network; and
- comprising at least 10 permanent or long-term (5 years or more) buildings [**I4**].

11.4.1 Status of REDI

- Early in 2006, federal renewable energy programs were subject to review. During this time, the Renewable Energy Deployment Initiative (REDI) - Incentive Program could not enter into new Contribution Agreements. In early July 2006 the REDI Program was reactivated and, for those applications that had already met all REDI Terms and Conditions, Contribution Agreements were issued. Under these Contribution Agreements, the period during which expenditures are considered to be eligible is from June 1, 2006 to December 31, 2006 [**I4**].
- The federal government announced an investment of $36 million for the new ecoENERGY for Renewable Heat initiative on January 19th, 2007 that will contribute to an increase in the use of clean renewable technologies for thermal applications through a mix of incentives and support for the development of industry capacity.

11.5 Sustainable Development Technology Canada (SDTC)

Sustainable Development Technology Canada (SDTC) is a not-for-profit foundation that finances and supports the development and demonstration of clean technologies which provide solutions to issues of climate change, clean air, water quality and soil, and which deliver economic, environmental and health benefits to Canadians. To do so, the Foundation draws from an investment fund of $550 million. SDTC was established by the Government of Canada in 2001 and commenced operation in November of that year. SDTC's mission is to act as the primary catalyst in building a sustainable development technology infrastructure in Canada. The Foundation reports to Parliament through the Minister of Natural Resources Canada [**I5**].

11.6 Technology Early Action Measures (TEAM)

Technology Early Action Measures (TEAM) is an interdepartmental technology investment program. TEAM supports projects that are designed to demonstrate technologies that mitigate greenhouse gas (GHG) emissions nationally and internationally, and that sustain economic and social development. TEAM's unique approach brings together industry, community, and international partners to encourage additional investment in innovative technology. TEAM's position in the technology innovation process has enabled the Government of Canada to support a wide range of technology options and paths for mitigating GHGs [**I6**].

11.7 Green Municipal Funds

The Green Municipal Fund has supported more than 500 studies, field tests, plans and capital projects across Canada to improve the quality of our air, soil and water and to reduce greenhouse gas emissions. As the only national fund that specifically addresses the needs of municipal governments and their partners, its range of financial solutions, resources, expertise and services has become the premier source for municipal governments pursuing environmental infrastructure initiatives. To date, 522 GMF studies, field tests, plans and capital projects have been approved for funding of $302 million, leveraging over $1.9 billion of economic activity in communities across Canada.

The Government of Canada endowed the Federation of Canadian Municipalities with $550 million to establish and manage the Green Municipal Fund (GMF). The 2005 federal budget added $300 million to the existing $250 million fund, of which $150 million is earmarked for brownfield redevelopment [**I7**].

11.8 Ontario Standard Offer Program

The intent of the program is to help Ontario meet its renewable energy supply targets by providing a standard pricing regime and simplified eligibility, contracting and other rules for small renewable energy electricity generating projects.

Eligibility

- Projects must generate electricity from wind, solar photovoltaic (PV), thermal electric solar, renewable biomass, biogas, biofuel, landfill gas or small scale hydropower.
- Projects must be located in Ontario with an installed capacity of not more than 10 megawatts (MW) and connected to an eligible electricity distribution system in Ontario at a voltage of 50 kilovolts (kV) or less.
- To be eligible, projects must have begun operation after the restructuring of Ontario’s electricity sector took effect.

- In some areas of the province, the Ontario Power Authority (OPA) may impose limits on eligible projects because of transmission system constraints.
- Applicants must meet certain requirements, including a connection impact assessment, environmental assessment and demonstrated site access, as well as other contractual terms.

The Standard Offer Contract

- Generators must enter into a contract with the OPA for a term of 20 years.
- Initially, all generators except solar PV projects will be paid a base rate of 11.0 cents per kilowatt hour (kWh) for electricity delivered to the local electricity distribution company. Starting May 1, 2007, 20 percent of the base rate will be indexed annually for inflation.
- Projects that demonstrate that they can operate reliably during peak hours will be paid an additional 3.52 cents per kWh for electricity delivered during peak hours.
- Solar PV generators will be paid a fixed price of 42.0 cents per kWh for the full 20-year term of the contract [**I8**].

11.9 Renewable Portfolio Standards and Renewable Energy Requests for Proposals

Several provincial governments and electric utilities are moving towards integrating Renewable Portfolio Standards into their long term power supply planning. A Renewable Portfolio Standard (RPS) ensures that a minimum amount of renewable energy is included in the portfolio of electricity resources serving a province or service region [I9]. In order to meet these new RPSs, provincial governments are releasing renewable energy requests for proposals for potential renewable project developers. Between 2004 and 2006, provincial governments and utilities will have issued RFPs for 6,000 MW of renewable energy. To date, the bulk of these requests for proposals have been filled by large scale wind projects [I10].

11.10 The Renewable Energy Advisory Committee on Training

The Renewable Energy Advisory Committee on Training is comprised of representatives from the renewable energy industries, Association of Canadian Community Colleges, individual colleges and Natural Resources Canada. With funding provided by NRCan's Renewable Energy Deployment Initiative (REDI), the Committee has guided research into the availability of renewable energy training in Canada and the human resources challenges faced by these renewable energy industries. The Committee has solicited and received proposals for renewable energy training from colleges and institutes from all regions of the country.

Based on this foundation, the Renewable Energy Advisory Committee on Training has guided and coordinated the development of a series of proposals to advance the status of renewable energy education and training in Canada. The primary goal of this initiative is to fill the need for leaders and skilled employees in the renewable energy industries. A secondary goal is to enhance the level of public knowledge about sustainable development issues in general, climate change and the need to develop sustainable energy options.

Prepared by the Renewable Energy Advisory Committee on Training, the strategy for the implementation of renewable energy training in Canada covers four main renewable energy technologies promoted by the Renewable and Electricity Division of NRCan, namely:

• Active Solar Thermal Systems and Photovoltaics Systems
• Low-emitting and high efficiency Biomass Combustion Systems
• Ground Source Heat Pump Systems
• Wind Energy Systems
• Small-scale hydro

The strengths of the Renewable Energy Advisory Committee on Training lie in the multidimensional partnerships linking ACCC and its participating member colleges and institutes with NRCan, industry organizations and engaged Aboriginal networks [**I11**].

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Appendices

Appendix I – Industry Informant Interview Guide

Industry

Participant Information

Name	
Organization	
Industry	
Phone number	
Date and time of Interview	

Introduction

Usual intro / ensuring speaking to the right person / is this still a good time.

In reporting the results, I will be taking notes. Nothing you say or do will be identified to you as an individual and you will never be contacted in connection with this particular session.

- Clarify other interview logistics:
- Time requirements (25 - 30 minutes)
- Permission to record (as needed)
- Assurance of confidentiality of responses
- Address any questions from interviewee

Purpose of Interview

- To better understand human resources issues within the renewable energy sector

Potential Questions from Interviewees

- Why is this research being done?

The objective of this project is to gather some basic information on the renewable energy sector in Canada, sufficient to identify the next steps needed to assist the sector in developing a human resource strategy.

- Who is being interviewed?

Industry, government and academic experts in the field.

- How will the information be used?

The primary intention is to inform HRSDC of this emerging sector in order for them to determine the best way for the department to assist in ensuring an efficient labour market (the right people with the right skills at the right time in the right place). However, others including the industry are expected to benefit from the basic sector profile provided. The final report will be a public document available in both official languages.

- Will I have access to the results?

Yes, all will have access to the results - not sure at this point which website it might go on, but it will be public.

We're going to begin by talking about factors driving or impacting demand within your industry …

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1. A. Thinking globally for a moment, I'd like you to indicate how much of a factor each of the following is in terms of driving or impacting demand/growth within your industry. Please use a scale from 1 to 10, where '1' represents 'not a factor at all' and 10 represents 'a very strong factor'. Let's begin with…

   -Government Policy
   - *Examples: Kyoto and climate change related policies, renewable energy portfolios, government economic incentives for renewables, etc.*

   -Regional Policy
   - *Examples: Provincial or municipal initiatives.*

   -Cost of traditional sources of energy
   - *Increasing cost of fossil fuel derived energy VS decreasing costs of renewables*

   -Access to raw materials
   - *For example access to steel for wind turbines, silicon for solar cells, biomass feedstocks for fuel etc.*

   -Labor issues
   - *Access to adequately skilled labor, cost of labor etc.*

   -Changes in technology/improving costs of technology
   - *Changes or improvements to technologies that are leading to cost reductions. For example, increasing wind turbine sizes, increasing solar cell efficiencies, cost reductions from large scale manufacturing of technologies, reduced raw materials use, etc.*

   -Intellectual property
   - *Patents for novel technical approaches that are impacting competition and driving an increased demand for certain industry players.*

   -New applications for technologies/New markets
   - *Design of new products using established renewable energy technologies. Examples include solar/LED lighting (combination of solar panels with light emitting diodes), applications of solar water heaters to fish farms, application of ocean wind turbines to desalination, etc.*

   -Consumer attitudes/demand/consumer pressure
   - *Early adopters, green consumers, etc.*

   -Any others?

B. Thinking domestically (within Canada) would your rating of any of these factors change? If so, why?

-Government Policy
- *Kyoto and climate change related policies, renewable energy portfolios, government economic incentives for renewables, etc.*

-Regional Policy
- *Examples: Provincial or municipal initiatives.*

-Cost of traditional sources of energy
- *Increasing cost of fossil fuel derived energy VS decreasing costs of renewables*

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-New applications for technologies/New markets
- *Design of new products using established renewable energy technologies. Examples include solar/LED lighting (combination of solar panels with light emitting diodes), applications of solar water heaters to fish farms, application of ocean wind turbines to desalination, etc.*

-consumer attitudes/demand/consumer pressure
- *Early adopters, green consumers, etc.*

-any others?

2. Do you believe that your organization will be growing over the next 5 years?

3. (**If yes at Q2**) We're trying to get a sense of the projected magnitude of that growth. How would you quantify growth in terms of sales or installed capacity (as a percentage increase)?
4. What about employment – in the next 5 years do you think your organization will have more employees, fewer employees or about the same number? Why do you say that? (obtain percentage change)

5. Do you define your organization's activity as energy generation, manufacturing, project development, consulting, industry association or government?

6. (**If energy generation at Q5**) In the next 5 years do you think the number of MW of generation to be installed will be more, less or the same as today? (obtain percentage change)

7. (**If manufacturing at Q5**) What is your current manufacturing capacity (MW per year/# of units/etc.)? In the next 5 years, do you think the capacity will have increased, decreased or stayed the same? (obtain percentage change)

8. (**If project development at Q5**) How many projects are you working on? What is the combined capacity of this projects in MW? In the next 5 years, do you foresee an increase in the number and size of you projects? (obtain percentage change)

9. (**If consultation at Q5**) How many projects are you working on? What is the combined revenues from these projects? In the next 5 years, do you think the number of projects/revenues will increase? (obtain percentage change)?

10. What are the biggest limitations to growth for your organization?

11. What are the largest areas of potential growth for your organization?

12. I'd like you to indicate how significant each of the following is in terms of being an area of potential growth. Please use a scale from 1 to 10, where '1' represents 'not significant at all' and 10 represents 'very significant'. Let's begin with…

    -Utility scale projects
    -Distributed/residential projects
    -Off grid projects
    -Consumer products
    -Specific client types (e.g. forestry sector, homebuilders etc.)
    -any others?

13. (**Ask if growth expected at Q2**) Overall, what proportion of your potential growth do you expect to meet through domestic operations?

I'd like to focus now on recruitment and retention issues …

14. Have you hired any skilled labour personnel in the past one to two years?

15. How satisfied are you with the skills demonstrated by recent hires (1 to 10 scale)? (Probe for reason for rating, particularly if the rating is less than 7)

16. How do you assess the qualifications of potential employees? E.g. certificates, work experience, on-the-job, etc

17. Is special training beyond standard trades/certificates/degrees required within your sector? If yes - what is needed?

18. Do you have difficulty-finding employees with a particular skill set? Which skill set(s)?
19. (If yes) Why do you think you have difficulty finding qualified employees?
    - Are you competing with other organizations or sectors? Which ones?

20. Do you offer any formal training courses to new employees? What kinds?

21. Based on what you know, are there course areas related to your industry that you feel there is a need for, that are not currently being offered?

22. As far as you are concerned, what barriers will prevent you from providing specific skill training for your employees?

23. Can you tell me the average percentage of turnover your organization experienced in skilled labour per year over the past three years?

    Turnover = total number of skilled labour that left the organization (including termination, layoff, resignation) in a 12-month period **divided by** the average total number of skilled labour in the same 12 month period.

24. Thinking about the issue of retention, has retention of skilled labour been a problem within your organization?

25. Are there things your organization needs to do to further address the issue of skilled labour retention?

26. Are there things your sector needs to do to further address the issue of skilled labour retention?

27. What is the estimated average age of people working within your industry?

28. What is the typical gender (male/female) distribution within your industry (provide an estimated ratio)?

29. What is the average level of education within your industry?

30. Are there any other comments you would like to make either about the availability of skilled labour or about any other issues we've discussed?

Thank you very much!

Appendix II – Association, Academic and Government Informant Interview Guide

12.10.1 Industry Associations, Academics and Government Representatives

Participant Information

Name	
Organization	
Industry	
Phone number	
Date and time of Interview	

Introduction

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Clarify other interview logistics:

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- To better understand human resources issues within the renewable energy sector

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- Will I have access to the results?

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We're going to begin by talking about factors driving or impacting demand within your industry …

31. A. Thinking globally for a moment, I'd like you to indicate how much of a factor each of the following is in terms of driving or impacting demand/growth within your industry. Please use a scale from 1 to 10, where '1' represents 'not a factor at all' and 10 represents 'a very strong factor'. Let's begin with…

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- *Examples: Kyoto and climate change related policies, renewable energy portfolios, government economic incentives for renewables, etc.*

-Regional Policy
- *Examples: Provincial or municipal initiatives.*

-Cost of traditional sources of energy
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-Access to raw materials
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-Consumer attitudes/demand/consumer pressure
- *Early adopters, green consumers, etc.*

-Any others?

Thinking domestically (within Canada) would your ratings of this factors change? If so, why?

-Government Policy

- *Kyoto and climate change related policies, renewable energy portfolios, government economic incentives for renewables, etc.*

-Regional Policy

- *Examples: Provincial or municipal initiatives.*

-Cost of traditional sources of energy

- *Increasing cost of fossil fuel derived energy VS decreasing costs of renewables*

-Access to raw materials

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-Consumer attitudes/demand/consumer pressure

- *Early adopters, green consumers, etc.*

-Any others?

32. Do you believe that your industry (technology sub-sector) will be growing over the next 5 years?

33. (**If yes at Q2**) We're trying to get a sense of the projected magnitude of that growth. How would you quantify growth in terms of sales or installed capacity (as a percentage increase)?

34. What about employment – in the next 5 years do you think your industry will have more employees, fewer employees or about the same number? Why do you say that? (obtain percentage change)

10. What are the biggest limitations to growth for your industry?

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17. Is special training beyond standard trades/certificates/degrees required within your sector? If yes - what is needed?

18. Is it difficult to find employees with a particular skill set within your industry? Which skill set(s)?

19. (If yes) Why does your industry have difficulty finding qualified employees?
    - Is it competing with other sectors? Which ones?

20. Do you know of any companies that offer any formal training courses to new employees within your sector? What kinds?

21. Based on what you know, are there course areas related to your industry that you feel there is a need for, that are not currently being offered?

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