Wind | Solar | Hydro | Marine/Tidal | Geothermal | Biomass | Storage

renewing futures

Meeting the Human Resources Needs of Canada's Renewable Electricity Industry

Final Report

electricity HUMAN RESOURCES CANADA
RESSOURCES HUMAINES, INDUSTRIE électrique DU CANADA

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Executive Summary

Electricity-related Renewable Energy (RE) technologies play a crucial role in sustainable economic development for the world and for Canada. Significant reductions in pollution and improvements in environmental conditions are expected as the low carbon electricity generated by renewable technologies gains market share. A massive global shift in technologies is underway and Canada is participating with plans for additional RE capacity in every province.

Growth in RE capacity will impact employment and labour markets. Adding capacity to meet government policy targets and the industry's vision of RE potential would create 620,000 person-years of construction employment and accumulate 34,000 jobs in operations by 2022. In most jurisdictions the addition of new jobs is a major policy goal related to these investments. A more limited deployment of RE capacity is considered in alternative scenarios that project 185,000 construction person-years of work and up to 19,000 jobs in operations.

Electricity Human Resources Canada (EHRC), in collaboration with Employment and Social Development Canada and industry stakeholders has initiated Renewing Futures (RF); a major human resources (HR) research project that will assess current and forecast data tracking the impact of RE deployment on labour markets. Renewing Futures will create a national human resources strategy that will guide the development of a skilled workforce to meet labour requirements.

The scope of the RF plans includes seven sectors:

1. Wind
2. Solar
3. Bioenergy
4. Geothermal
5. Hydro (Small and Large)
6. Marine; Tidal and Wave
7. Integration and Storage

Economic activity related to the deployment of these technologies and their connection to the grid is spread among many employers. RF analysis identifies this employment across the supply chain including:

- Research and development
- Manufacturing and distribution
- Project planning
- Construction and installation
- Operation and maintenance, and
- Grid operation, maintenance and distribution

There are important "legacies" including the urban populations, industrial and resource activity, wind, sun, rivers, tides, biofuels and geothermal energy that are unevenly distributed across Canada's geography. Further, Canada's provinces have jurisdiction over both the energy and labour policies that drive RE deployment. The RF analysis and strategy is prepared on a Provincial basis to reflect this diversity.

Finally, the time frames for the RF project extend back to the 1990s and forward to 2022 – spanning the long term changes that are crucial to understanding trends and planning HR support systems.

Research activities that support the strategy include:

- A global review of research sources covering government policy, human resources management and labour market analysis for RE activity,
- A Technology Review that created a profile of the seven technologies that will be deployed and provincial energy market assessments that project additions to RE capacity from 2011 to 2022,
- Input from over 400 stakeholders from interviews, focus groups, regional engagement sessions and an employer survey, and
- A RF labour market information system that includes measures of supply and demand, market balances for eighteen key occupations and an inventory of post-secondary programs that train new RE employees.

We built the case for a strategy up across five themes.

1. Growth and change

Growth is the dominant theme in the global story of renewable energy. But the future path of RE deployment in Canada is uncertain and growth involves change that can be both risky and disruptive. RF research developed three scenarios to measure the range of growth and related risks by sector and region.

A. The *Utility Case* is based on a review of Provincial utility reports, energy plans and interviews with energy planners in each province.

B. The *Reference Case* is based on the National Energy Board (NEB) 2011 "Energy Supply and Demand Projections to 2035".

C. The *Vision Case* is based on the announced targets and published visions of the industry itself and the government policy statements and objectives for RE.

Together these three cases bracket the range of likely growth in the RE systems from 2012 to 2022. The Vision case is referenced more frequently in the report as it is designed to test the higher limits of investment and deployment of RE and, in turn, define the upper levels of labour requirements. RE employment in the Vision case increases two to three fold from the starting base in 2012. Growth on this scale can be disruptive; displacing workers in other areas and creating employment cycles. There are concerns about product and service quality, workplace productivity, reliability, quality and safety.

The report concludes that *environmental pressures will dominate and the industry must prepare for the growth path described in the Visions case for each of the seven technologies*. This growth will include both benefits and costs. A national HR Strategy must include elements that address all of these.

2. Technologies and the Supply Chain

Findings show that work in the six core RE sectors will grow dramatically but will deploy mostly the current, mature technologies and systems. In the Vision scenario, the deployment reaches 42,800 MW and this effort will create 620,000 person-years of construction and installation jobs across the 2012 to 2022 period. Employment in operations rises each year to a total of 34,000 jobs in 2022. The Reference and Utility scenarios offer an alternative view of more modest expansion that creates between 185,000 and 190,000 person years of work in construction and between 19,000 and 21,000 jobs in operations by 2022.

Wind systems provide the largest increment to capacity as turbines, rotors and bases continue to increase in size. As systems grow in scale new materials will be used and the complexity of installation and operations will increase.

Solar PV systems will also provide a large component of the incremental RE capacity. Additions are almost entirely in Ontario. Solar systems are relatively labour intensive and the deployment of new systems will be largely confined to existing technologies. Employment gains are concentrated in the manufacturing and distribution part of the supply chain and labour market impacts will depend on the extent of local sourcing of components. There is some potential for innovation in, for example, building integrated systems and work continues on the potential for solar thermal.

Biofuel systems have been part of Canada's RE portfolio for many years. There is a large potential for growth and some innovation through the addition of, for example, "purpose grown" agricultural systems. New capacity is expected to be developed in parallel with growth in forestry resources.

Geothermal system potential exists across Canada and activity is centered in pilot projects and site assessment for feasibility and development. Canadian companies have developed technical expertise in this area and are active in international development.

Canada is a world leader in hydroelectricity and large sites provide over half of total national electrical power capacity. The RF analysis includes provision for the addition of 11,400 MWs of new large hydro capacity to the conventional utility system. Labour market impacts and HR implications for this development fall into the growth and management of the utilities and the related consulting firms and contractors who have traditionally built and maintained these systems. RF analysis treats small hydro developments as a separate activity and tracks the addition of over 900 MWs of capacity in five provinces.

Tidal and Wave systems are being introduced as a trial basis with activity and employment related to this work in Nova Scotia. Canada has one of the few operating tidal systems at Annapolis. The RF plans include some limited ongoing development of tidal capacity.

The most important technological changes will be concentrated at the interconnection points and in the distribution systems maintained by the utilities. Increasing the capacity of the grid and adding Smart Grid improvements involve upgrading the technical skills of a range of key

occupations and integrating new IT and distribution systems. Changes in storage and grid systems have the largest technological implications across the system. Here new technologies are prominent with significant and variable impacts on skills, training and certification.

By 2022, in the Vision Scenario, there will be 100,000 people working on RE projects. Employment is widely distributed among employers at varying points on the supply chain and across regions. A large proportion of jobs will be in Ontario.

3. Stakeholders and their diverse roles

Provincial government energy policy is the critically important determinant of RE deployment patterns. Strong growth will be facilitated where these policies provide incentives and recognize the skills and qualifications of the needed workforce. On the other hand, budget cuts or policy limitations could restrict the deployment of RE systems.

Employer survey findings describe 350 respondents working in RE deployment. In general these employers were working in more than one RE sector and offering services at several points across the supply chain. Many employers also reported working in areas outside RE. Firms in the sample were small with half of the sample employing fewer than 10 workers. Altogether the firms in the sample employ 19,800 people. Given the diversified nature of these businesses, their workforce likely is employed for a large part of the time outside RE.

The workforce is concentrated in technical areas with employers reporting that technicians and skilled trades were the most numerous and engineers were the third most numerous groups of employees.

The Renewing Futures LMI system focuses on eighteen key occupations, identified by the employers. These occupations fall in three broad groups; leaders and managers, engineers and technologists and skilled trades. Some 41,000 employees in these and other occupations are estimated to work, in 2012, in RE jobs spread across the supply chain. Most of the labour force in each of these occupations, are not working in RE jobs. Key market outcomes, including compensation, entry qualifications and certifications, are determined in the wider markets. These broader market conditions are the starting point for RE managers.

A review of post-secondary training and certification identified 95 specific programs across Canada. These programs include all three occupational groups and the largest number of programs is offered by community colleges to engineering technicians and technologists. These programs form the initial core of a training system. There are no apprenticeship programs that target RE. Many private, short term training and certification programs are offered for solar and wind, but growth is uneven and certification standards are not widely applied.

4. Labour markets

There are repeated references to skills shortages in the broader labour markets for most of the occupations needed by RE employers. While the highest risks seem to be in the West and related to construction projects, there are quite unique circumstances for many occupations.

Labour Market Information (LMI) systems have been developed for several industries and occupations that compete with RE employers for these eighteen key occupations. These systems divide labour requirements into expansion demands that are related to industrial growth and replacement demands that are related to demographic trends and retirement patterns. The workforce available to meet demand is estimated from measures of immigration, trends in postsecondary programs and the mobility of the workforce across industries and regions.

LMI systems for construction tracks strong and cyclical demands for many of the key RE trades and occupations related to major infrastructure and resource projects in most provinces. This includes employment in major hydro-electric generation and transmission and distribution systems.

While labour requirements for these projects are cyclical, there is a pattern of skill shortages in many key trades that are targeted by RE employers.

LMI analysis for the electrical utility industry in the "Power in Motion" study identified regular and persistent labour shortages related to retirement patterns. Historical cycles in employment leave a distinctive demographic profile and a future of shortages of managers and specialists with essential skills and experience. This HR legacy in the utility sector may deprive RE employers of the opportunity to hire needed managers with technical skills and electricity system experience.

Similar LMI systems for engineers and information and communication technology highlight shortages of candidates for positions that combine technical training with industry experience. For engineers there is often an abundance of new graduates and a shortage of specialized or experienced engineers.

Human resources planning can be linked to each of these regional, industry and occupational LMI profiles to shape RE actions to take advantage of available candidates (e.g. graduating engineers and trades available as major projects end) and address key gaps (e.g. experienced engineering leaders).

5. Human resources management and key occupations

The survey findings reveal a large group of small employers who are confident of their capacity to manage human resources and committed to training and other support systems. These firms see many other business issues as more important than HR and they have just experienced a period of relatively few problems recruiting. Further, they have well established plans for hiring – often from other RE employers. **This picture signals flashing red lights for a national human resources strategy. The firms that will be the target beneficiaries for the strategy very likely do not see a problem!**

But there is a problem. Taken together all the employers in the sample cannot meet their new and ambitious hiring plans. Competitors recruiting the same occupations in other industries are developing strategies, expanding support and certification systems and programs to attract workers in anticipation of continuing shortages. Further, they will turn to a post-secondary training system with very fragmented programs and to apprenticeships that change slowly and have almost no specialization in RE skills.

Very large increases in labour requirements for RE deployment will bring recruiters into already tight labour markets. Employers have met previous labour demands by hiring from the rest of the industry but this is not a viable strategy for 2013 to 2022. Existing training and certification programs will need to more than double current capacity for RE workforce and there is no consensus on the content of programs or the need for certifications. In many cases there are barriers to the mobility of the workforce across provinces and industries. Narrow interests and competing systems for certification threaten to frustrate the strategy while RE growth creates an imperative to expand training programs.

6. Human resources management and key occupations

The report has considered the plans and practices of RE employers and the state of the labour markets that characterize the period from 2012 to 2022. Findings suggest that if employment grows as fast as projected in the Vision scenario, the industry will not be able to fill vacancies with properly qualified candidates. HR management plans must be adapted to meet the labour market challenges and the need for greatly expanded training and certification. This change has the potential to be disruptive. Industry stakeholders describe a need for improved safety, work quality and system reliability. A national human resources strategy for RE is needed to meet these challenges.

Canada's RE industry has a compelling story to tell government and job seekers. Strong growth in employment spread across many years creates opportunities for careers and advancement and this message will have strong appeal in an economy with limited growth and few jobs for youth. Working together, RE employers can make a case for investment in training, career promotion and occupation standards to promote mobility across provinces and sectors.

Collective action is not assured. The case for a strategy must first clearly define and demonstrate specific advantages for each employer. Even then, creating an awareness of the problem, the solution and motivating action will be a major challenge.

The strategy needs clear goals that can be measured and timelines marking progress. Stakeholders agree that success means:

- More graduates from post-secondary programs in sufficient numbers and with qualifications that meet employer needs, and
- More bridges that connect programs, certifications and employers across sectors and provinces to provide mobility in job search and career prospects for advancement.

Strategic actions will be initiated for each occupation platform, by sector, and will focus on the specific needs and circumstances highlighted in the research findings. Initiatives will have specific elements that target practical actions and advantages for individual employers:

- Training and certification content that addresses needs,
- Plans for promoting the adoption and use of new HR features, and
- Certifications or designations that allow measures of completion and subsequent progress in labour markets.

The strategy will include plans to cover four groups of occupations:

- Leadership and management; project development, design, planning, finance, IT, research and policy
- Engineering and technology; consulting expertise and specialized skills and experience
- Trades and related occupations (e.g. helpers and installers, supervisors); contractors and trade specializations, certification and training
- Sector specializations; training and certification

These findings point out the need for a national HR strategy for Renewable Energy that includes:

- A plan to increase the skilled workforce available in each province in each of the four groups
- Expanded access to training and certification for key occupations in each group
- A focus on portability of skills and certifications across regions and industries
- Building bridges and career paths that retain key workers and promote careers in RE
- Efforts to promote training, promotion and careers that span all the sectors and employer groups in RE

1. Introduction

Renewable energy (RE) technologies play a crucial role in sustainable economic development for the world and for Canada. The International Energy Agency (IEA) begins the "Energy Technology Perspectives 2012" report describing renewable energy in the following manner:

> *"Low-carbon electricity has system wide benefits that enable deep reductions in CO_2 emissions in the industry, transport and buildings sectors. Analysis shows how emissions per kilowatt–hour can be reduced by 80% by 2050, through deployment of low carbon technologies. Renewable energy technologies play a crucial role in developing low carbon electricity and enabling deep reductions in CO_2 emissions. The RE share of the total average world generation increases from 19% currently to 57% by 2050, a six fold increase in absolute terms. In fact, low-carbon electricity is already competitive in many markets and will take an increasing share of generation in coming years.[1]"*

Achieving these targets for deploying RE has important implications for labour markets. Employment created by the growth of the RE industry is recognized as a major economic benefit and is an integral part of energy strategy in the European Union. Similar advantages can be expected in Canada. Electricity Human Resources Canada (EHRC), in cooperation with the RE industry and other stakeholders, has initiated "Renewing Futures" a major, national human resources (HR) research project that will provide current

1 Taken from International Energy Agency, "Energy Technology Perspectives, 2012", executive summary, page 3.

and forward looking information on the impact of RE deployment on labour markets and key occupations across Canada. Renewing Futures will create a national HR strategy for electricity related renewable energy (RE) assisting in building a skilled workforce that will meet employer needs for the next ten years. The strategy will cover training programs, regulations and government policies, certification, interprovincial mobility, retirements and retention and sector specific specializations.

Growth is the central theme. Global investments and economic activity related to deploying Renewable Energy systems have grown explosively in the last decade. In Canada, for example, there were just 322 MWs of wind capacity in 2003 and that grew to 6,201 MWs by 2012. Growth for solar PV systems increased capacity from 12 MW (2003) to 765 MW in 2012.

Canada's RE industry has been tracking labour conditions and HR managers see a need for planning for future jobs. For example, Industry Canada and the Canadian Wind Energy Association (CanWEA) surveyed employers in 2010 and discovered that 79% of respondents expect to expand their wind energy-related workforce over the next 2 years and 34% of those employers expect to double or more than double employment. Further, *"Fifty-five percent of respondents believed there was a shortage of experienced and skilled labour in the wind energy sector. Key fields where the shortage was identified include specialist technicians, project managers and power engineers."*[2]

These findings were repeated throughout employer interviews in the other RE Sectors and in other industries. This change shifts significant resources on a global scale. Major investments in the industry have been growing steadily for the past fifteen years. While nothing is certain in the current economic environment, the conventional view is that this shift will continue for another fifteen years or longer.

Renewing Futures is an initiative of Electricity Human Resources Canada. The Renewing Futures mandate is to assess the capacity of Canada's workforce to sustain the expansion of electricity related renewable energy generation (RE) systems. For example the report provides answers to the following questions:

- How much will the RE system grow and what changes are associated with the growth?
- Who employs this workforce, and what are their HR plans?
- What skills and occupations are needed?
- Where will new entrants come from? What is the capacity of post-secondary programs, employers in other industries and immigration to meet labour requirements?
- Will the available workforce equal requirements and, if not, how does the industry respond?

Renewing Futures provides current and forward looking information on the impact of RE deployment on labour markets and key occupations across Canada. Renewing Futures creates a national HR strategy that assists in building a skilled workforce that will meet employer needs for the next ten years. The strategy will cover training programs, regulations and government policies, certification, interprovincial mobility, retirements and retention and sector specific specializations.

The scope of this inquiry includes employment across a large part of renewable energy activity. A focus on electricity related renewable energy was chosen and sectors, the supply chain, time and regions define research boundaries.

2 "Canadian Wind Energy Sector Profile, 2010" Industry Canada and CanWEA.

Employers and the workforce that is active in these seven sectors are located across a long supply chain that links to a wide range of businesses. The Renewing Futures research identifies the following seven supply chain segments:

1. Research and Development
2. Manufacturing and Distribution
3. Project Planning
4. Construction and Installation
5. Operation and Maintenance, On-site
6. Operation and Maintenance, Off-site
7. Grid Operation, Maintenance and Distribution

A thirty year time frame defines history back to 1990 and projections to 2022. This span captures the major global investments in RE that were driven by environmental concerns and also projects far enough into the future to assist human resource planning in areas like post-secondary programs and new technology developments.

Canada's ten provinces define the geographic boundaries. Government energy and labour policy jurisdiction, natural energy resources and the quality of existing data sources all point to this scope. In some cases, the limited size of some provinces limits the coverage provided here.[3]

This report uses the term "Electricity-related renewable energy" and abbreviates it as RE as a way of summarizing activity within the chosen boundaries. Specifically, the report focuses on the Canadian workforce in the seven sectors and across the seven links in the supply chain that is tied to electricity delivered to the grid. Both large and small hydroelectricity generation is included. In many cases the focus shifts to small hydro systems; leaving the analysis of large hydro as part of Canada's conventional utility system. Note that this convention does not include some activity that is often considered part of the renewable energy sector. For example, the chosen scope does not include bio-fuels, heat pumps, off grid electricity systems and related areas like electricity conservation. These exclusions do not reflect on the clear importance of these energy systems, but are required by resource limitations.[4]

The Renewing Futures research plan included several distinct tasks including:

1. Industry contact through:
   - A. Key Informant Interviews
   - B. Industry Focus Groups
   - C. Regional Engagement Sessions
2. A Technology Review
3. An Employer Survey
4. A Review of government policy and post-secondary programs
5. Creation of a Renewing Futures labour market information system

Findings from each of these steps are included throughout the report, and a complete description of each methodology and findings is provided in supporting documents.

3 Data and project resource limitations prohibit the inclusion of findings for the Northwest Territories, Yukon and Nunavut. Data for Prince Edward Island is often limited as well.

4 It was not always possible to respect these boundaries and measures and findings will likely include activity in areas like off-grid system, combined heat and power systems and other related areas.

This report is presented in seven sections with seven detailed supporting documents:

1. *Introduction*
2. *Growth and change*
3. *Technologies and the supply chain*
4. *Stakeholders and their diverse roles*
5. *Labour markets and the bridges that connect them*
6. *Human resources management and key occupations*
7. *Elements and preliminary plans for the RE HR Strategy*

Appendices and Supporting Documents:

- *RE Technology Review*
- *RE Employer Survey*
- *Renewing Futures Labour Market Information System*
- *Sector Summaries*
- *Provincial Summaries*
- *Post-Secondary Training and Certification Inventory*

Key elements of an RE National Human Resources Strategy are included in a separate report.

2. Growth and Change

Growth has been the dominant feature of global RE activity over the past fifteen years. Growth is a huge positive, representing opportunity and attracting investment and innovation. There are, however, challenges associated with change. This section focuses on the past and future extent and dynamics of change in renewable electricity systems.

Elements of Growth

There are enduring structural forces driving investments in RE systems. The primary reason for new capacity is the global drive for low carbon generating systems that will reduce Greenhouse Gas Emissions (GHG) associated with local air pollution and global warming. Benefits beyond environmental gains include energy security and diversification, economic stimulus and employment creation and general industrial diversification. Established RE systems like large and small hydro and bioenergy in co-generation, are a long-standing part of these solutions. Technological developments and government policy promote a range of newer wind, solar, tidal/wave and geothermal systems as part of the drive for growth in low carbon electricity generation.

There are many current studies and forecasts that describe these themes. Three recent reports set out similar conditions both globally and for Canada that fit closely with the RE projections and the Renewing Futures research presented here for Canada.

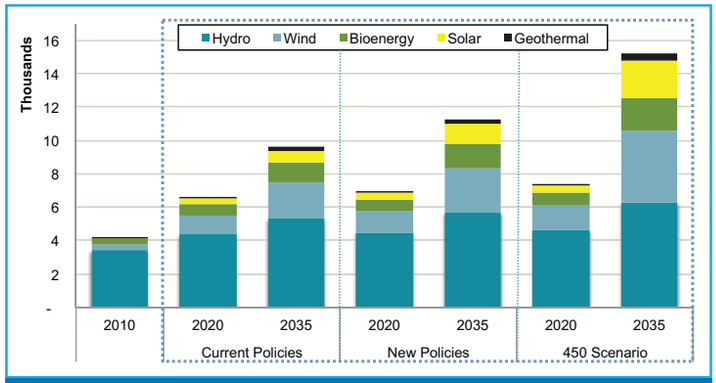
The International Energy Agency, in its 2012 World Energy Outlook, anticipated continuing growth in the extent and the share of RE systems in virtually every country. Additional RE capacity is anticipated in government policies and system plans. These plans will both raise the proportion of electricity production in renewables and help reduce the level of GHG emissions.[5]

These studies, and many others, confirm nine global themes that are central to the Renewing Futures vision for Canada. These include:

- Strong growth in all RE systems is associated with declining production costs – especially in solar PV – but these costs are generally projected to remain above conventional costs across the scenario,
- Risks to projections of RE capacity are significant and are captured in several scenarios that span possible outcomes,
- Large hydro systems are the largest suppliers of RE globally and their growth continues,
- Wind is the second largest source and growth in the installed capacity for wind systems are larger than other sources,
- PV solar is the third largest and fastest growing sector,
- Gains in bioenergy, geothermal and tidal/wave are more limited and geographically isolated,
- Overall growth in RE system capacity is projected to be between 60 and 80% between 2010 and 2020 – averaging 5 to 7% annually when large hydro installations are included, and
- Overall growth increases installed capacity by 3 to 5 times 2010 levels by 2020 – when the RE excludes the large hydro legacy systems.

Exhibit #1 summarizes the IEA outlook for the five key sectors. Global gains projected here are similar to or larger than the Renewing Futures projections for Canada. Growth is on a very large scale.

Exhibit #1: Global Growth in Renewable Electricity Generation by Sector



Source: International Energy Agency – World Energy Outlook, 2012

There are powerful drivers promoting change *but* there is also momentum favouring alternative solutions – e.g. natural gas systems –and risks that growth will be curtailed by changing policy or consumer preferences. *Uncertainty* is a dominant feature. IEA projections are divided into three scenarios to capture the range of possible outcomes.

These realities are highlighted in the 2013 Mid Term Market Report that updates to the 2012 IEA outlook. Basic themes and trends noted above are confirmed, but the tone shifts to uncertainties and risks for the RE industry. The Executive Director of the IEA, **Maria van der Haven** comments:

> "Current world energy trends are clearly unsustainable. Global energy needs are growing; supply patterns are changing but still rooted in fossil fuels; and CO2 emissions reached record highs in 2012. The International Energy Agency (IEA) carbon intensity index recently revealed a clear but disturbing picture: despite technological development and international efforts, the carbon intensity of the global energy supply has barely changed over the past 20 years...
>
> For mature renewable electricity markets and technologies, the challenge is for governments to maintain deployment momentum while optimising support costs and maximising benefits to consumers and society; and to enable the system integration of higher shares of variable renewables such as wind power and photovoltaics."[6]

5 See International Energy Agency, World Energy Outlook, Renewable Energy Outlook, 2012, Page 212.

6 See International Energy Agency, "Renewable Energy Medium-Term Market Report, 2013" Page 31

The message here is that the growth anticipated for RE, globally and in Canada, comes with many risks and uncertainties. The scale of change is large and the potential for interruptions, cycles and disruptive impacts are considerable. IEA projections for Canada, in the 2013 Medium Term Update, are consistent with RE capacity scenarios prepared for Renewing Futures. In their most likely scenario the IEA projects an increase of 25% from 2012 to 2018 for all sectors in Canada. Wind capacity grows by 3 times and solar by 5 times across the five year period. These projections fall slightly below the highest growth Renewing Futures scenario for Canada but well above the two other scenarios.

Very large increases to complex systems using new technologies connected to old "legacy" systems are contemplated here. These changes require large investments by private investors who must rely on uncertain energy markets, government policy and consumer preferences. Investments must overcome changing procurement requirements, shifting deadlines, alternative local environmental and other regulations that introduce both delays and accelerated schedules.

New RE capacity is often introduced to replace older, carbon intensive systems – especially coal. This introduces another disruptive element of the change represented by RE investments. They are often not adding to new capacity but displacing resources (including skilled labour) that is already in place.

The Renewing Futures analysis assessed risks and uncertainties noted here through the creation of three alternative scenarios. The scenarios are intended to reflect the range of possible outcomes and the uncertainties that are associated with projections that extend from 2013 to 2022. Three scenarios define upper and lower limits to labour requirements.

A. The *Utility Case* is based on a review of Provincial utility reports, energy plans and interviews with energy planners in each Province. Acting as distributors of electricity, these stakeholders, and their plans for system capacity, are key decision makers. Projections of installed capacity for each RE sector have been developed in this scenario using this source.

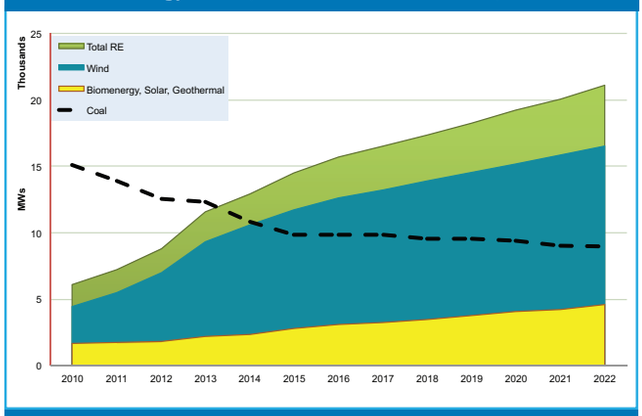
B. The *Reference Case* is based on the National Energy Board (NEB) 2011 "Energy Supply and Demand Projections to 2035". With some modification and added details this document identifies one perspective on the growth of RE installed capacity. This projection was selected as a widely cited and detailed source that is linked to economic and industry forecasts that act as drivers. The NEB's view of the future for RE and competing sources from the conventional industry acts as one anchor for the report.

C. The *Vision Case* is based on the announced targets and published visions of the RE industry itself and the government policy statements and objectives for RE. This case is designed to test the higher limits of investment and deployment of RE and, in turn, define the upper levels of labour requirements.

The NEB scenario for RE sectors are part of a larger, consistent review of economic conditions, energy policy and prices, market demands, conservation efforts and the substitution of energy production across types. The NEB scenario captures the substitution of new RE capacity for carbon intensive coal systems. Exhibit #2, reflects both the overall NEB projections for RE but the assumed, parallel reduction of coal generation. Numbers in the exhibit suggest that, at least nationally, new wind capacity can be seen as largely replacing coal and this is consistent with government policy and plans in several provinces.

Exhibit #2: Electricity Generation Capacity in Canada, by Sector

National Energy Board, 2011 Base Case Forecast, Canada



Source: National Energy Board (2011), Energy Supply and Demand Forecasts to 2035

Exhibits #3 and #4 track the cumulative total and annual change in the installed capacity for RE systems in the three Renewing Futures scenarios from 2012 to 2022. Exhibits #3a and b highlight the growth from 2012 to 2022 in MWs of installed capacity both including and excluding large hydro systems. Large hydro installations are a dominant part of Canada's electrical utility system and they give Canada a strong environmental position in low carbon energy systems. These large hydro systems are structurally quite distinct from the other, newer RE systems as they are part of the existing utility system and draw on well-established technologies and related workforce. Additions to large hydro capacity are part of the existing infrastructure and draw on established employers and their workforce. Given the size of these facilities, they tend to dominate the statistics. It is revealing to consider change in the RE sector excluding these large installations as this narrower focus captures more of the dynamics of expected change for new employers and their labour requirements.

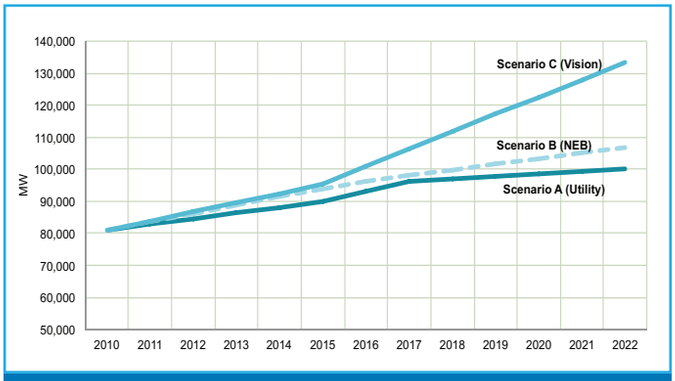
Exhibit #3a reports the projected increase in all RE sectors, including large hydro. The increase in the overall capacity of these systems varies from a low of 23% in the Utility Case to 64% in the Vision case. Of course the installed capacity base of 60,000 MWs tends to dominate these comparisons.

Exhibit #3b focuses on the smaller group of RE sectors where growth is much more dramatic. This is especially true in the Vision Scenario that reflects the ambitions and potential of each technology seen through the eyes of engineers, promoters and government policy makers. Growth in the more restrained cases developed by the Utilities and the NEB scenarios, is actually half of the Vision case. There are many reasons for the caution and more limited expectations in the Utility and NEB cases. These include policy risks related to spending restraint, the limited capacity of transmission and distribution systems to integrate new power, and shifting consumer preferences.

Note that in the Vision Scenario, the projected increment to wind capacity is comparable to the additions from major large hydro projects. This is largely the result of the known and short-term plans for wind installations dominating the short run period to 2022 while most of the big large hydro projects under consideration will not come on-line before 2022.

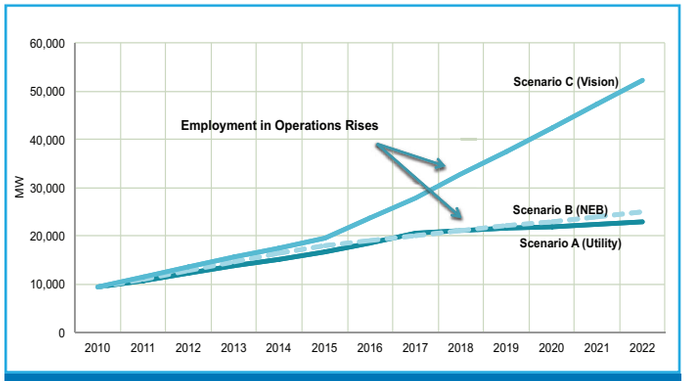
Exhibits 3a and 3b describe the cumulative change in the total installed capacity and this measure captures the level and change in the *operation* of these systems. There will be a steady increase in electricity production and employment across the scenarios. Increments to this activity will depend on the pace of investments in new systems.

Exhibit #3a: Renewable Electricity in Canada, Installed Capacity, 2012 to 2022, All Scenarios, Including Large Hydro



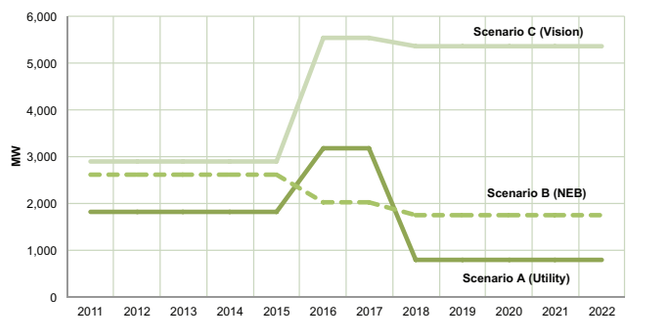
Source: EHRC and Prism Economics and Analysis

Exhibit #3b: Renewable Electricity in Canada, Total Installed Capacity, 2012 to 2022, All Scenarios, Excluding Large Hydro



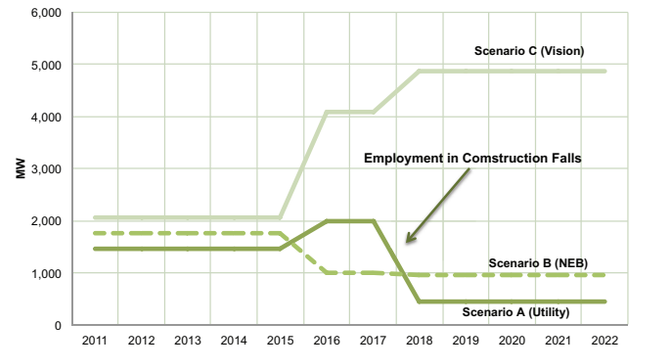
Source: EHRC and Prism Economics and Analysis

Exhibit #4a: Change in RE Installed Capacity, Canada, Three Scenarios, Including Large Hydro



Source: EHRC and Prism Economics and Analysis

Exhibit #4b: Change in RE Installed Capacity, Canada, Three Scenarios, Excluding Large Hydro



Source: EHRC and Prism Economics and Analysis

Exhibits 4a and 4b shift to the annual investments and the pattern of *additions* to capacity. The timing of the investments and the related projects is very difficult to predict. Measures developed here distribute new projects in each sector in equal annual increments from 2012 to 2022 – and this certainly imparts an unrealistically less cyclical or disruptive pattern. It is likely that these projects will emerge in a much more uneven pattern and the stop-go cycles of projects represents a significant risk and uncertainty for the future of planning in general and labour requirements in particular.

Note that investments and construction activity are higher in the future than, generally, has been the case in the past. This implies higher employment in all activity tied to the additions to capacity. But the Utility and NEB cases include periods, often after 2018, when project activity will decline and there will be an *associated drop in labour requirements*. The key point here is that activity and, in particular, labour requirements related to the *increments* to RE capacity are much larger and potentially much more volatile that activity tied to operations.

The dynamics set out in Exhibits 4a and 4b describe the magnitude and volatility of expected growth. Growth on this scale can lead to *disruptive* change. The report turns to these risks later as it considers the potential impact in areas like work quality, productivity, safety and system reliability.

Legacy and Change

While much is new and emerging about Renewable Electricity systems, the changes described here are deeply rooted in Canada's history, geography and resource base. Canada has a vast, untapped potential for additional renewables in every sector. But wind, sun, rivers, tides, biofuels and geothermal energy are unevenly distributed with the best potential sites often remote from the center of energy demand. These natural supply and demand endowments must be linked together using new or expanded infrastructure for transmission and storage. This starting mix of resources, potential, demand and infrastructure are the legacy and this is as important as the environment imperatives that drive RE deployment.

Each Province has its own mix of these endowments, and provincial governments have the dominant jurisdictional role in both energy and labour policy. Changes that are tracked in the Renewing Futures scenarios are, then, tied to these legacies and Provincial policy as well as to emerging technology. Accordingly labour requirements and related human resource policies are very different when seen at the provincial and sector level. While there are distinct geographic and sector legacies there are many technical and structural similarities in the development of RE systems in each sector. This comingling of different legacies and similar sector-specific technologies highlight the need for mobility and flexibility in the management of new systems.

There are very big differences in projected changes by province and sector and the three scenarios capture this. One historically fixed reality is the location and development of large hydro generation facilities in British Columbia, Manitoba, Ontario, Quebec, and Newfoundland and Labrador. These systems, and the many plans that will add new generating capacity, make these Provinces rich in carbon free electricity and allow for more limited plans to deploy other RE systems. These legacies have implications for RE that extend beyond Provincial boundaries as, for example, all three Maritime Provinces are able to look to their links to the new, large hydro development in Newfoundland and Labrador, as an alternative to other local RE deployment.

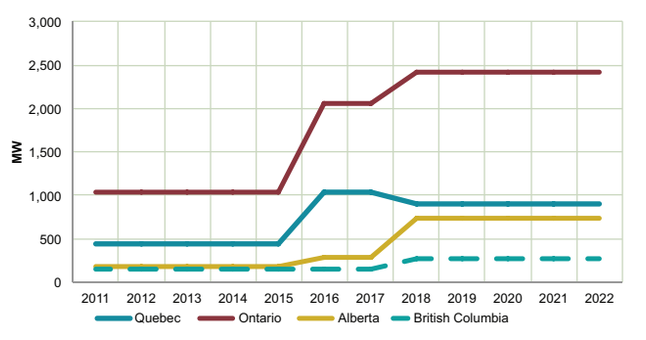
Another historical driver is the initial and growing industrial base that is a large part of electricity demand. Alberta and Ontario stand out as centers of industrial / resource demand that must be met from carbon intensive generation systems at the present. Both Provinces are looking to RE to meet these demands and large hydro developments are not available on the needed scale.

Exhibits #5a and #5b set out the implications of legacies and RE potential in the Vision scenario. In this and other cases, the report uses the Vision scenario as a reference point for the analysis. This does not reflect the view that the Vision scenario is the most likely outcome. In fact, each scenario is an independent assessment of the future and none is seen as more likely than another. Rather, the Vision scenario has the largest cumulative investment in RE and is highlighted because it represents the most severe test of the capacity of the available work force.

The extent and timing of the RE deployment from 2012 to 2022 is related to the legacies noted above in each province. Investment in RE in Ontario is by far the largest, with Quebec and Alberta following. Industrial demands are the dominant drivers here. BC lags behind, deploying just a fraction of Ontario's investment, and this reflects its legacy of large hydro potential.

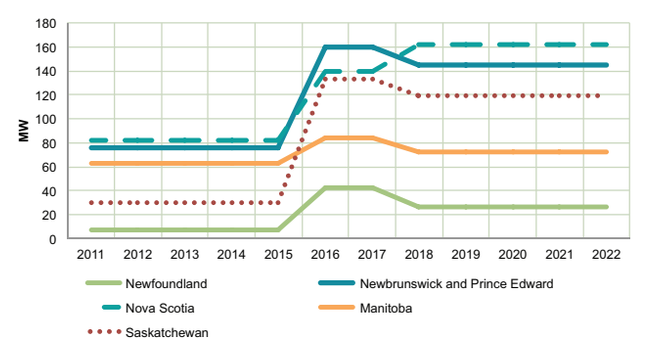
Exhibit #5b reports the same measures of additions to RE installed capacity in the smaller provinces. Notably, the dominant plans for large hydro development in Newfoundland and Labrador limit other RE deployments. Wind farms dominate plans in the other Provinces in terms of MWs of new power – but research and some initial development in tidal and wave technology in Nova Scotia are notable as well.

Exhibit #5a: Change in Installed Capacity, Vision Scenarios, Large Provinces, Excluding Large Hydro



Source: EHRC and Prism Economics and Analysis

Exhibit #5b: Change in RE Installed Capacity, Smaller Provinces, Vision Scenario, Excluding large Hydro



Source: EHRC and Prism Economics and Analysis

Displacement and Disruptive Change

Investments anticipated in this section are primarily associated with benefits and positive economic impacts. From the perspective of this report the addition of jobs in the manufacturing, design construction and operation phases are the focus. These new jobs are just one impact of RE deployments that also have direct impacts on energy markets, environmental conditions and other industries. It is apparent that rapid growth can be disruptive. There are a variety of economic viewpoints and models that can be used to measure and interpret these benefits and costs of RE investments.

Recent IEA work highlights the need for a consistent analysis of employment impacts that reflects the benefits and costs of investments in all sectors of the economy. Benefits from jobs and environmental improvements need to set against costs including the *displacement* of conventional energy systems and related impacts in the economy outside renewables.

Measuring employment and labour market impacts associated with RE activity have been a policy priority almost from the start of the current round of RE. In Europe, where RE deployment began in earnest, job creation has been given almost equal importance to environmental improvement as a policy priority. The International Energy Agency's implementing agreement on Renewable Energy Technology Deployment (RETD) has undertaken an Economic and Industrial Development (EID) – Employ project to review measures of benefits and costs associated with job creation In selected countries, including Canada. The RETD – Employ project proposes new standards for the analysis of employment impacts on large scale deployment of renewable energy technologies.

Among other things, the RETD – Employ effort focuses attention on gross versus net labour market impacts. Gross measures are limited to simple job creation from new RE investments while net impacts consider the effect of RE activity in other sectors of the economy. Net effects include the impacts of higher costs in general and the displacement of jobs in conventional energy generation that is replaced by RE in particular. The Renewing Futures labour analysis presented here takes these global standards for human resources analysis to a new level. This approach considers not only the substitution of RE systems for conventional energy, but also assesses the effects of RE activity for occupations in labour markets across multiple industries. Displacement impacts are included in the Renewing Futures approach.[7]

Indeed, the Renewing Futures approach, begins with a very different premise from the other RETD –Employ work as it examines the potential for labour market tightness and skills shortages. While this approach is not unique to Canada, it broadens the analysis that is generally applied to labour market impacts.

We need to consider another group of impacts. Investment on the scale anticipated here creates the potential for *disruptive* growth. Opportunities in RE are moving targets shifting in unpredictable ways as policy, energy markets and economic conditions shift and set up cross currents. The potential for sudden surges and then periodic downturns in activity combines with the potential for attracting both new producers and workers to create risks and uncertainties. Labour market assessments and analysis of human resources strategies needs to include:

- Financial risks,
- Production / consumer risks and impacts on quality in components, systems, installation and electrical reliability, and
- Workplace risks related to safety and productivity.

Financial risks arise from delays and changes in policy, planning, regulatory clearances and related costs. Stakeholders contributing to this research often focus on the scarcity of investors with experience in RE and with the willingness to accept the associated risk. Two structural responses are apparent in this environment. At one extreme very large international businesses target global opportunities

7 Natural Resources Canada (NRCan) hosted an international meeting of the IEA – RETD EID – employ group in Ottawa at the start of this project. The Renewing Futures approach was explained as an extension of the various economic models and measure being used in other countries. For more on the RETD – Employ work see http://iea-retd.org/archives/publications/employ

and work across a wide part of the supply chain (e.g. manufacturing, design, construction and installation). These businesses spread the risks across a large number of projects in many countries and build a critical mass of experience and skilled partners. At the other extreme, a very large number of small employers extend their current work outside RE activity to include specialized RE contracts working with consortia of other businesses. Consortia are led by developers who may be part of very large energy businesses with an interest in diversifying their interests across alternative energy systems. Thus engineering firms, contractors, legal and policy planners and often diversify into RE as opportunities arise. The latter approach often seeks to manage risk by limiting commitments to short term contracts for almost every aspect of the work -- including employment contracts that limit exposure to long term labour costs. Research presented in Section 3 highlights the second type of structural adaptation among Canadian RE employers.

Production risks include the potential for cyclical demands for components of RE systems to interfere with the development of reliable suppliers. These risks would be most apparent in the production, distribution and installation of new technologies. Production risks include the potential for inferior quality in equipment and components as well as errors in installation as inexperienced workers are employed in manufacturing.[8] These risks are magnified in RE installations where consumers are taking risks themselves as they chose to shift from conventional systems to new, more expensive but environmentally beneficial systems. New markets for RE systems depend on growing consumer confidence and the ability to deliver promised advantages.

The skills of the Canadian workforce studied relate to the workplace risks. Evidence presented by stakeholders confirmed concerns that weak technical skills in the design and installation of RE systems are connected to significant labour cost risks including safety, quality and productivity. All employers working on RE installations are under time and cost pressures. Uncertain schedules and time pressures can allow the employment of unskilled or inexperienced workers. This can result in lower productivity, delays, poor quality, rework, accidents and turnover. The impact of these disruptions can extend to the entire industry. Evidence presented during the Renewing Futures research suggests that there are industry-wide concerns about reliability, consumer perceptions of product quality related to these, workplace safety, as well as production risks.

Growth and Change – Conclusion

The future path of RE deployment in Canada is uncertain. The most important risks that emerge are those that relate to assessing the adequacy of Canada's skilled workforce associated with RE deployment. Given this starting point, the Renewing Futures approach is to emphasize *that environmental pressures will dominate and industry must prepare for growth across a wide range of technologies*. This growth will include both benefits and costs. A national HR Strategy must include elements that address all of these.

8 There are many examples of these issues arising for the RE industry. Most recently there have been reports of quality problems with solar PV components manufactured in China.

3. Technologies and the Supply Chain

This section of the report summarizes the findings of a Technology Review that considered the range of RE systems that are now installed and the likely new technologies and systems that will be deployed from 2012 to 2022. The Review considered each of the seven primary technology sectors and integration and storage:

1. Wind
2. Solar
3. Bioenergy
4. Geothermal
5. Hydro: Large and Small
6. Marine: Tidal, Waves
7. Integration and Storage

Employers working in these sectors are distributed across a supply chain of economic activity that spans research and development at the start and system maintenance and operations and connection of capacity to utilities at the end. This section concludes with a review of the distribution and characteristics of RE employers across the supply chain.

Technologies

The mix of RE technologies to be deployed is distinctly different in each province but each sector will apply current and mature technologies. This means that the evolution of the size and mix of sectors in each province is the main driver of the growth and shifts in needed labour, equipment and materials.

Analysis revealed few examples of new or emerging technologies that will be deployed on a scale that will require change in the mix of skills needed in the workforce. The most important changes in technologies and systems are the upgrades and improvements to the interconnections between RE facilities and the utilities and the modernization of distribution systems. These latter advances are very important to the increase in the share of renewable electricity to be purchased from each sector.

One key measure that drives the analysis is the installed cost of new capacity. Exhibit # 6 provides the point estimates that were used in the Renewing Futures analysis. These estimates are based on a much broader sample of research on costs and technologies that were part of the Technology Review. In general, the current level and the expected efficiency gains and cost reductions are indicators of the scale of deployment that is likely. For example, the installed cost of wind systems are among the lowest and this reflects the more mature and broadly based deployment of wind systems. These measures include labour costs and are used in the Renewing Futures LMI model to calculate employment.

Exhibit #6: Key Assumptions for Installed Capacity in the RE Sectors, $/MW - 2012 to 2022

RE Sector	Cost	Annual Change 2011-2022
Wind (land Based)	$2,800	0%
Solar (PV)		
Residential Retrofit	$5,410	-2.5%
Residential New Construction	$4,820	-2.5%
Small Commercial	$4,940	-2.5%
Large Commercial	$4,860	-2.5%
Utility	$3,100	-2.5%
Bioenergy	$3,750	0%
Geothermal	$4,141	0%
Hydro (Run of River)	$3,500	0%
Marine	$5,688	0%

Source: EHRC, Prism Economics and Analysis

The following sections summarize the findings of the Technology Profiles and focus on the employment implications. Details on the state of current and emerging technologies, cost trends, market and regulatory challenges and HR implications are available in the full Technology Review.

Sector Highlights – Wind

Wind systems are the second largest of the RE sectors, after hydro, both globally and in Canada. Rapid growth in installed capacity has been proceeding in most countries with additions being driven by the availability of top quality locations and the impact of government policies. Canada had just over 5,600 MWs of wind capacity in 2012, up from 4,000 in 2010 and headed for between 12,000 and 35,000 MWs in 2022 depending on the scenario.

Sites with wind potential are widely dispersed and often are remote from centers of energy demand. Systems are developed both on and off shore with the former more common in Canada. The latest advances in Europe are in very large scale off-shore wind farms that include the largest capacity towers and turbines. There has been only limited off shore developments in Canada and these have been restricted in Ontario.

Wind technologies are well developed with several alternative global suppliers of system components (e.g. towers, rotors, turbines and generators) available to meet rising demands. New wind systems will be developed on a large scale in each scenario and in all Provinces. While there are few expected changes in the system technologies, the scale of deployed systems, including the towers, turbines, rotors and other components will grow larger. At the same time the number of turbines on each farm is also increasing. In Canada, for example, the Canadian Wind Energy Association CanWEA reports that the average installed capacity of (MWs) per wind farm turbines has risen steadily since 1993 and the number of MWs per wind farm has increased from less than 1 MW in 1993 to just under 40 in 2013. The average number of wind turbines per wind farm has increased from 1 in 1993 to over 22 in 2012. These changes involve the use of new material such as composites in the towers and high performance concrete in the base. Larger and more numerous towers add to the scope of work in lifting (crane operation) and transporting prefabricated components. New labour skills are associated with these changes.[9]

9 More detail on these developments in wind technology is provided in the RF Technology Review, page 51.

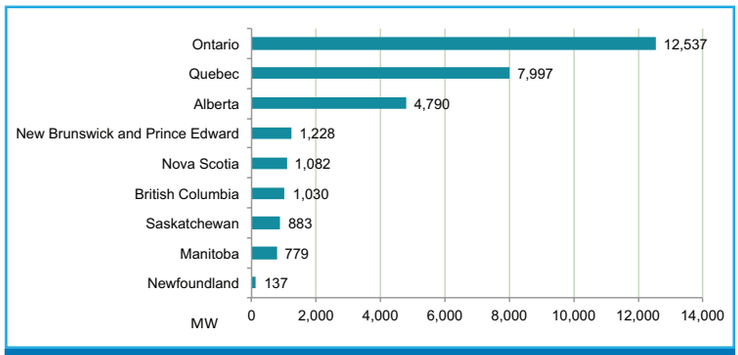
Canada has leading manufacturers and suppliers working on smaller, mid-sized and off-grid systems and related frames, blades and tower base systems. The larger scale of commercial, industrial and utility deployments may limit the ability of Canadian manufacturing and suppliers of systems to grow with the market.

Construction and operation of the wind systems is very capital intensive. Technological innovation is focused on the engineering of materials and mechanical / electrical systems in the components. Large global suppliers of these systems are primarily in Europe and Asia. Growth in these systems has been significant and competition has been intense with Asian concerns recently gaining share from Europeans. Engineering and manufacturing has been the most important source for jobs in wind systems.

Improvements in turbine efficiency and the rising scale of systems will combine to reduce costs. But wind technologies are mature and only limited cost reductions are expected to help the competitive position of commercial wind installations.[10] As noted in Exhibit # 6 above, the installed cost of wind systems are among the lowest of the RE technologies.

Exhibit # 7 tracks the expected increment to installed capacity in wind systems in the provinces in the Vision scenario. These gains are distributed across all Provinces and they are the largest contributors to all RE employment across sectors and provinces. Installed capacity will grow between 2x and 7x in the lowest and highest scenarios – with associated employment gains.

Exhibit #7: Change in installed capacity, Wind by Province, MWs, Scenario C, Cumulative from 2012 to 2022



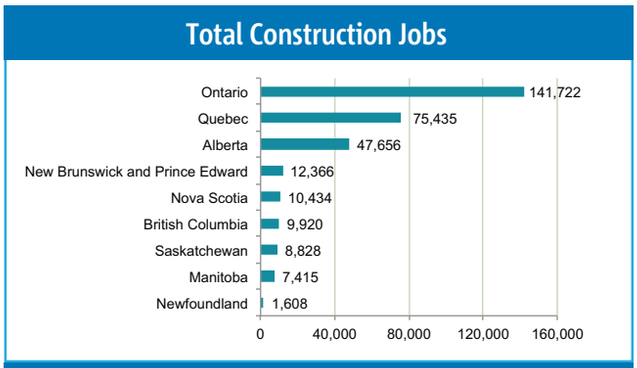
Source: EHRC, Prism Economics and Analysis

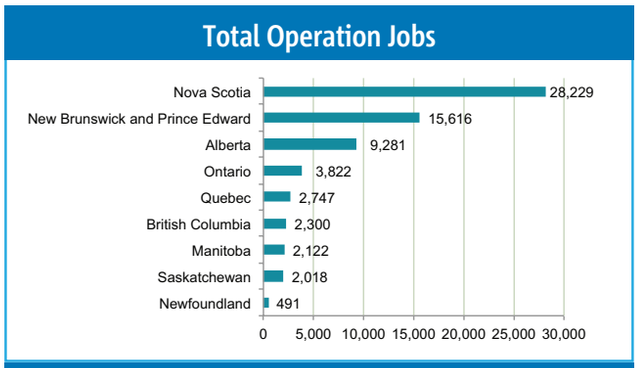
Job creation is sensitive to the extent of local procurement of system components.[11] The mechanical / electrical sophistication, capital intensive and large scale of these systems adds to the complexity and specialized nature of the technical skills and experience needed in installation and operation. Exhibit #8 summarizes the overall employment impacts and these are considered in more detail in section 5 and 6 below.

10 The Technology profile reports research that estimates these cost reductions to be as low as perhaps 0.5% annually for LCOE and Installed costs / MW and these have been rounded out to 0 in the occupation model

11 The Prism/JEDI model used to estimate employment includes an adjustment that recognizes the impact of local and imported use of system components. Assumptions used here, in all provinces, were based on local content proportions needed to meet Ontario local procurement standards in Provincial regulations. For more detail on the model and its calculations see Section 5 below and the report on the Renewing Futures LMI System documentation.

Exhibit #8: Employment, Wind, by Province, # of Jobs, sum 2012 to 2022, Scenario C





Because of the scale of development and the intermittent nature of the power, wind systems are tightly linked to the technical development of the utility distribution systems. Market and integration challenges relate to:

- Increasing utility power quality requirements,
- Lower capacity factors associated with lower resource quality,
- Complex interconnection requirements in general and variations regionally,
- Difficult transmission siting processes, and
- Concerns about connecting wind facilities to aging electricity grids

To accommodate these factors many modern wind turbines have grid-friendly operating characteristics including – voltage control/regulation; fault ride-through capabilities; real power control, ramping and curtailment; primary frequency regulation; inertia response; short-circuit duty control.[12]

Sector Highlights – Solar

Solar power has significant potential across Canada with, for example, areas in the southern Prairies having access to resources on a scale similar to areas of the southern United States. Canada's potential can be accessed through photo-voltaic (solar PV) and concentrated solar thermal power (CSP) systems. There is some interest in developing CSP systems in Canada and Canadian businesses are active investors and developers of CSP technologies in the U.S. No CSP systems, however, have yet been built in Canada and none are expected before 2022. In contrast, solar PV systems are the fastest growing RE in Canada.

PV technologies include conventional mono and poly silicon based solar PV cells. Both these technologies have established mature markets and are linked to multiple suppliers across a global supply chain. Global markets for solar PV systems have been growing at a 3-year compound

annual growth rate (CAGR) of 66%. Solar PV systems – predominantly C-Si cell - will dominate the production / installation processes in Canada to 2022.

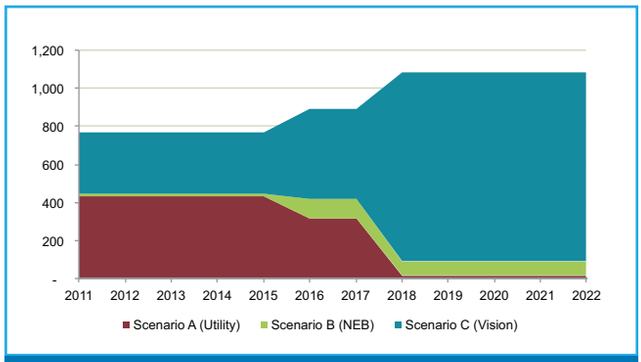
China has emerged as the world's largest supplier of solar cells and modules. Strong Chinese supply has been gaining market share and is contributing to lower prices and costs.

Solar PV systems have higher Levelized Cost of Electricity (LCOE) than many RE alternatives. There will be some changes in these systems with thin film solar PV and building integrated building systems becoming more popular. As the efficiency of energy conversion improves for solar PV cells the LCOE and installed costs will decline, improving the competitive position. These cost reductions in solar systems are among the largest projected for RE. An annual decline of 2.5% in costs lies in the middle of several projections and is used in the Renewing Futures analysis as one driver prompting incremental installation of solar systems to 2022. Cost reduction and improved energy efficiency are important for the advance of solar systems in many Canadian markets where the cost of conventional electricity remains relatively low.

Solar PV deployment, on a large scale, will be focused in Ontario with other provinces still considering or just introducing systems on a trial basis. Solar PV deployment will add employment across the supply chain, but the biggest job creation is in manufacturing. Ontario's Green Energy Program has promoted the growth of some 650 businesses and the capacity to manufacture 158 MW of solar PV cell capacity since 2005. Growth will be driven, in part, by the local content requirements in Ontario regulations.

Exhibit # 9 shows the annual increment to solar PV capacity in Ontario. The Renewing Futures Vision scenario has been adjusted to include employment in Ontario manufacturing of PV cells and related systems in response to the local procurement features in the system. However, these dimensions of solar system deployment will change in the future as the World Trade Organization has recently ruled that Ontario's policy is in violation of international trade agreements. Ontario announced new domestic content requirements in response to the WTO ruling in August 2013. These changes were made too late in the research schedule to be incorporated into the analysis, but it is clear that this change would reduce the employment impacts.[12]

Exhibit #9: Increments to solar PV Installed Capacity in Ontario, Three Scenarios, Annual 2011 to 2022



Source: EHRC, Prism Economics and Analysis

The Renewing Futures LMI model identifies five solar markets; residential retrofit, residential new, small and large commercial and utility. LCOE and installed costs are reduced in the larger scale commercial and utility markets.

Solar is the only RE sector where skills shortages and labour costs have been cited as an issue. Installation involves both low voltage and cabling work and high voltage work on the grid connection. As employment growth accelerates attention will focus on:

- Competition with other sectors for key occupations,
- Rising labour costs, and
- The mobility of the skilled workforce across sectors, industries and regions.

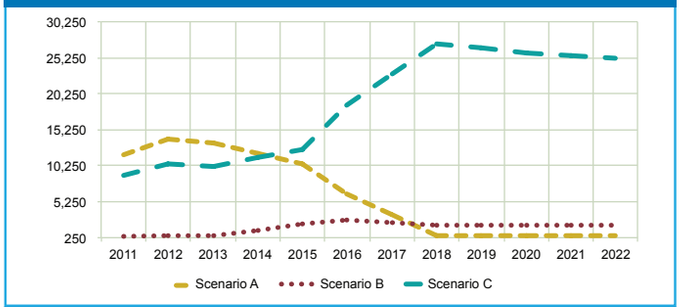
As cell prices drop the relative costs of more labour intensive components of installation will rise including racks, cabling, inverters and substations.

Exhibit # 10 shows the employment impacts of solar deployment in Ontario.

12 See Ministry of Energy directives to the Ontario Power Authority, August 16, 2013.

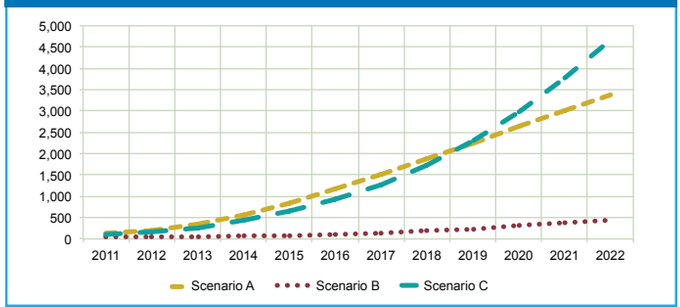
Exhibit #10: **shows the employment impacts of solar deployment in Ontario.**

Construction Jobs, Solar, Ontario, three scenarios, annual 2011 to 2022



Source: NREL, Prism Economics and Analysis

Operation Jobs, Solar, Ontario, three scenarios, annual 2011 to 2022



Source: NREL, Prism Economics and Analysis

Sector Highlights – Bioenergy

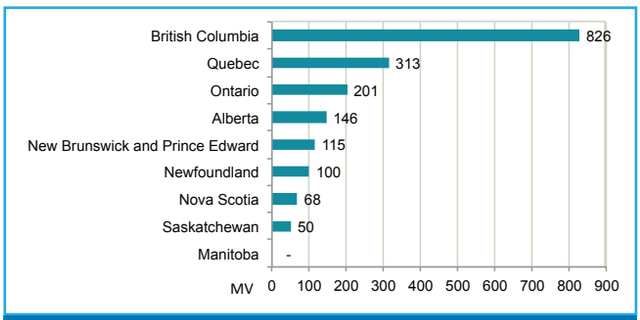
Bioenergy is currently generating the third largest amount of alternative electricity for Canada's utility grids following hydro and wind. Canada's natural resources are combined with existing and new technologies to create a significant potential for bioenergy. Environmental benefits and policy incentives will promote significant growth for bioenergy over the coming decade. A wide range of processes are covered here with many providing both electrical and thermal energy – often in cogeneration processes. Advances in technologies are emerging and include improvements in areas like: anaerobic digestion, Stoker/FBC Steam-Electric Combustion, Municipal Solid Waste (MSW) Incineration and Landfill Gas (LFG).

Bioenergy systems generate electricity from the bi-products or waste of resource and manufacturing industries (e.g. forestry, agriculture) and waste management. These systems have been operating for a long time and new technologies and policies are encouraging further development. While the potential for electricity production from cogeneration systems is large, there are even greater opportunities to diversify forestry, wood manufacturing and agricultural industries into biofuel and other advanced products. Single purpose thermal/heating systems and advanced biofuels, composites and related activity have significant employment potential but are beyond the scope of this study.

Growth prospects are tied to the fortunes of forestry, agriculture and waste industries. For example, the Forest Products Association of Canada (FPAC) reports that there are 31 forestry related cogeneration systems associated with pulp and paper and sawmills in Canada in 2012 and another 20 are expected by 2022. A significant portion of the electricity generated in these systems may remain off-grid as industrial users build in remote locations to meet their own needs. These off-grid systems are not part of the scope selected for this research; however, it is possible that some of the capacity includes off-grid systems especially in Scenario C.

Bioenergy projects are ongoing in most provinces and the largest capacity is in British Columbia, Quebec and Ontario. Exhibit #11 reports the total increment to bioenergy capacity in RE by Province with British Columbia being the largest supplier. Incremental capacity, reported in Exhibit #11, increases by over 80% from the 2012 base levels. These gains, which do not include off-grid power generation, exceed the expectations of FPAC noted above. Bioenergy generation related to the forestry industry is a specific focus for B.C. and seems destined to add the largest component of Canada's new capacity. While these gains are impressive, the growth in solar systems noted in the last section are even greater, and by 2022 solar systems are producing more electricity than bioenergy.

Exhibit #11: **Change in installed capacity, Bioenergy, by Province, MWs – sum of 2012 to 2022**



Source: EHRC, Prism Economics and Analysis

There are strong connections to other industries including the development of the wood pellet industry and related systems that produce biofuels destined for export. While this activity may well provide fuel for electricity generation, the employment impacts are also beyond the scope of this research. Similarly, the potential for "purpose grown' agricultural products that would fuel new bioenergy RE was recognized by stakeholders but is not included in the estimates of capacity and employment used here.

LCOE and installed costs of bioenergy RE systems are highly variable; depending on location, fuel costs and other factors. Installed cost per MW, used to calculate employment impacts in the Renewing Futures LMI system, is above wind and close to the cost of small hydro. The economics of bioenergy systems depends on a long list of factors including the scale of operations, location, the economics of the primary industry activity, government incentives, permits and regulations, and the proximity and cost of collecting raw fuel materials.

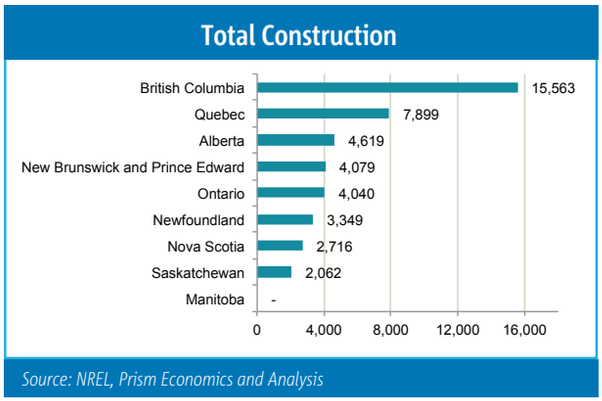
One measure of the long term potential for bioenergy systems was apparent in the Statistics Canada 2010 Survey of Environmental Expenditures. This survey tracks direct industry expenditures and added spending on RE in 2010 for the first time. Findings reported that Canadian businesses spent $455 million on capital for renewable technologies and bioenergy energy technologies accounted for over 75% of the total.

Bioenergy systems have a distinct employment impact with greater labour requirements in general and much higher labour content during operations. Exhibit # 12 tracks the employment impacts in Scenario C, the Vision scenario.

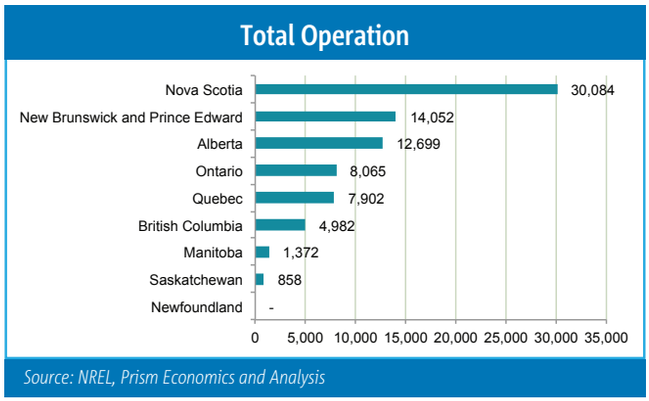
Workforce skills in bioenergy systems include distinctive reliance on:

- Chemical engineering and related technician / technologists,
- Mechanical engineering and related skills and trades including pipefitters and boilermakers,
- Logistics and fuel collection make operations more labour intensive and engage key skills like truck drivers, and
- Mechanical engineering and trades related skills during installation and operations in industrial systems and high pressure steam applications.

Exhibit #12: Employment Impacts, Construction and Operations, Incremental Bioenergy Capacity, by Province, MWs – sum of 2012 to 2022



Source: NREL, Prism Economics and Analysis



Source: NREL, Prism Economics and Analysis

Sector Highlights – Geothermal

Heat that occurs naturally beneath the surface of the earth can be captured in both heat and power systems. There are two distinct technologies that apply this energy – geothermal and geoexchange. The latter includes that transfer of relatively low temperature conditions at shallow depths into heat and cooling systems through heat pump technologies. Geoexchange systems are not part of the scope of the Renewing Futures study. Geothermal systems include high temperature water and steam systems that occur naturally close to or at lower depths from the surface. These systems can be adapted to electricity generation with a series of mature and emerging technologies.

There are very large, established geothermal electrical generation systems in many countries including the United States, Australia, Iceland, Japan, Indonesia, Philippines, and across Europe. CanGEA estimates that there are 11,000 MWs of installed geothermal electricity capacity in the world in 2011.[13] Current global capacity could grow to as much as 51,000 MWs by 2030.[14]

In Canada there are many sites where geothermal systems could be developed with NRCan estimating that 5,000 MWs of geothermal capacity are potentially available in shallow sites and with available technology. An additional 10,000 MWs of capacity may be available in other sites using enhanced geothermal systems (EGS) technology that is under development.[15] This potential has attracted investment and government interest in research, mapping and drilling activity to identify sources and in the ongoing development of generation capacity.

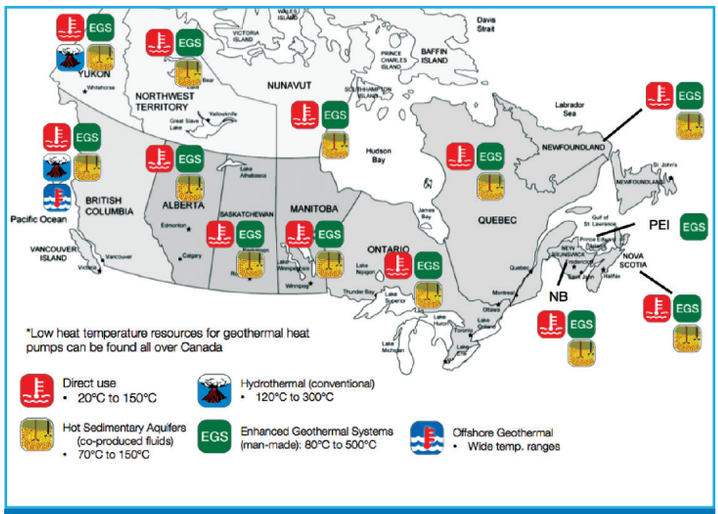
Drilling systems needed to develop geothermal potential can be linked, in some cases, to the oil and gas and mining industries. Oil and gas wells and mining sites have been discovered to have geothermal potential creating natural shared advantages. Canada's expertise in these industries and their technologies can be combined with power generation projects and some are now in the exploration and feasibility stage.

13 See CanMetENERGY, Sector Profile, An Assessment of the Geothermal Energy Sector in Canada, 2011, Figure 15

14 See the Technology Review report page 71.

15 See CanMetENERGY, Sector Profile, An Assessment of the Geothermal Energy Sector in Canada, 2011.

Exhibit #13: Geothermal Energy Available Across Canada



Source: CanGEA Annual Report 2012 and Ko, M., Richter, A. and A. Thompson. 2012. Canadian Geothermal Projects Overview 2012. CanGEA Annual report, (Online)

There are five types of potential geothermal applications; direct use, hydrothermal, hot sedimentary aquifers, enhanced geothermal systems (EGS) and offshore systems. While geothermal energy is potentially available in every province, western Canada has many notable sites. Exhibit #13, developed by CanGEA and NRCan as part of the sector profile, sets out the potential for each of the five geothermal technologies across Canada.

While there are not yet any installations of geothermal capacity in Canada, CanGEA identifies eight sites and projects that are being assessed for feasibility and development. Activity in geothermal systems also includes the work of several Canadian companies who are investors and developers in international systems. Beyond this, Canadian research and academic organizations are involved in projects and collaborations both nationally and internationally.

Where geothermal projects exist they are producing electricity at a LCOE that is comparable to, or lower than, other RE systems and have the added advantage of producing continuous base load power. Installed costs and related employment impacts are highly variable depending on the site, depth and quality of reservoirs, government incentives, permits, regulations and connection to the grid.

Research during the preparation of the three scenarios used in the Renewing Futures LMI system did not find sufficient evidence for adding geothermal capacity. This reflects, in part, the location of some geothermal sites in Western

Canada where large hydro systems already provide abundant RE. While the occupational analysis and HR management discussion later in this report does not measure the impacts of geothermal systems, the findings remain relevant.

It is possible to apply the Renewing Futures LMI system to assess the labour requirements of geothermal systems based on current U.S. installations. As a special simulation, the Renewing Futures LMI model was used to estimate the impact of 5,000 MWs of new geothermal capacity across Canada.[16] The 5,000 MWs correspond to the findings of the CanmetENERGY study that identified this potential in shallow reservoirs that can be accessed with current technology.

If 5,000 MWs of geothermal capacity were added in growing increments across the forecast interval from 2015 to 2022, there would be approximately 93,000 person years of work during construction and installation and then some employment in operations building to 7,000 jobs. These jobs would include engineers, engineering technicians and technologists and trades. Development might coincide with the expansion of mining and oil and gas systems in the west and labour requirements would compete for many of the skills needed in those industries. These labour market and HR impacts are the topic of further discussion in section 5 and 6 below and findings there can be readily understood for geothermal development on the scale suggested here.

16 This use of the Renewing Futures LMI system is based on the application of the JEDI model developed by the NREL in the United States. The JEDI model provides cost and employment impacts for geothermal systems based on U.S. developments. For more details on the system see the Renewing Futures companion document "Renewing Futures, Labour Market Information System" May 2013.

Canada's first geothermal power plant has been announced for development using heat resources underneath oil and gas fields in southern Saskatchewan. The plant will have a capacity of 5 MW and construction is scheduled for 2014.[17]

Sector Highlights – Small and Large Hydro

The base of Canada's electricity generation industry is made up of almost 500 hydroelectric power sites with a combined capacity of 74,000 MWs.[18] It is approximately 60 percent of the country's total electricity generating capacity. The facilities are typically capital intensive. However, Canadian hydro generators are among the lowest cost providers of power in the world. They offer Canadian households and industries a distinct economic and environmental advantage.

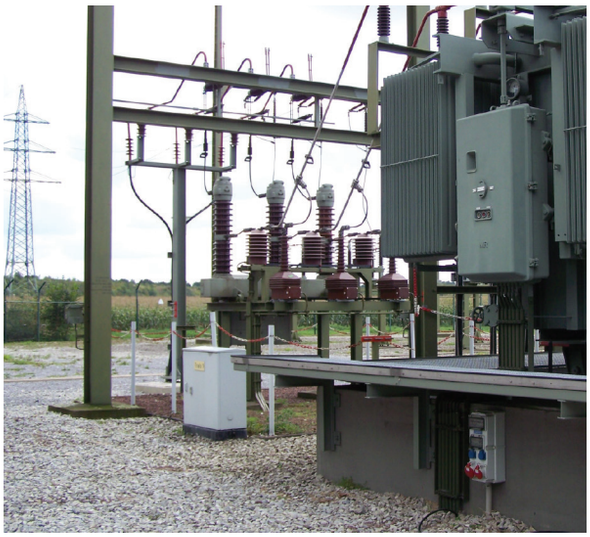
The hydropower industry has developed most of the large sites that are close to major load centers. The labour needed to operate and maintain these facilities is limited to a relatively small, highly skilled workforce of technicians .[19] However, large hydroelectric utilities do have substantial ongoing workforce requirements. They must, either directly or through contractors, manage and upgrade the transmission and distribution systems on which they depend. These companies also face challenges securing skilled employees who are willing and able to work on remote northern sites where many new generation and transmission facilities are built. In many cases projects are close to First Nation communities and developers attempt to hire as many Aboriginal people as possible. The projects are sometimes challenged to ensure that local community members have the up-to-date high-level skills necessary to work effectively and safely on the site.

The *Power in Motion* study outlined a series of labour market and HR management issues that are expected to arise from changing demographics as well as the structure of the utilities. The authors identified recruiting, skills, and retirement as likely to be the priorities for the industry. The study found only a few HR issues related to the existing

17 See Renewable Energy World.com, "Deep Earth Plans Geothermal Plant Amid Canadian Oil Wells" June 3, 2013

18 SOURCE: Canadian Hydropower Association.

19 An exception here is the Ontario expansion of the Niagara Power system where a new diversion of the Niagara River through a recently commissioned 10.2 km tunnel, 12.7 m in diameter, allows the Sir Adam Beck Power Plant to increase its average output by 1.6 TWh.



technology of the generation industry as a whole, and found none for hydro facilities in particular.

Power in Motion also assessed how new electricity generation technologies will affect transmission and distribution systems and the demand for labour associated with them. The results indicate that legacy distribution systems are likely to need extensive refurbishment involving substantial investments. The impact of this, including HR impacts, will apply equally to large hydro and all other power sources.

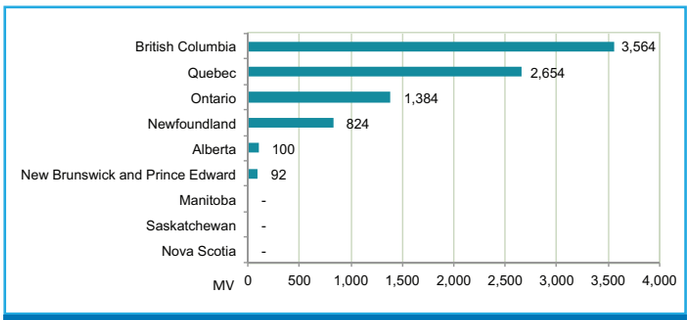
Large hydro projects are planned or underway in British Columbia, Manitoba, Ontario, Quebec, and Newfoundland and Labrador that will provide a major part of Canada's added RE capacity to 2022. Projects total $50 billion, add 11,400 MWs of RE capacity and include:

- La Romaine in Quebec
- Site C and the Waneta extension in BC,
- Keeyask and initial stages of Conawapa in Manitoba, and
- Gull Island and Muskrat Falls in Newfoundland and Labrador.

These are substantial projects. Large hydro will continue to dominate renewable energy in Canada. However, the scope of the Renewing Futures analysis excludes large hydro. The large hydro projects will require some of the same occupations as other RE activity but the traditional hydro industry's overall HR issues are distinct from the new forms of RE.

Exhibit #14 reports the projected change in installed capacity for large hydro systems in Scenario C. Construction for many of the large projects reported here will be spread across many years and extend beyond 2022. The ultimate addition to Canada's RE capacity from large hydro will be much larger than the increments that are ready by 2022.

Exhibit #14: Large Hydro - Change in installed capacity, MWs, total 2012 to 2022, by Province, Scenario C



Source: EHRC, Prism Economics and Analysis

Traditionally small hydro projects (those with less than 50 MWs of installed capacity) are considered part of the RE process.

There is potential for small hydro projects in all provinces. Small hydro is fourth, behind wind, solar, and bioenergy, in RE capacity potential. Small hydro projects have a distinctive cost structure with:

- High cost for installed capacity but low LCOE compared to other RE sectors,
- High pre licensing, planning and permitting costs driven by government requirements, and
- Costs that are very sensitive to scale and location.

This generation relies on largely mature technologies with limited opportunities to lower long-term costs and increase generation efficiency. However, industry observers and researchers at NRCan have identified one of those opportunities as being very low head generation systems, where new technologies are improving efficiencies.[20]

20 See for example the report by Hatch Associates for NR Can "Low Head Hydro Market Assessment" March 2008, that reports a potential for over 2,000 sites with over 4,000 MWs of capacity

Exhibit #15 reports the projected installed capacity for small hydro systems in each province from 2012 to 2022 in Scenario C (the vision case). Ontario leads the other provinces. The findings in Exhibit #14 are sensitive to the 50 MW threshold and the results presented here might be seen as under representing the potential for British Columbia. BC Hydro identifies a number of projects in the over 50 MW range that might be appropriate to include here.[21] In addition, the tracking of small hydro potential here misses the potential reported by some stakeholders for small hydro projects in BC and Alberta and advances in very low head technology.

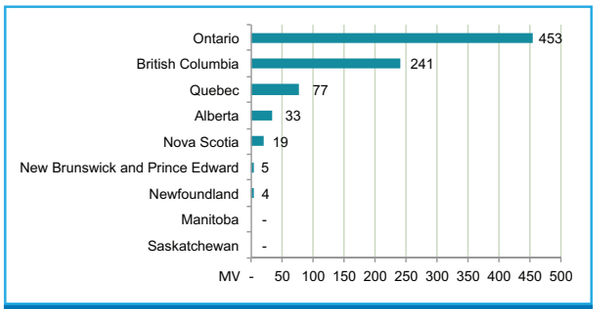
The market assessment section of the Technology Review – which defined the numbers presented here – noted several other factors limiting small hydro as a potential source, including a note that there is a ban on small hydro development in Newfoundland and Labrador.

Small hydro RE developments are known to place specific challenges for some skills and occupations:

- There is a reported shortage of power engineers, specialized civil or electrical engineers, and management skilled at regulatory approvals.
- Design and installation of small hydro is more labour intensive than other RE developments and relies on:
  - Specialty concrete formwork and related skills, and
  - Project management and supervisory skills in remote locations.

Exhibit #16 reports the employment implications of small hydro development by Province. Findings reported here suggest that job creation in small hydro could potentially be higher, especially in B.C. and Alberta, and the implications of stronger employment gains will be considered in Section 5 and 6 below.

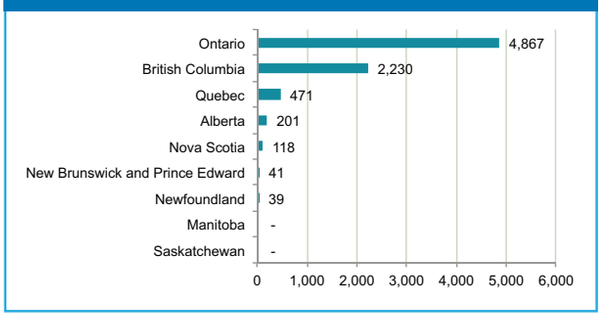
Exhibit #15: Installed Capacity in Small Hydro Projects, Cumulative change, 2012 to 2022, Scenario C, Vision



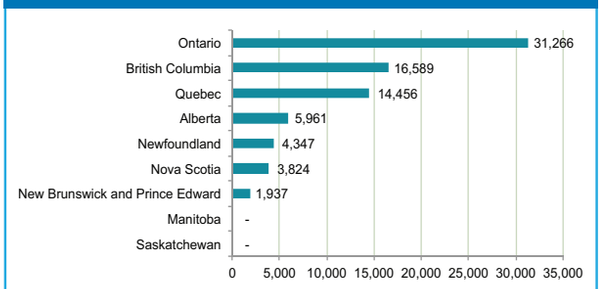
Source: NREL, Prism Economics and Analysis

Exhibit #16: Employment Impacts, Construction and Operations, Incremental Small Hydro Capacity, by Province, MWs – sum of 2012 to 2022, Scenario C

Total Construction Jobs (Full Time Equivalents), Small hydro, by Province, 2012-2022, Scenario C



Total Operation Jobs, Small hydro, by Province, 2012-2022, Scenario C



Source: NREL, Prism Economics and Analysis

21 For example BC Hydro reports of Electricity Purchase Agreements (EPA) with Independent Power Providers (IPP) that account for 51 RE projects in development with over 2,000 MWs of capacity. Of this half are small hydro and up to five report capacity greater than 50 MWs. Some stakeholders were optimistic about this potential for small hydro in B.C. and in Alberta and argued that more capacity could be added in Scenario C. For its part, BC Hydro confirmed the much smaller number that is in Scenario A.

Sector Highlights – Tidal and Wave

There is global interest in tidal and wave technologies that generate electricity. Four sites have been developed around the world and are serving as trials for different technologies. Canada's potential for tidal and wave technologies is concentrated in Atlantic Canada, British Columbia and Nunavut. Activity in Nova Scotia is moving forward with government support and the development of tidal systems in the Bay of Fundy. Cost and technology for in-stream tidal energy are not yet at the commercial stage and estimates of project feasibility are highly variable and depend on many factors.

There is just one tidal installation, in Annapolis, Nova Scotia, with a capacity of 20MW, currently generating electricity. The Canadian Marine Renewable Energy Technology Road Map has set a target for Canadian industry to be involved in the installation and servicing of 2,000 MW of marine renewable energy by 2030. The tidal and wave energy technologies are in the R&D and demonstration stages[22] :

- Several companies are developing competing designs,
- Current and recent demonstration projects are testing the operational capabilities of the turbine designs as well as the environmental impacts (Navigant Consulting, 2007),
- The wave and tidal technologies are yet to be commercialized, and
- Investment and R&D is still required to develop commercial technology and the infrastructure to aid deployment (ARUP, 2011).

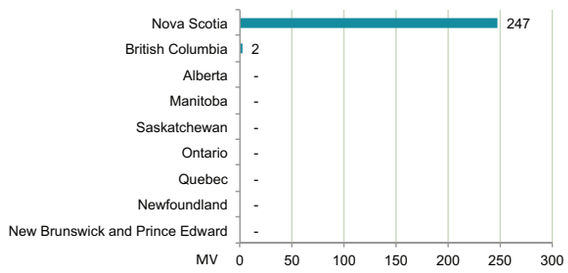
The market adoption cycle for these technologies is revolving around concept, testing, and pre-commercial phases. Tidal barrage systems have been well developed and act much like a conventional dam. Installed costs and LCOE estimates for all wave and tidal systems are highly variable and speculative as they are based more on design and prototypes than on operating systems.

Technologies to harness tidal and wave energy have distinct environmental impacts. In stream tidal and wave technologies are the newer, pre-commercial technologies and these are being assessed worldwide and at FORCE in Nova Scotia. Barrage / dam (tidal range technologies) have been

shown to have negative environmental impacts and are not being promoted in Canada.

The three scenarios focus on alternative paths for the addition of new installed capacity in the Nova Scotia tidal / wave systems to 2022 and a demonstration project in British Columbia. Exhibit # 17 tracks the three cases showing a high of 282 MWs of tidal power in 2022 in the Vision scenario.

Exhibit #17: Installed Capacity in Tidal and Wave Projects, Cumulative change, 2012 to 2022, Nova Scotia and B.C., Three Scenarios



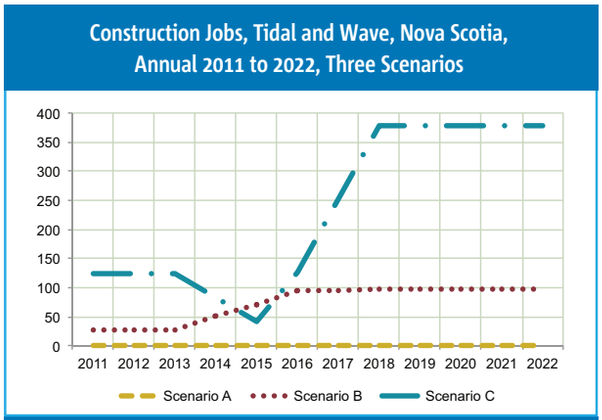
Source: NREL, Prism Economics and Analysis

Canadian companies involved in tidal and water current energy conversion technologies include; Blue Energy International, Clean Current Power Systems, Mavi Innovations, New Energy Corporation, Verdant Power, and Water Wall Turbines (see: Natural Resources Canada, 2010).

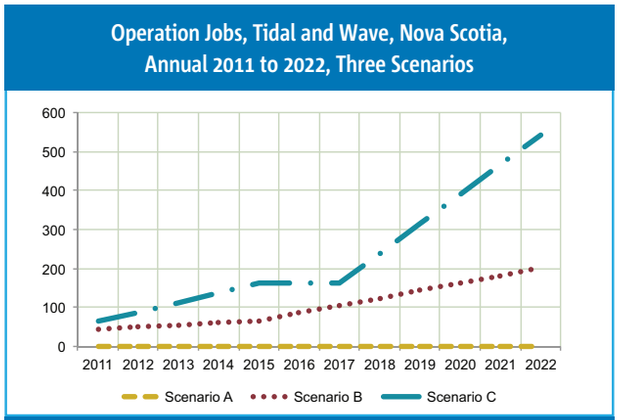
The three scenarios for added capacity would support a small increment to employment and this potential is set out in Exhibit #18 with a peak potential for almost 1,000 jobs.

22 For Technology Descriptions, see Technology Profiles –Tidal and Wave Energy Appendix 6.

Exhibit #18: **Construction Jobs, Tidal and Wave, Nova Scotia, Annual 2011 to 2022, Three Scenarios**



Source: NREL, Prism Economics and Analysis



Source: NREL, Prism Economics and Analysis

Jobs and economic activity will be limited to international and domestic engineering and project management work in the early stages of the supply chain from 2013 to 2022.

Summary – the Six RE Sectors

Thus far in Section 3 we have summarized the findings from the Technology Review for the six principal RE technologies. In general, the research shows that the potential for significant added capacity is expected to use mature and existing technologies under a wide variety of circumstances related to legacies, geography, industries and government policies. Estimates of added capacity in MW and associated employment show that wind systems will generate by far the most jobs, followed by solar.

Exhibit #19 summarizes the overall employment estimates across the three scenarios. The analysis arrives at an average of 14 jobs per MW for construction and installation.

Altogether, the deployment anticipated in Scenario C will add 42,000 MWs of new capacity (excluding large hydro) and this will generate a total of about 620,000 jobs in construction and installation distributed across the years, provinces and sectors. Work in the operations of these new systems accumulates across the scenario reaching 34,000 jobs in 2022.

Exhibit #19: **Incremental Capacity and Employment Impacts – 2012 to 2022, All scenarios**

Scenario	Incremental Installed Capacity, MWs	Total Cumulative Employment – 2012 to 2022 Construction and Installation Person-Years	Peak Employment, operations in 2022 FTE Jobs
Scenario A – Utility Case	13,800	190,000	19,000
Scenario B – NEB Case	15,000	185,000	21,000
Scenario C – Vision Case	42,800	620,000	34,000

Source: EHRC, Prism Economics and Analysis

Sector Highlights – System integration

The Technology Review reveals that the biggest challenge for the deployment of the RE systems is the process of linking all the new capacity to the existing utility grid. These challenges are shared between the various RE employers and the utilities. The process is complicated by several concurrent and often related changes that are impacting the grid and distribution systems at the same time as RE systems seek access. These include:

- A significant backlog of needed repairs and refurbishments to transmission and distribution systems left over from an extended drop in maintenance and improvements during the 1980s and 1990s,

- New technologies that enable electricity conservation and improvements to system performance through the introduction of "Smart Grid" and grid modernization,
- The impact of distributed generation from several remote sites and the need to manage the variable addition of or demands for power from these sources, and
- The intermittent nature of new power added from new technologies – in particular solar and wind.

Much of this work is required even in the absence of the RE investments anticipated in the three Scenarios. The impact of RE systems in adding to the value and volume of this investment can be approximated by considering the number in interconnections that are implied by the MWs of installed capacity projected in each scenario. Consider, for example, that if the average RE facility has an installed capacity of 30 MWs, the Scenarios A, B and C imply a total of 450, 520 and 1,400 interconnections between 2012 and 2022 respectively. This work is added to the incremental work noted above as utilities refurbish the existing systems, modernize the grid and add Smart Grid applications.

These changes require both the installation of existing and new technologies. Existing systems must be expanded to connect new RE facilities to the grid and the (often simultaneously) refurbish of the existing utility systems. These changes represent a large and growing investment and labour requirement. There is also the opportunity to install new technologies at various points in the RE interconnection and the modernization of the current utility systems.

These latter, new technologies could be divided into three categories:

1. Interconnection systems,
2. Storage systems, and
3. Grid improvements / Smart Grid systems.

New technologies are available in these three areas and they are the most important examples of situations where labour skills, training and certifications are changing.

Economic activity that creates and installs the RE systems falls across a supply chain from research and design, through manufacturing to installation and distribution. The full supply

chain is described in the next section. Work and technologies considered here fall at the end of the chain as manufactured and prefabricated components are moved to the RE site, installed, connected to each other and then to the electricity grid. As work proceeds towards the delivery of electricity to final use the technical requirements become more complex – primarily because the voltages increase and the opportunities and challenges to manage efficiency are most prominent.

At the point where RE power joins the grid, the connections often require a new substation or equivalent installation to manage the introduction of the new load. Stakeholders describe a wide range of processes and labour requirements at this stage in the work. In particular, there were references to new, prefabricated substation systems that reduce costs and complexity, and there were references to new grid based switches. It is clear that the largest share of the work and costs associated with the interconnection of RE capacity lies with the developer and the utilities.

The capacity of any existing grid to accept new and intermittent RE power depends on the mix of supply and demand at the start. Further, the challenges of balancing supply and demand in the grid increases as the proportion of supply from intermittent sources, like solar and wind, increases. The quality and reliability of the power delivered from the RE systems becomes increasingly important as their proportion of the total electricity supply rises. Interconnection challenges and related technical costs are the focus of utilities and government procurement with added new requirements to the operating systems installed in the RE facility to improve operating characteristics including – voltage control/ regulation; fault ride-through capabilities; real power control, ramping and curtailment; primary frequency regulation; inertia response; short-circuit duty control.[23]

23 See IEEE Special Edition (vol. 9, #6, Nov/Dec 2011).

These changes impose new labour requirements and skills on electrical engineers, power engineers, power station operators, electrical engineering technicians, construction and industrial electricians, and power line technicians. Indeed the addition of new skills and the redefinition of work at this level are happening now in provincial training and certification and in individual utilities.

The addition of storage systems will occur at various points in the grid connection as various storage technologies reach market maturity and the need for these systems to balance loads increases. Investments in this area are driven by many electrical features beyond the added RE systems – but there is no doubt the improved storage technologies and added capacities will work to the advantage of renewables. Employers currently involved in manufacturing and installing RE systems have a stake in investments in new storage and this interest must be connected to a HR strategy for RE.

The advantage afforded to renewables from improved storage systems creates a common interest between RE employers and the growing electric car industry. As the technology improves and the fleet of electric cars grows, the storage potential for this pool of vehicles increases. This shared interest has drawn stakeholders from the electric industry to the Renewing Futures process and this creates an important partnership that can strengthen and broaden HR initiatives.[24]

There are similar factors driving smart grid technologies and related grid modernizations that include system management and operation. New technologies are being applied to facilitate remote generation and related switching systems and these are another example of critical new systems that enable RE advances. New technologies add to system efficiency and reliability through sophisticated operations centers. These systems provide the best examples, in the Renewing Futures research, of new technologies that are changing the skills, certifications and job descriptions of key occupations including power engineers and power station operators. Changes in these occupations are being handled differently in each province and across utilities.

These new technologies are also distinct from many of the others mentioned in this section because they focus on information and communication technology (ICT) applied in the utilities and across the system management. These ICT systems and their related HR skills will be added both to the skill set of the existing workforce (e.g. power line technicians) and to a new tier of IT specialists. Here again the employers who are directly engaged in RE deployment have an interest in the addition of these new technologies and related training and certification.

It is very difficult to estimate employment in the workforce engaged in interconnection and grid modernization because this group is divided among RE employers, specialized electrical contractors and the utilities. A rule of thumb offered by one stakeholder was that one in four of new electrical engineering technicians, power station operators and related workers hired at utilities would be needed to respond to RE demands with the balance working on the other utility changes. The report returns to labour market conditions and HR management issues for these occupations in Sections 5 and 6.

Supply Chain

A wide range of employers who generally work together through contractual relationships on a project by project basis implements the processes and systems described above. Renewing Futures research seeks to embrace all these employers and recognize the complex linkages that draw them together. This section sorts out these employers and the relationships that bind them through the concept of a supply chain. Seen in this way, the process of installing and then operating a RE facility is accomplished through a series of steps that each adds value through accumulated components and services.

Exhibit #20 divides the Renewing Futures supply chain into seven parts and then describes each in terms of what work is performed and the respective employers engaged at each

24 Stakeholders from the electric car industry joined Renewing Futures focus groups and regional engagement sessions and articulated this shared interest. This group includes both private companies and utilities who have invested in trials that test the potential of electric cars to provide storage. Their interest will extend into the implementation of the HR initiatives.

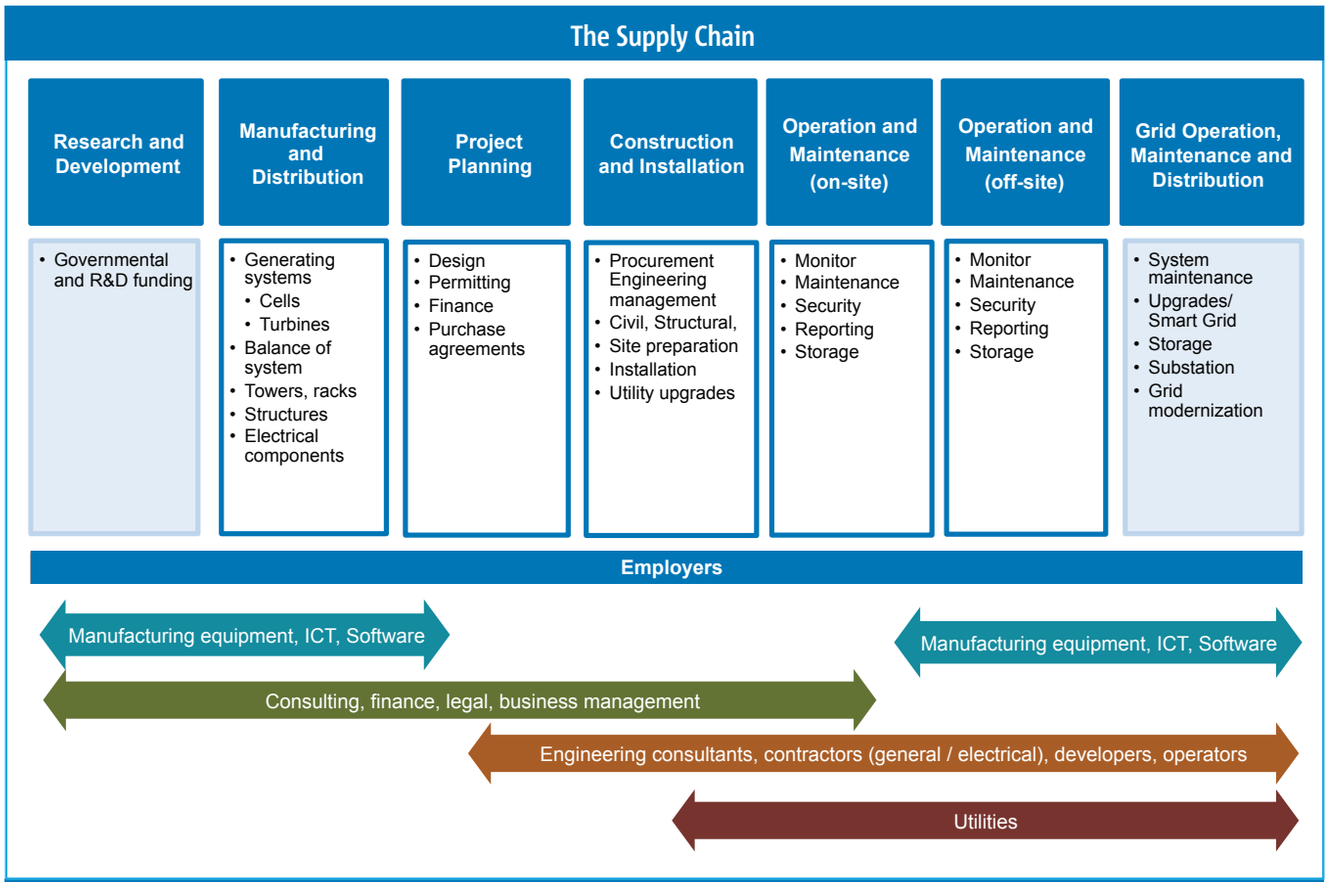
point. There are many variations of this supply chain in the literature on RE and the categories chosen here reflect the organization of the Renewing Futures LMI system and, in particular the structure of the sector models.[25]

The Renewing Futures LMI system measures employment in the five middle links in the chain: manufacturing and distribution, project planning, construction and installation, operations and maintenance (on-site) and operations and maintenance (off-site). The initial work in research and development and the final work in the utilities are recognized as the starting and ending points. While it is not possible to measure expenditures and employment at these points on the supply chain, the discussion in preceding sections clearly signals that this work is an important part of the analysis. Indeed, the success of Canadian investment at these points could be seen as critical to the realization of the deployment plans set out in each Scenario.

The tasks attributed to each point on the supply chain in Exhibit #20 are indicative of the occupations that would be employed at that stage. Analysis returns to this important occupational aspect of the RE system in section 6. Employer groups described at the bottom of Exhibit # 20 correspond to the groups targeted in the employer survey which will be described in Section 5.

Exhibit # 20 is a key description of the dispersed and diverse distribution of the work associated with RE projects. The associated distribution of the RE workforce across many employers and industries is a critical feature that needs to be reflected in HR planning.

Exhibit #20: The Renewing Futures Supply Chain



Source: EHRC and Prism Economics and Analysis

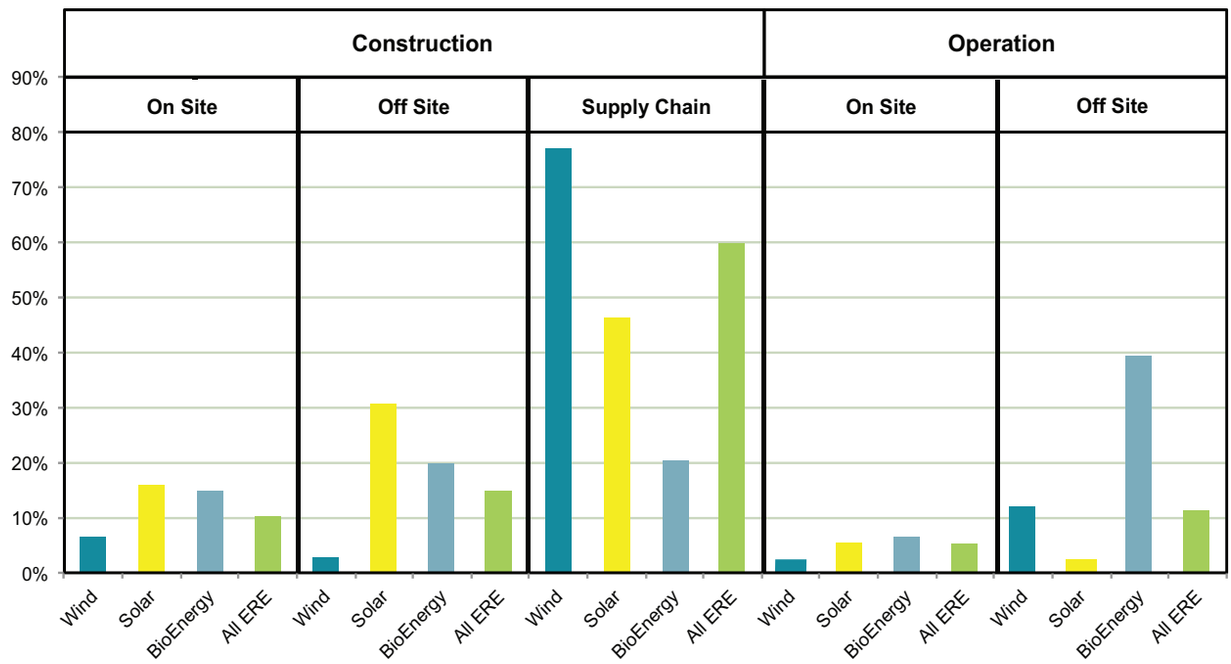
25 The Renewing Futures LMI system uses the JEDI series of models to describe the distribution of expenditures and employment among suppliers. The JEDI models, in turn have been built to recognize the stages of the supply chain noted in Exhibit #19. It is the structure of the JEDI model that really sets the boundaries and defines the five central categories where employment can be measured across the supply chain.

The Renewing Futures LMI model tracks the distribution of the employment set out in each of the six sectors along the supply chain. Exhibit #21 focuses on the workforce estimated for the largest sectors: wind, solar and bioenergy. Employment analysis at this level of detail is not reliable for the other, much smaller, technologies. Estimates in the Exhibit are limited to Scenario C, the Vision Scenario results, as these are the ongoing focus of the analysis of labour market capacity.

Exhibit #21 reveals another critical point about employment in RE systems as it points to very different distribution of jobs across the supply in each sector. Note that construction, installation and operations in RE systems are capital intensive. The most important source of job creation in wind and solar is in the manufacturing and distribution of components. This finding, in turn, highlights the need to measure the percent of spending on components that are procured locally. Findings in Exhibit #21 are based on the assumptions noted earlier that tie local procurement to Ontario targets set in policy intended to build these components of the industry locally.

Another highlight in Exhibit #21 is the distinct pattern of job creation in bioenergy systems where work is created during the operation of the facility through the collection of raw materials.

Exhibit #21: Distribution of Employment Across the Supply Chain, All RE sectors, Scenario C.



Source: EHRC and Prism Economics and Analysis

The Renewing Futures LMI system also estimated employment across regions. Exhibit #22 draws together the findings for Scenario C by province and highlights the starting employment in 2011 and the final employment in 2022. Note that Exhibit #21 is tracking employment in each year in construction and installation as well as operations. The former jobs are transitional and the latter are permanent. Employment gains are concentrated in Ontario and this is a consequence of added wind and solar capacity and the assumed sourcing of components locally.

In the Vision scenario there will be almost 100,000 people working in RE systems in 2022. These people will be employed all across the supply chain and many will be working outside RE projects at various times. In any event these are large numbers and they are concentrated in some critical and sensitive occupations. The report returns to the labour market implications of this work in Section 6 and turns first to the conditions and characteristics that define employers in the next section.

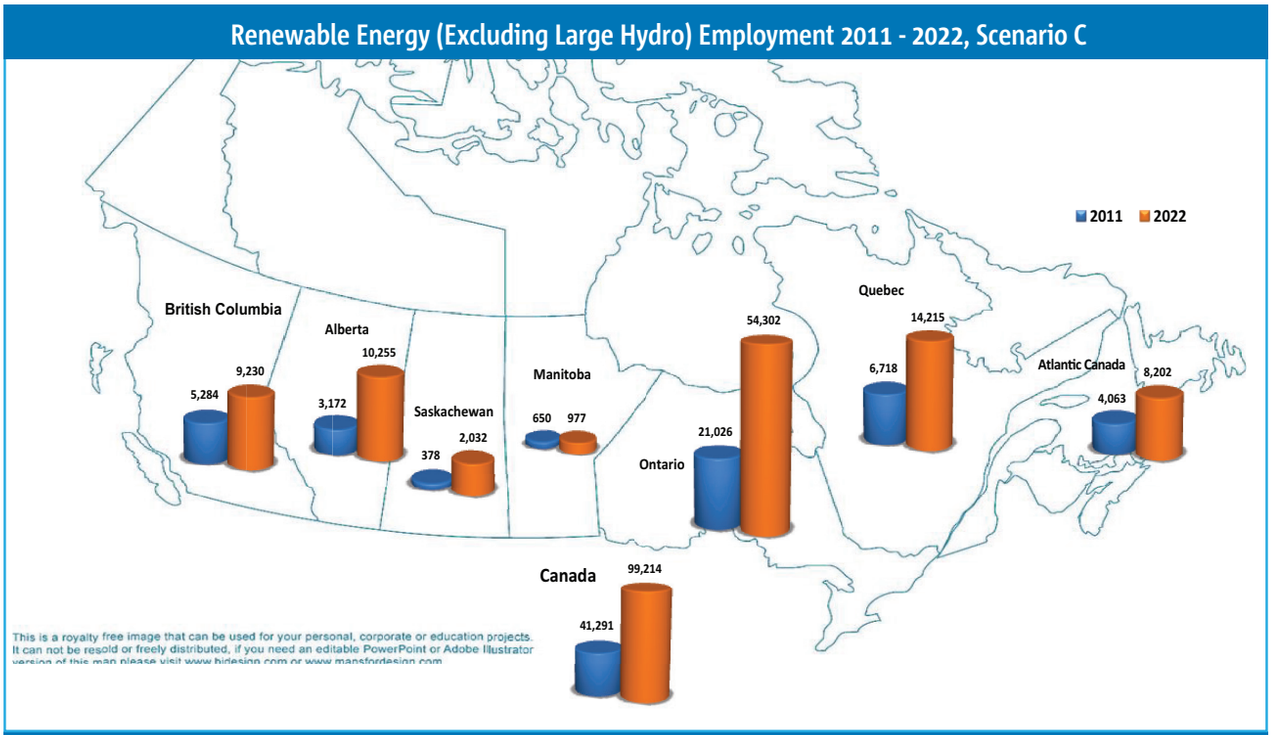
Technology and the Supply Chain – Conclusions

This concludes section 3 on technology and the supply chain. Findings reported here show that work in the six core RE sectors will grow dramatically but will deploy mostly the current, mature technologies and systems. In the Vision scenario the deployment reaches 35,000 MW and this effort will create 619,000 person years of employment across the period from 2011 to 2022 across the full supply chain in all sectors.

There are quite distinct developments at the end of the supply chain as the RE facilities are connected to the electricity grids. Here new technologies are prominent with significant and variable impacts on skills, training and certification.

By 2022 there will be 100,000 people working on RE projects. Employment is widely distributed among employers at varying points on the supply chain and across regions. A large proportion of jobs will be in Ontario.

Exhibit #22: Geographic Distribution of employment in RE Sectors, Cumulative Employment Gains 2011 to 2012, Scenario C



Source: NREL, Prism Economics and Analysis

4. Stakeholders and their Diverse Roles

This section turns from the focus on the technologies and processes to the stakeholders who manage all aspects of RE systems. The report covers four stakeholder groups: government, employers, the workforce and trainers. In each case the objective is to describe the roles they play in human resource development for RE, the labour markets and delivering needed skills to the RE workplace.

Government – Energy and Employment Policies

Governments play a central role in RE systems globally – primarily in their role of creating and implementing energy policy. There is an important secondary role for government in employment and occupational regulations, training and certification. In both cases provincial governments have the main jurisdictional authority in Canada.

Where governments have accepted a goal of reducing environmental damage and GHG emissions from carbon based energy, they have often turned to RE as an option. Policies designed to encourage deployment of RE have been a central feature of the industry's growth. In general, these

policy approaches are implemented through:

- Broadly based initiatives like a carbon tax or carbon offsets / bid and trade systems,
- Setting long term targets for RE system supply as a proportion of overall electrical production and establishing portfolios of suppliers
    - Targets are often specific to RE sectors; seeking, for example, added wind, solar or bioenergy capacity,
- Inviting private providers to submit proposals for the development of sector specific RE systems, and
- Supporting long term supply arrangements through Feed-In-Tariff systems that set prices for independent power providers (IPPs) and customers.

At their core these programs use government resources and regulations to encourage RE deployment. The extent of the incentives and their costs are a political and fiscal decision and as electoral results and economic conditions change so do these policies. Specifically, current weak economic growth and accumulated government deficits are acting to limit incentives that encourage RE deployment. More generally, stakeholders often comment on the central role played by government policy and the investment risk that is related to unexpected or short term changes in these policies and programs. The risk that government will alter tax incentives, change subsidies and alter the terms of procurement are often seen as the most important risks to future RE deployment.

Government policy is ultimately focused on the difference between the higher Levelized Cost of Energy (LCOE) of RE systems and conventional systems. Government priorities and available funding often depend on the extent of carbon content in existing, legacy systems in each Province and the related environmental impact. Thus, for example, both Ontario and Alberta have an incentive to replace existing coal based systems with RE alternatives. In contrast, provinces like British Columbia and Newfoundland and Labrador rely now, almost exclusively, on hydro power and face fewer incentives to promote RE systems. Often, RE systems face a barrier as many Provinces have adopted a low electricity cost policy in the past and these low costs raise the barrier to consumers or add to government costs for RE policies.

The Technology Review includes a summary of current provincial policies with respect to RE. The Vision Scenario has been set, in part to reflect the announced policies and system targets for RE generation and / or GHG emissions controls. This discussion often emphasizes the distinction between the energy policy objectives set by government and the capacity and practical challenges to implementing these objectives in the grid. These latter challenges are often the concern of the provincial and local utilities. The extent of different views on RE deployment is partly revealed by the difference between the projections of installed capacity in Scenario A and C.

Exhibit #23 provides a short summary of the current state of energy and RE policies in each Province.

Exhibit #23: Summary of Provincial Energy Policy

British Columbia	• Directed BC Hydro to create a Standing Offer Program for clean and renewable resources of up to 15 MW, • 2006 and 2008 Clean Power Calls as well as targeted Bioenergy Calls based on competitive bidding processes encouraged incremental clean and renewable development
Alberta	• Support for renewable energy projects through the Climate Change and Emissions Management Fund • Support for biomass-based electricity from Alberta's Bioenergy Programs (Bioenergy Producer Credit Program, Biorefining and Commercialization and Market Development Grant, and Infrastructure Development Grant Program • Support for renewable energy projects through Alberta Innovates – Energy and Environment Solutions • Net billing for micro-generation • Alberta carbon offset program

Saskatchewan	• Target of doubling wind power capacity by 2017 to 9% of total generating capacity • Net metering for small producers • Financial assistance for renewable energy projects • Request for proposals – wind
Manitoba	• 1,000 MW of wind power
Ontario	• 10,700 MW of renewable energy capacity, excluding hydroelectric, by 2018 • Renewable Energy Standard Offer Program • Feed-in tariff program f or smaller projects • Competitive program for larger projects • Net metering for small producers
Quebec	• 4,000 MW of wind power installed capacity by 2015 • Requests for proposals for 800 MW of wind power • Net metering for small producers
New Brunswick	• Legislated renewable portfolio standard of 10% 2016. • Policy commitment to increase RPS to 40% by 2020 • Net metering and embedded generation feed-in tariff programs for micro and small generators • Request for proposals - wind
Nova Scotia	• Legislated renewable portfolio standard of 40% renewable generation by 2020 • Enhanced net metering for distribution connected customers • Community feed-in tariff program for distribution connected projects • Request for proposals for large-scale, transmission connected projects
Prince Edward Island	• Policy target of 30% of renewable energy by 2013 • Net metering for small energy producers • Feed-in tariff for wind
Newfoundland and Labrador	• Through development of hydroelectricity resources at Muskrat Falls, over 98% of electricity for the province will come from renewable sources • Continue to support and study potential for hydro and wind development in isolated areas with the view to developing renewable resources as a means of replacing diesel generation • Support research and development initiatives to reduce greenhouse gases emissions by promoting RE development • Provincial Government committed to utilize revenues from non-renewable energy resources to further support clean energy development
Northwest Territories	• Hydro, biomass and solar energy strategies to promote the use of renewable energy technologies • Renewable Energy Fund to subsidize renewable energy generation

Nunavut	• Implementing Ikummatiit, a territorial energy strategy that focuses on alternative energy sources and efficient use of energy
Yukon	• Through its Energy Strategy, a commitment to increase the supply and use of renewable energy, including a 20% increase in renewable energy supply by 2020.

Source: Natural Resources Canada

The Exhibit #23 summary provides further confirmation of the assumptions and stakeholder views used to build the forecasts in the three scenarios. Indeed, all the targets and plans set out above are consistent with the outcomes included in the Vision Scenario C – with the possible exception of wind power targets in Quebec which are not met until 2016. While economic and political conditions are uncertain, a foundation of support for RE deployment remains part of each Province's plans.

Provincial Employment and Education Policy

Provincial governments are also responsible for the regulation of professions and occupations. These regulations define the range of work and the related training for many of the key occupations in RE systems. This includes the regulation of engineers, engineering technicians and technologists and the skilled trades. These systems of regulations and training are compulsory in some cases (e.g. engineers under some circumstances and trades like electricians) and voluntary in many others. Provincial occupational standards have a major impact on working conditions and are associated with funding for training and certification programs. Overall, employment regulations and occupational standards have a major impact on the available skills in the workforce. The extent to which provincial labour policy accommodates or neglects RE needs will have a critical long term impact of labour market conditions and HR skills adequacies.

Provincial legislation also creates self-regulating professional associations that establish their own rules for membership, qualification and specialization. This includes engineers, engineering technicians and technologists, and the skilled trades in many provinces.

Occupational regulations described are often created to establish skill standards that protect consumers, promote safety, limit accidents, secure higher quality workmanship and support industry quality. These objectives are all directly relevant to managing the elements of disruptive change, described in Section 2.

Given the expected growth and the variability of the mix of RE systems across provinces, it is important for the workforce to be mobile and flexible, moving across projects and sectors with relative ease to meet shifting labour requirements. This mobility can be restricted where Provinces chose different occupational standards. There are a variety of intergovernmental and professional arrangements that are designed to limit this potential problem. For example:

- The Agreement on Internal Trade enables any worker qualified in one Province to have access to employment in any other province or territory,
- Through the initiative of Engineers Canada and the affiliated provincial associations, professional engineers, licensed in one province or territory, can become licensed in another jurisdiction,
- Credentials for Engineering Technicians and Technologists and Red Seal journeypersons are recognized across Canada, and
- Agreements among Provinces – including the LIMA agreement between Alberta and British Columbia – are expanding the range and depth of mutual recognition of occupational qualifications.

While these programs promote the mobility of labour, some impediments remain in place. For example, differences in apprenticeship programs limit the movement of apprentices in some key RE occupations across provinces. Initiatives that target common provincial occupational standards and labour mobility are very important for RE employers. To the extent that they can be expanded or adapted to meet specific occupational needs for RE work they will serve to reduce labour costs in the industry.

No province has yet established distinct renewable electricity occupations – and there are no plans to do so. One standard has been established for journeyperson electricians working with solar installations and is recognized by the Canadian Standard Association and is related to the occupational standards set in the apprenticeship system for electricians.[26] There are, also, private certifications and related training programs that set occupational skill standards for solar system installers and wind technicians. These standards have been set outside Canada and are applied in some programs in Canadian training centers. [27]

Provincial governments have been asked to apply trade regulations to RE installations and have ruled that formal trade certifications are not needed in some cases. These are contentious decisions that have important implications for labour costs and workplace practices related to safety and quality. Section 6 below returns to these issues.

While these regulations can serve to protect safety and work quality standards, they can also present barriers to change. Where RE systems require variations or specializations within an existing occupation, regulatory systems can slow or hinder changes that recognize new conditions. This is particularly true for skilled trades that are part of the apprenticeship system. Once established these trade standards provide valuable, national standards that employers can recognize through the Red Seal program. But change in these systems is delayed by the need to reconcile standards in each province.

26 CSA Standards recognizes a CECA / NETCO / IBEW training standard for journeypersons for solar PV installations. CECA reports that over 1,000 electricians have been trained in the program.

27 Two examples here include the NABCEP certifications offered in the United States and the BZEE certification for wind technicians developed in Europe. In both cases, there are just a few examples of Canadian training programs that teach to these standards.

Government, in its role setting both energy and occupational standards, will play a key future role in the development of a fully qualified, skilled workforce of the RE industry.

Employers

This section introduces the RE employers for the first time; reviewing the general nature of their businesses and workforce. The report returns to employers again in Section 6 when the focus shifts to human resource management and the firm's experience with skills, recruiting, training and other HR specifics. Information used to describe the employers is primarily drawn from the survey prepared by the Renewing Futures team.

The survey was conducted during January and February 2013 and was based on a population of just over 1,800 RE businesses. Senior management and HR staff in 349 businesses responded to a series of questions on labour issues and human resource management. The response rate of over 18% was higher than normal for most surveys of this type, and large enough to assure the statistical reliability of findings for all the major groups covered.

Employers were first asked to describe their businesses in terms of work outside RE activity, in each of the six RE sectors, work across the supply chain and location. Findings are consistent with the Technology Review and prior international research. For example, the Technology Review builds a foundation for analysis on the current and expected change in installed capacity by sector and province. The distribution captured there is heavily skewed to Ontario – based largely on the large and growing wind and solar sectors there. The employers in the survey fit this profile as well.

Similarly, Canadian employers in the survey fit the profile of their international counterparts. For example, the ILO found RE employers in other countries are small and diversified. Commenting on employers in the wind sector the study notes:

> Many of these businesses are likely to have a range of other specialties in addition to wind and renewable energy, which can give them flexibility to respond to changes in demand from clients without having to hire and fire staff. This also means that many people working in these areas only work on wind power part time or intermittently.[28]

28 See "Skills and Occupational Needs in Renewable Energy" ILO Geneva, 2011 page 61

The general characteristic of employers as small firms working across a wide range of sectors and the Renewing Futures sample repeats these activities. Further, these features are associated with business strategies that aim to minimize risks and maximize opportunities by diversifying across a wide range of activity.

Readers are encouraged to review a more complete description of the employer survey in a companion document to address questions about methodology and interpretation of findings.[29]

Turning to the survey results, the size distribution of the sample is very broad with over half of the responding firms employing fewer than 10 employees and just 11% employing more than 50. Exhibit #24 reports the distribution of the sample by employment.

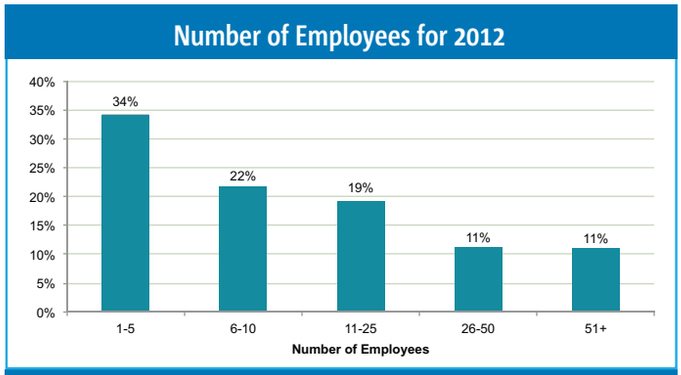
Using firm revenue as a second measure of size reveals a similar result with over half the respondents reporting less than $2 million in revenue.

Survey questions identified the distribution of work in the responding firms across industries, the supply chain and RE sectors, revealing that many employers are diversified across several areas of business. In other words, there are few employers in the sample who are specialized in just one sector and type of work.

So, for example, Exhibit #25 reports the extent to which responding firms work exclusively in any part of the RE industry. 60% of the sample find at least 20% of their work outside RE and almost 25% of the sample find more than half of their work in other industries.

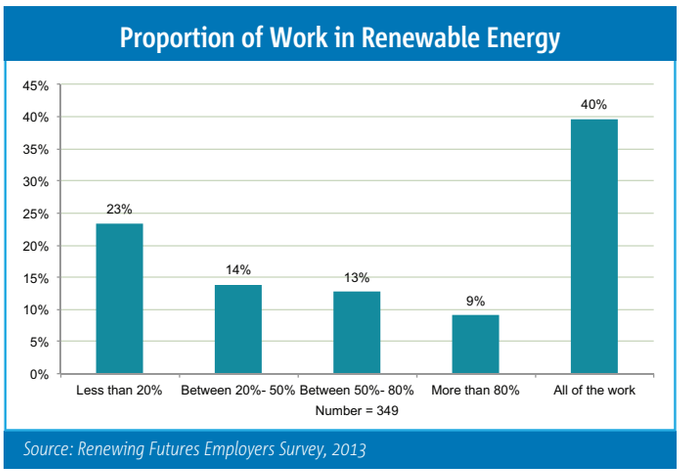
Exhibit #26 moves on to consider the activity of respondents across the supply chain. Again diversity is the main finding with over half of responding firms working in manufacturing, consulting, project planning and development, construction and operations. Another small group in the sample are involved in research and development.

Exhibit #24: **Distribution of RE Firms by Size, Employment**



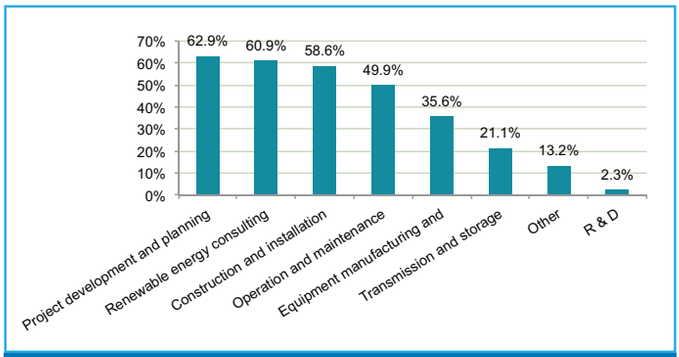
Source: Renewing Futures Employers Survey, 2013

Exhibit #25: **Distribution of Survey Respondents by Industry of work**



Source: Renewing Futures Employers Survey, 2013

Exhibit #26: **Distribution of Employer's Across the Supply Chain in RE**



Source: Renewing Futures Employers Survey, 2013

29 See "Analysis of the Renewing Futures Employer Survey, May 2013"

Finally the survey established the distribution across sectors, finding that only half of the respondents work in only one technology. Exhibit #27 divides the sample into firms working in just one sector versus multiple sectors. The blue columns in Exhibit #27 show the proportion of firms in the sample working in each sector – either uniquely or as one of several sectors. Employers in the sample report activity in every RE sector including the smaller geothermal and marine sectors. In the latter cases, the respondents are involved in research, consulting, design and other areas. Half of the sample firms work in just one sector. The red columns track the activity of the half of the sample working in multiple sectors showing that, for example, 24% of the firms in the sample are specialized in solar work. This corresponds to a group of just 40 of the 349 respondents that work only in solar, and many of these firms are active across the supply chain and in other industries.

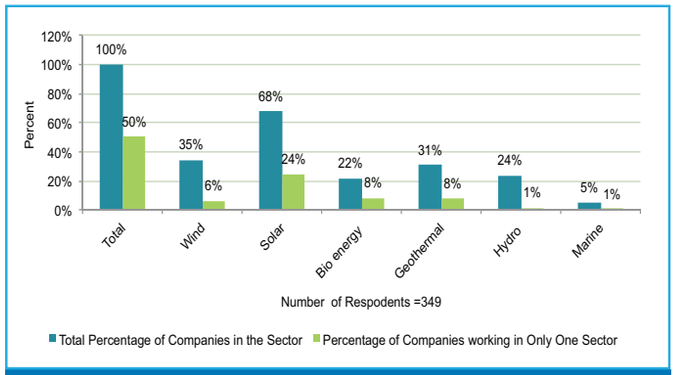
In short, there are very few businesses in the sample that are uniquely specialized in one sector and activity in the RE industry. This apparent preference for diversification signals a corporate strategy targeting a portfolio of businesses that are diversified to manage risk and allow flexibility to seize opportunities.

Next responding firms were asked to describe their workforce in terms of the top five occupations employed and the top five most critical occupations. Exhibit #28 tracks the top occupations identified in terms of overall size.

Exhibit #28 reports that two thirds of responding firms indicated that technical occupations, skilled trades and labourers are the five largest groups of employees. Electricians and electrical engineering technicians and technologists are the two largest groups. The distribution signals the very technical mix of occupations. There is a large number of support staff in accounting, sales, marketing and finance as well.

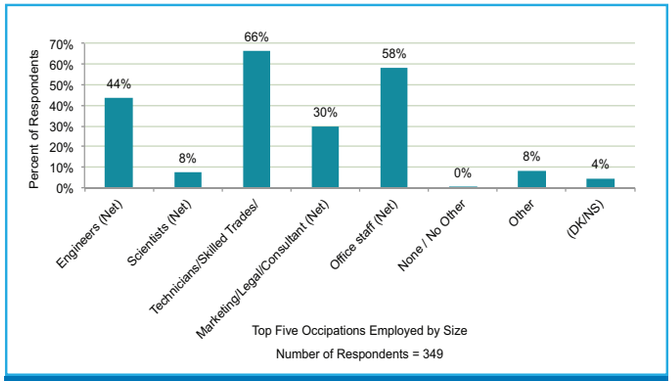
There is an important shift in emphasis when respondents were asked to identify the five most critically important occupations. Engineers, while numerically smaller than office staff, rank higher in terms of overall importance. Exhibit #29 reports the findings.

Exhibit #27: Distribution of Firms across RE Sectors



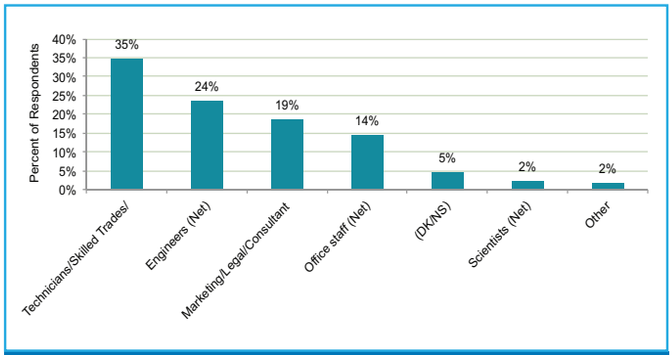
Source: Renewing Futures Employers Survey, 2013

Exhibit #28: Proportion of Responding Firms Reporting Top Five Occupations



Source: Renewing Futures Employers Survey, 2013

Exhibit #29: Proportion of Responding Firms Reporting Top Five "Critically Important" Occupations



Source: Renewing Futures Employers Survey, 2013

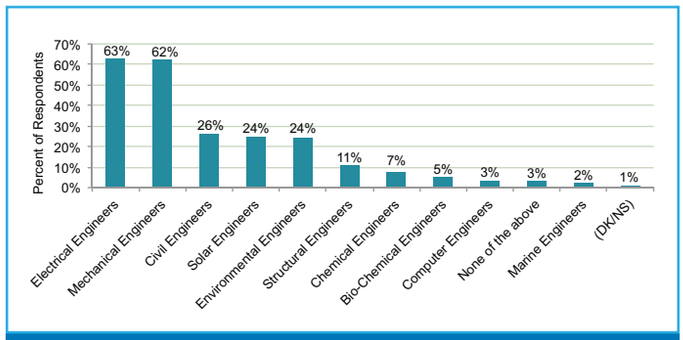
When employers are asked to identify critically important occupations the emphasis placed on technical occupations increases with the focus on the skilled trades and engineers. The report returns to the recruiting and skills needs for these technical occupations in Section 6.

Attention shifts to these critically important occupations and to hiring plans, recruiting issues, training and other HR management features. Practical HR planning focuses on individual occupations and Exhibits #30 and #31 move the analysis to this level, identifying the engineering occupations and construction related trades in the survey.

Findings in Exhibits #30 and #31 confirm the expected roles for electrical engineers, electricians and some other technical occupations. But there is a very high proportion of the workforce in other technical areas like mechanical engineering, plumbers and welders that was not expected. At various stages in the validation of the findings, stakeholders were asked about this and confirmed that these occupations are, in fact, a big part of the workforce. Respondents and stakeholders also confirmed that employers would include several specialized occupations like solar installers and wind technicians in the construction helper and labourer category.

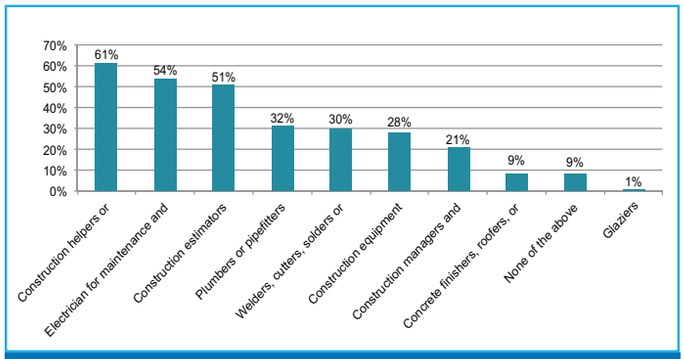
Employers in the sample report employing 19,800 people. This estimate includes all occupations. Nine percent of the employers are unionised. Half of the sample reporting that all staff work on a full time basis and the balance have varying proportions of part time and seasonal work. This workforce does not work only in RE sectors as the employers are diversified in other industries. Assuming that these employment patterns are representative of the full 1800 firms in the population and accounting for part time and work outside RE, these results would be consistent with the Renewing Futures LMI system estimate of 41,000 working in RE related activities at some point on the supply chain. The survey results then provide an independent estimate confirming the Renewing Futures LMI results reported in Exhibit #21.

Exhibit #30: Distribution of Engineers Employed in the Renewing Futures Sample



Source: Renewing Futures Employers Survey, 2013

Exhibit #31: Distribution of Construction and other Skilled Trades Employed in the Renewing Futures Sample



Source: Renewing Futures Employers Survey, 2013

The Workforce and Job Seekers

This section of the report narrows the discussion to a series of key occupations that will be the priority for HR strategies and also broadens the view to include the work done by the key occupations in other industries. These two steps prepare the analysis for the final labour market assessments and consideration of HR management issues for RE employers recruiting and managing this key group of people.

Survey results and the estimates prepared in the Renewing Futures LMI system identify a series of key occupations that are critical to the HR planning of the employers. Exhibit #32 gathers eighteen selected occupations into three broad groups.[30] As attention shifts to these occupations for the balance of the report, these three groups are used to summarize and consolidate important findings. Each of the three groups has a distinctive profile and role in RE deployment.

Leaders and Managers are the smallest and most specialized group. They are the enablers and the innovators who provide far more than individual talent to the deployment of RE systems. This group are the key players who bring investors, financial support, partners and collaborators and decisions on technologies to be used. Stakeholders commented in the focus groups and regional engagement sessions that this group is the most difficult to recruit and the most important for success. Section 2 noted the combination of rapid but cyclical growth, risks and uncertainty that characterize RE deployment. In all the scenarios the scale of RE activity will grow by a factor of 2 to 10 times and this change can only happen with the leadership of this group.

Exhibit #32: Key Occupations in the RE workforce

Occupational Categories	Renewable Energy Core Occupations
Leaders and Managers	1 Engineering managers 2 Utilities managers 3 Information systems analysts and consultants 4 Financial auditors and accountants 5 Sales, marketing and advertising managers 6 Other Leaders and Managers
Engineers and Technologists	7 Electrical and electronics engineers 8 Mechanical engineers 9 Electrical and electronics engineering technologists and technicians 10 Mechanical engineering technologists and technicians 11 Power systems and power station operators 12 Other Engineers and Technologists
Trades and Related	13 Electricians (except industrial and power system) 14 Power system electricians 15 Electrical power line and cable workers 16 Mechanical trades 17 Construction trades helpers and labourers 18 Other Trades and Related

Source: EHRC, Prism Economics and Analysis

Leaders and managers are not new entrants or graduates recruited out of post-secondary programs. They all bring specialized skills and experience from other industries or they are home grown inside the existing RE workforce. Skills in this group are not just managerial or entrepreneurial – but extend to legal / policy, sales, marketing and information technology. The latter IT specialists will be leading RE deployment in their roles in specialized suppliers and in the utilities. They will initiate new systems to monitor, regulate and balance the complex new connections that join many remote RE generating systems to local and remote consumers.

Engineers and engineering technicians and technologists emerge as the core group that join the RE teams together across the supply chain and across sectors. The range of technologies (e.g. hydro and bioenergy) and the scope of activities (e.g. design and interconnection) engage a full range of engineering skills (e.g. from chemical to environmental). Recognition of the specialized labour requirements for RE deployment is really only apparent, to this point, in training programs that target the engineers – in particular the engineering technician and technology

30 Stakeholders mentioned more than eighteen occupations but it was decided to work with this smaller group to keep the discussion concise. Each of the three main groups has an "other" category that contains a further group of occupations that are certainly important and share many of the features that are highlighted in the discussion of the eighteen.

programs in the colleges. Specialized training that originates with this group must spread upwards to the professional engineers and outwards to the trades if the skilled workforce is to grow. The engineering workforce is at the hub of the HR development process.

Skilled trades include a long list of workers with varying degrees of expertise. This workforce embraces a large number of new entrants who are starting as installers and helpers and who require essential skills in manufacturing, construction and installation processes to assure safety and work quality. These new players need to work with the apprentices and journeypersons who have the depth of skills to complete the job at the points where voltages are highest, equipment most complex and errors most costly.

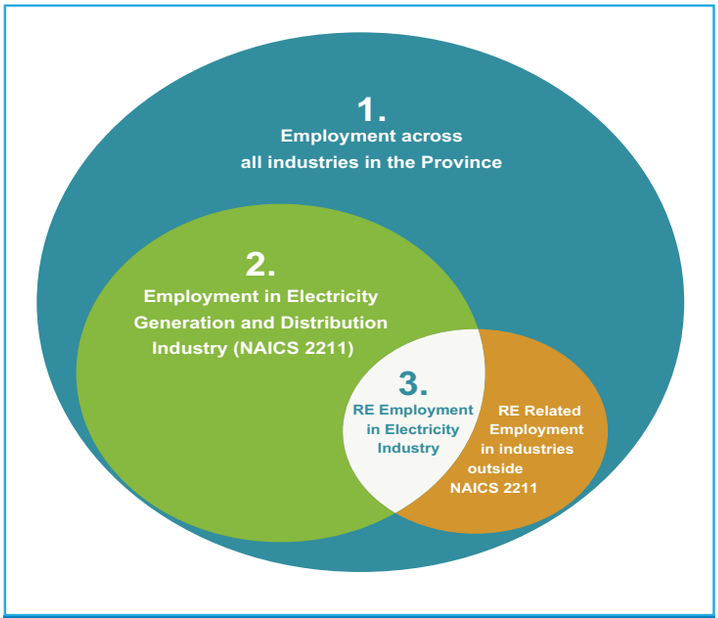
Working from the perspective of these three broad groups, the report now turns to the roles and circumstances that apply to the eighteen occupations set out in Exhibit #32. The first task is identifying the labour markets that determine the core working conditions. Analysis begins at the level of a province wide labour pool for each broadly defined occupation.[31]

The workforce for these occupations is employed across a wide range of employers with work opportunities often spanning the full supply chain set out in Exhibit #32 above. For most of the eighteen occupations only a small sub group would currently be employed in RE systems. The balance of the workforce, work in other industries where key labour market outcomes are determined including wage and other compensation, qualifications and specializations, career paths and recruiting / job search patterns. Where the majority of the workforce is outside RE jobs, key outcomes will be determined by these exterior employment conditions.

In many cases there will be an intermediate pool of labour, in the electrical utility industry, with skills and experience that are particularly suited to RE work. This labour pool, as shown in Section 6 below, is a preferred recruiting ground for RE employers.

Exhibit #33 provides a schematic view of the three labour pools that can be identified for each of the eighteen occupations. The first and biggest pool is the province wide workforce for the occupation. The second is the workforce working in the utility industry and the third – really the target for the Renewing Futures system – is the workforce employed by RE employers. The latter workforce is the most difficult to measure with a portion of the current workforce in the utility industry and the balance in other work spread across the supply chain.

Exhibit #33: Distribution of Key RE Occupations across Labour Markets



Source: EHRC, Prism Economics and Analysis

31 This starting point is, in part, dictated by provincial statistics for standard occupational classifications (usually at the 4 digit level). This is the most reliable foundation as it is likely where the best (perhaps only) statistical measures are available.

The relative size and the extent of the overlap shown in Exhibit #33, of course, varies by occupation. Some occupations (e.g. power engineers and power station operators) may be entirely inside the utility industry while others (e.g. electrical engineers) may be almost entirely working outside both the RE and the utility employers.

The Renewing Futures LMI system described above provides estimates for three labour pools for each occupation. Exhibit #34 summarizes these for the three groups: Managers and Leaders, Engineers and Technology and Skilled Trades. Province wide measures are the most complete and statistically reliable and they are used in most cases to describe the basic labour market outcomes that dominate HR management for RE employers. Examples of key labour market changes – retirement, new entrants and hiring requirements – are included to show the relative importance of the broader labour market. Electrical utility measures are derived through an update of the Power in Motion report that focused on these employers and their workforce. In many cases the labour market outcomes and the utility industry conditions found at this level are a key reference point for RE employers. Finally, the estimate for RE employment in the utility industry is a very rough approximation that is based on the installed capacity in RE systems as a share of the total installed capacity. The logic is that measures of utility employment would include the workforce currently engaged in the operation and maintenance of the existing RE systems. This implies that the RE employment in the overall utility industry would be only a small portion of the overall workforce with the majority of RE employees working outside the electricity utility industry in other parts of the supply chain.

Exhibit #34: Employment in RE Occupations, Province Wide, Electrical Utilities and RE employers

Labour Market Indicators - All Industries		Leaders and Managers	Engineers and Technologists	Trades and Related	Total
Employment	2012	588,356	229,562	713,962	1,531,880
	Change 2006 to 2012	48,451	19,635	76,744	144,830
	Change 2012 to 2022	54,002	18,575	25,462	98,039
Retirement (Average Annual)	2006 to 2012	12,983	5,058	15,233	33,274
	2012 to 2022	17,124	5,800	17,515	40,438
New Entrants (Average Annual)	2006 to 2012	9,707	5,605	16,701	32,012
	2012 to 2022	9,197	5,249	15,845	30,291
Hiring requirements in addition to New Entrants (Average Annual)	2006 to 2012	12,662	3,636	16,778	33,075
	2012 to 2022	12,803	2,176	3,911	18,890
Electrical Utility Industry (NAICS 2211) Employment					
Employment	2012	10,785	18,099	19,872	50,768
	Change 2006 to 2012	1,851	3,334	4,229	9,414
	Change 2012 to 2022	1,582	3,358	3,972	8,911

Renewable Energey in Electrical Utility Industry (NAICS 2211) Employment					
Employment	Scenario A - 2012	632	1509	1317	3,457
	Scenario A - chg. 2012 to 2022	472	1047	1266	2,785
	Scenario B - 2012	634	1863	2082	4,579
	Scenario B - chg. 2012 to 2022	32	461	933	1,426
	Scenario C - 2012	653	1927	2146	4,726
	Scenario C - chg. 2012 to 2022	1073	3005	3044	7,122

Source: POMS, Prism Economics and Analysis

Estimates are presented for initial 2012 levels and broad measures of expected growth are reported for the period from 2006 to 2012 and for the forecast period from 2012 to 2022. There are various reference points that can used to assess the estimates in Exhibit #35. First, it is clear that a large portion of the workforce, in each occupation, works outside of both RE and the utility industry. The eighteen occupations selected here represent almost half, 50,000, of the utility workforce that was estimated at 100,000 in the Power in Motion study. This finding implies a strong connection between the HR issues and labour market outcomes for the utility employers and RE employers. This is not because they serve the same markets but because they employ the same occupations. Finally, the roughly 4,800 RE workforce that is identified in the utility sector would be just over 10% of the roughly 40,000 workforce that is estimated for all RE work across the supply chain in Exhibit #22. These basic labour market estimates for each of the three labour pools are used as the starting point for analysis of detailed occupations in the final sections of the report.

Post-Secondary Training and Certification

Findings so far signal the need to prepare for growth – perhaps rapid growth – in RE employment. Jobs will be added for key technical occupations working in well-defined tasks across the six RE sectors. Rising labour requirements are already widely expected and the more pressing question is where the needed workers will be found. At this point attention shifts to the post-secondary training and certification programs that prepare the needed workforce.

As the Renewing Futures research approach looks to the supply side of the labour market, it moves in to an area that many other studies on RE employment have not covered. As the next section points out – the real imperative for HR management is the risk of skilled labour shortages. This side of the employment picture attracted the attention of the ILO Study cited earlier. Again that research parallels the Renewing Futures approach and points to post-secondary training programs.

> Successful transition to a low carbon economy, therefore, depends among other things, on accessibility of effective training programs... To make the most of investments in renewable energy governments and social partners need to make sure that the workforce is adequately trained... An efficient training system for renewable energy must be integrated within the overall policies to support the growth of the sector, involve social partners in the design and delivery of training and include a good combination of practical and theoretical knowledge.[32]

32 See "Skills and Occupational Needs in Renewable Energy" ILO, Geneva 2011, page v and vi

This section summarises a review of post-secondary training and certification programs prepared as part of the Renewing Futures research. Analysis covered the content of programs in universities, colleges, apprenticeship and private programs. A mapping tracked the links that connect these programs to the key occupations described above. The working level of this analysis included 32 occupations – the eighteen noted in Exhibit #32 and another 14 that are gathered in the "other categories". Programs were first identified in their capacity as preparation for the occupations and then a second search isolated programs with RE content.

The first search identified 340 programs, offered in 114 institutions that prepare candidates for the occupations.

Exhibit #35 extracts the 95 programs that specifically mention renewable energy and/or any of the six technologies.

Exhibit #35: Post-Secondary Programs Offering RE related Specializations

Occupations	Programs – RE Specific
Leaders & Managers	
Technical Sales Specialists	11
Natural and applied science policy researchers, consultants and program officers	4
Engineering and Technology	
Engineers	13
Engineering Technicians & Technologists	39
Trades & Related	
Trade Apprenticeship Programs	n/a
Other Trades	1
Solar PV Installers	14
Wind Turbine Technicians	11
Geothermal/GeoExchange Installers	2

Source: EHRC and Prism Economics and Analysis

Programs noted in the exhibit include both short and long term durations. Private trainers offer short term programs over a few hours or days. Longer term university or college programs include some specialized course time for RE topics in existing certificate, diploma or degree curriculum. University engineering programs and college certificate and diploma programs for engineering technicians and technologists dominate the list. In contrast there are virtually no apprenticeship related training programs (or even courses) that mention RE specializations. Private suppliers and industry associations provide needed training and certification for entry and lower skilled workers through short term programs for solar PV installers and wind turbine technicians.

The 13 university programs include undergraduate level programs in environmental engineering, opportunities with a research and specialized training (e.g. geothermal engineering at the University of Regina) and a Masters of Engineering in Clean Energy at the University of British Columbia. There are also advanced and specialized programs that target interconnections, the grid and conservation with, for example, Hydro Quebec partnering with six Quebec university engineering departments to provide Power Engineering degrees.

Community colleges in most provinces offer the largest and most important group of post-secondary programs. These are mostly certificate and diploma programs related to electrical, mechanical, environmental engineering programs and targeting a full range of renewable energy technologies. The key point is that the colleges, in responding to the labour requirements of the industry, have chosen to provide training that spans all renewable sectors.

There are a few specialized college programs for wind technicians and solar PV installation – but these tend to be shorter, certificate programs. Stakeholders hold quite different opinions about these programs with some concern that they are too short and do not offer needed skills in areas like safety and technical knowledge of electrical systems. Others argue that longer and more complex programs are not needed for entry level workers and, if required, will add to labour costs and deter new entrants.

The only RE specialization that is related to apprenticeship is the IBEW / CSA / CECA training and certification program for solar systems and this is a short program offered to journeyperson electricians who will be qualified to do high voltage and interconnection work. This program is optional and designed for journeyperson electricians (construction) only; it is a step towards promoting a more qualified solar PV workforce. Overall, 1000 electricians from Ontario have taken the training, of which 73 went on to write and pass the CSA exam. Electricians from other provinces also wrote and passed the CSA exam: specifically, 26 from Alberta and 17 from British Columbia.

While the apprenticeship system has not yet responded to RE requirements, stakeholders mentioned the need for specialized skills in electrical, mechanical trades and welding. As noted above, the apprenticeship system has more complex institutional features and requires more time and broader collaboration than other providers to expand or adjust to RE needs.

Certifications and Private Providers

Finally, the Renewing Futures review of post-secondary programs gathered information on certifications offered and private training. Specific programs are offered for solar, wind and geothermal systems. These programs are not widespread in Canada, but they are examples of how to meet the growing need for trained and certified workers.

These programs are all targeting new entrants with very limited work experience or technical education. Programs and qualifications are preparing students for an entry level job with a focus on safety and rudimentary principles that are applied on-the-job.

Solar Photovoltaic Installers

For solar PV installers, training is mainly offered in Ontario and usually consists of five-day workshops that primarily focus on safety, product features and installation while in some cases, marketing, system design and sales training is offered. Over the last few years, enrollments in these workshops have declined, and annual numbers of completions (depending on size of training institution) can range from 10 to 250. Some training providers have attributed shifting government policies on renewable energy to this decline. Interestingly, some training providers noted that on average, half of the students enrolled in their programs are from out-of-province, or from a different country altogether.

The North American Board of Certified Energy Practitioners (NABCEP) entrance exam is an example of a private certification that could be linked to the solar PV programs. NABCEP is a U.S based organization that certifies individuals based on their competence and commitment to upholding standards of practice, ethics, and professionalism.[33] Currently, only 12 individuals are NABCEP (Solar PV) certified in Ontario.[34] Canadian training providers have voiced their concerns over the lack of unified standards in solar PV installation in Canada, citing that the quality of work is being jeopardized. Indeed, the U.S is grappling with a similar problem.[35]

33 NABCEP 'About Us' http://www.nabcep.org/about-us

34 http://www.nabcep.org/installer-locator-agreement

35 National Renewable Energy Laboratory. Solar Installation Labor Market Analysis. Pg.29, 30.

Geothermal & GeoExchange Installers

Training for geothermal and geoexchange installation appears to be very limited, with several institutions (e.g., St. Lawrence College and the Northern Alberta Institute for Technology) winding down their programs due to low enrollment. This is not to say that the learning of geothermal and geoexchange is lost; several universities and colleges touch on these forms of energy, however, it is accomplished at a broader level, and within more general environment-focused programs.

The Canadian GeoExchange Commission, a national organization focused on growing the industry,[36] offers accreditation and certification to ensure quality geoexchange installations across the country. According to their website, a total of 515 individuals have been certified, of which 43% or 221, are from Ontario, 21% or 110 , are from Québec, and 11% or 58, are from British Columbia. The rest of the provinces have a distribution of less than 10% each.

Wind Turbine Technician

Colleges located in British Columbia, Alberta, Saskatchewan, Ontario, Québec, and Prince Edward Island offer certificate or diploma-based programs for wind turbine technicians. Depending on the size of the institution, program completion numbers can range from 12 to 100 per year.[37] One training provider commented that based on an internal survey done by his institution, about 250 wind turbine technicians are employed in Ontario. There is growing interest in an international certification for wind technicians. The BZEE designation is now being offered as part of two Canadian wind technician programs. BZEE is a German center for training in renewable energy that sets standards for training programs and certifications for the wind industry.

The review of training and certification programs reveals that there is a strong base to build on. At a minimum the expansion of these existing programs will add to the breadth and depth of the needed workforce. There appear to be several gaps in the current offering – especially given projected labour requirements and stakeholder comments. These gaps would include programs that target industry leaders and

developers, apprenticeship programs that target the skilled trades and certifications that provide a broadly based assessment of entry level skills. The impact of these programs is revisited for each of the key occupations in Section 6.

Section 4 – Conclusion

Provincial government energy policy and occupational and training standards are critically important determinants for RE deployment patterns. Strong growth will be facilitated where these policies promote growth and recognize the skills and qualifications of the needed workforce. On the other hand, budget cuts or policy limitations could severely restrict the deployment of RE systems.

Many small employers have well-diversified interests in RE activity that spans sectors and activity across the supply chain. Employers at every point across the system share an interest in a set of sixteen occupations that are critical to their growth.

The Renewing Futures LMI system focuses on sixteen key occupations in three broad groups; leaders and managers, engineers and technology and skilled trades. Some 41,000 workers in these and other occupations are estimated to work in RE jobs spread across the supply chain. Since most of the workforce in each occupation work outside RE, labour market outcomes in the wider markets are a key factor for HR managers.

36 http://www.geo-exchange.ca/en/cgc_visions_strategies_p4.php

37 Based on incomplete information; difficulty in obtaining graduation numbers from each institution. Completion numbers obtained from three institutions: Great Plains College, Holland College and St. Lawrence College.

A review of post-secondary training and certification identified 95 specific programs across Canada. These programs include all three occupational groups but the largest number of programs is offered by community colleges to engineering technicians and technologists. These programs form the initial core of a training system. There are no apprenticeship programs that target RE. Many private, short term training and certification programs are offered for solar and wind, but growth is uneven and certification standards are not widely applied.

There is a risk that diversity will frustrate a national HR strategy if:

- provincial policies create uncertainty and fragment workforce qualifications,
- diversified employers are focused on risks to investing in the long term RE workforce and contracting out,
- the workforce needs flexibility and options to seek work outside RE and,
- trainers develop largely short term programs to meet immediate opportunities.

5. Labour Markets

Stakeholders described in the previous section are the decision makers that determine labour market outcomes. This section turns to market measures that summarize their actions and guide human resources planning for the key RE occupations. Analysis here compares supply (i.e. the available workforce), and demand (i.e. labour requirements) and assesses the likelihood that there will be shortages. Further, the discussion refines the idea of labour and skill shortages in a way that focuses the industry on practical plans to meet complex requirements.

There is no doubt that rising employment and new jobs are an important national benefit of RE deployment. This analysis, however, qualifies the positive economic benefits by considering the extent to which employers already employ most of the available workers and plan to add to their workforce. New RE requirements may compete for needed workers. Anticipating the extent of labour shortages and putting remedies in place will assure that RE activity does not prompt more severe shortages or raise labour costs.

Skill shortages, especially in the key RE occupations, have been highlighted by employers, noted in the media and are the focus of government policy. Shortages in the industry were apparent in a 2009 study by the Electricity Human Resources Canada and CanSIA.

> *Currently, 41% of companies are experiencing labour shortages. The most frequently mentioned areas of skills shortages were installation (of those companies experiencing shortages, 75% had a shortage in this function); technical areas (39%); systems design and integration (39%); sales (39%); project management (25%); and, engineering (25%).*[38]

And Canada is not alone in these circumstances. As far back is 2007, the EWEA was commenting on shortages for the wind industry in Europe.

> *In the last two to three years, wind energy companies have repeatedly reported an acute shortage of workers within certain fields. The general pressure on human resources, resulting from strong economic growth, is reinforced by the extraordinary performance of the sector itself since the end of the 1990s. From 2000 to 2007, wind energy installations in the EU increased by 339%. This has led to a multiplication of job offers in all the sub-sectors, especially in manufacturing and development activities.*[39]

The ILO Study cited above draws the same conclusions about the potential for rapid RE deployment to set up the risk for labour shortage. The study notes:

> *The shortage of green-collar professionals with cutting-edge skills in energy efficiency, green engineering and green construction has already been identified in a number of countries as a major obstacle in implementing national strategies to cut greenhouse gas emissions or address environmental changes.*[40]

The last section set out the scope of analysis covering labour markets for18 occupations in province-wide markets and for sub markets in the conventional and RE portions of the electrical utility employment. As these requirements change, in particular as the RE component of demand rises, attention shifts to where the needed workers will be found.

This section will describe the current and expected labour market conditions that will confront HR managers as they recruit needed workers across the scenarios from 2012 to 2022.

Requirements

RE labour requirements for the 18 key occupations are expected to rise rapidly with the potential for cyclical variability as economic conditions change and projects start and stop. It is also likely that the ebb and flow of activity will shift jobs across provinces and among RE systems. Growth and variability will drive recruiters and job seekers into and out of the labour markets at irregular intervals and this, by itself, will create periodic shortages.

This growth and variability in employment alter RE prospects in job markets that are largely dominated by other employers. Given the importance of the workforce outside RE, the starting point in the analysis of markets is the broader labour requirements across all industries.

For example, a reality in Canadian labour markets is more rapid growth in the western Provinces. This is especially true for engineers, engineering technicians and technologists and the skilled trades. This trend is expected to continue – at a diminished rate – across the 2012 to 2022 scenario horizon.

The Renewing Futures LMI system captures this dynamic through the general forecast for key occupations in each province. This level of market activity is measured in the POMS model and includes tracking several key market measures.[41] On the demand side POMS distinguishes expansion demand (requirements related to job creation in response to changing industrial conditions), and replacement demand (requirements driven by long term demographic trends including retirement).

Exhibit #36 gathers POMS measures for the percent change in employment in each of the three major groups, from 2012 to 2022, by Region. Growth, for virtually all the occupations, is strongest in British Columbia, Alberta and Saskatchewan. In Atlantic Canada, especially in Newfoundland and Labrador, there is an investment cycle that drives employment up at the start of the period and then, as the projects end, employment declines by 2022. In fact, the trend to stronger growth in the west was more pronounced over the last ten years.

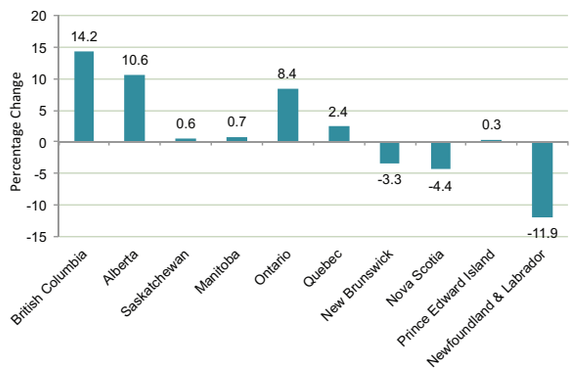
38 See "The 2009 Labour Force Survey of Canadian Solar Industry" Electricity Sector Council page 3

39 See "Wind at Work, Wind Energy and Job Creation in the EU", European Wind Energy Association, 2008 page 10

40 See "Skills and Occupational Needs in Renewable Energy" International Labour Office, Geneva, 2011, page vi

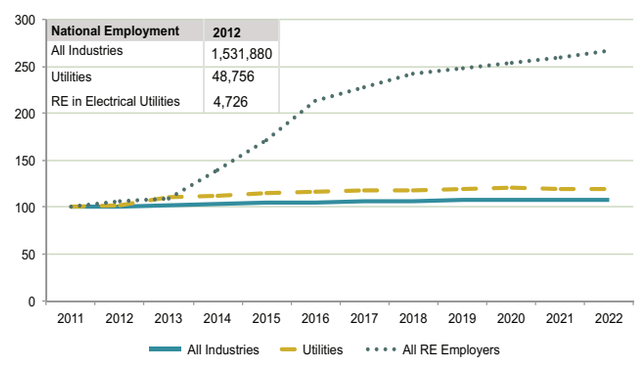
41 The Provincial Occupational Modeling Systems was created by Stokes Economic Consulting and is used as a starting point for both the Renewing Futures LMI system and the Power in Motion analysis done by EHRC in 2010. A detailed description of the Renewing Futures LMI system is available in "Renewing Futures, Labour Market Information System"

Exhibit #36: **Employment Growth 2012-2022 RE Key Occupations - By Province - All Industries**



Source: POMS and Prism Economics and Analysis

Exhibit #37: **Employment Growth, Key Occupation Groups, National totals – Electricity Utilities and RE jobs**



Source: POMS and Prism Economics and Analysis

These trends suggest that labour shortages are more likely in the Western Provinces.

A second dimension of changing labour demand is shifting requirements across industries. The dominant feature for labour markets, from the RE perspective, is the rapid growth in RE employment compared to other industries. Exhibit #37 draws from the Renewing Futures LMI system to track the annual growth in national employment from 2012 to 2022 in the three major groups. The POMS forecast for most of the occupations is for only modest increases in employment. There are, of course, regional and industrial variations on this pattern, but the expectation is that annual growth rates will remain close to just 1% in most years. In contrast, the projected growth in the electricity utility industry is higher – but rarely rises above 2%. Finally the gains in RE jobs are much greater. But, as the insert in the graphics shows, the number of workers involved in the RE growth is very small compared to the national labour force.

Exhibit #37 suggests that RE employers could, perhaps, recruit from other industries. Growth will be limited and RE employers would need only a small fraction of the workforce. But this strategy assumes that specialized skills and experience for each occupation, needed by RE employers, are available in the other industries and that there are available (perhaps unemployed) workers.

In fact the limited growth in Exhibit #37 for national employment captures only expansion demand. By far, the largest driver of labour requirements is demographic conditions and retirements. Turning again to the POMS data, Exhibit #38 tracks the growing proportion of the labour force that will be retiring in each of the three key groups from 2012 to 2022.

Exhibit #38: **Replacement Demand for Key RE Occupations, as a % of the labour force**

Replacement Demand		2012	2022
Leaders and Managers	Replacement Demand	14,849	18,446
	% of Labour Force	2.4	2.8
Engineers and Technologists	Replacement Demand	5,499	5,950
	% of Labour Force	2.2	2.3
Trades and Related	**Replacement Demand**	16,517	18,101
	% of Labour Force	2.0	2.2

Source: POMS and Prism Economics and Analysis

Retirement is the dominant theme. Of course, demands related to retirement are highest for leaders and managers. Employers in all industries, even with only limited expansion demands, will be hard pressed to plan for and replace retirements.

Labour and Skill Shortages – Structural Causes

The profile of labour demand presented above helps to clarify the nature of emerging labour shortages. A critical driver is retirements. To complete the picture, the Renewing Futures LMI model turns to the supply side and considers additions to the workforce. A domestic option is to draw the younger population into the necessary post-secondary programs and build the needed replacements over time. While investments are being made and programs expanded, there are two reasons why the domestic option may not be able to meet all the requirements. First, the aging of the population leaves fewer than 2.0% of the population available to join the workforce and these additions are less than the combined expansion and replacement demands. There is, thus, a long term structural trend to lower unemployment and general labour shortages. Second, programs to attract youth into RE occupations will be limited by strong competition from other employer groups and government spending cuts.

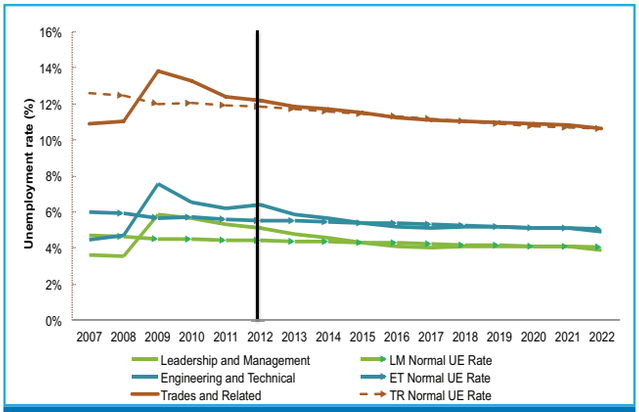
Exhibit #39 turns again to the POMS measures and tracks national unemployment from 2007 to 2022 in the three key RE occupational groups. All the unemployment measures trend down as expansion and replacement demands steadily exceed the available workforce. Unemployment rates are lowest for leaders and managers where job tenure is very high and higher in the trades where work is more cyclical. But the structural trends imposed by demographics dominate in all cases and steadily reduce the pool of unemployed.

Annual unemployment rates in Exhibit #39 track the cyclical rise in unemployment in 2009 and project a steady decline as unemployment falls. The normal rate of unemployment, also shown on Exhibit #39, tracks the long term average values excluding cycles and allowing for the long term demographic effect. Note that unemployment was far below normal levels in 2007 and labour markets were very tight. Conditions trend back towards those conditions in each year from 2012 to 2022.

Tight labour market conditions force recruiters to reach beyond local markets and draw from a more mobile workforce in other industries and regions. This strategy is examined in more detail below – but the national conditions described here imply that poaching from other employers is not a viable national strategy – there are not enough workers in Canada to meet demands. After measuring expansion and replacement demand and then allowing for new entrants from Canada's younger population the POMS system calculates a residual "net in mobility". At the national level, net in mobility represents the recruiting that must look outside Canada – immigration.

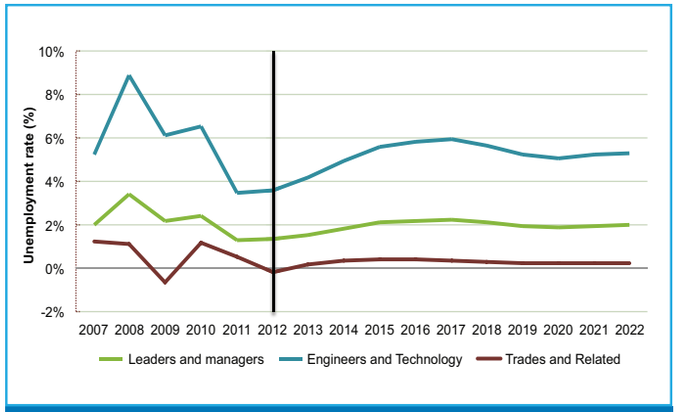
Exhibit #40 tracks net in mobility as a percentage of the workforce, at the national level each year from 2007 to 2022. Requirements are above zero – demanding immigration in almost every year to meet demands. A higher proportion of the workforce recruited off shore, signals tighter domestic labour markets. Even during the recession in 2009, recruiters for some key occupations turned to immigration. So, for example, a summary measure of pending labour shortages is the high and rising proportion of the engineering workforce that must be recruited from outside Canada.

Exhibit #39: Unemployment Rates - Canada, Key RE Occupations, Main Groups, 2007 to 2022



Source: POMS, January 2013 Provincial Forecast

Exhibit #40: Net in-Mobility as a % of the Workforce, Canada, Key RE Occupations, Major Groups, 2007 to 2022



Source: POMS, January 2013 Provincial Forecast

Labour shortages emerge, then, as a chronic and long term risk even at the broadest levels. As the analysis turns to each occupation, specific industries, specialized skills and training programs, the magnitude of the challenge grows clearer.

Labour and Skills Shortages – Industry Analysis

Ongoing reports from employers and supporting market evidence of shortages has prompted the creation of LMI systems for many Canadian industries and occupations. These systems probe the details of labour markets and point to the specific challenges and strategies for HR managers. A short review of their findings adds clarity and depth to the challenges facing RE management.

The following four research reports describe the labour market perspectives for competing employers.

Power in Motion

The *Power in Motion*, 2011 Labour Market Information Study, reviewed labour requirements in the electricity industry, from 2011 to 2016, with a focus on 19 key occupations. The conventional industry includes the large and established electricity utilities and many smaller start-up companies. Altogether the industry employed 108,000 in 2011. Large hydro employers, arguably part of the RE group, represents 50% of this capacity.

The report describes the transition from the current Legacy to a Next Generation system of electrical power production. Large and growing investments are anticipated – based more in the need to refurbish the old legacy system and less on expanding capacity. Projected investments will: add large hydro generation systems, replace coal and refurbish and expand nuclear systems, expand and upgrade transmission and distribution systems to accommodate distributed generation and Smart Grid improvements.

The transition to the next generation included a provision for adding 12,000 MW of renewables capacity (excluding large hydro) from 2011 to 2016. Plans included major new large hydro projects, but the majority of construction was expected to be completed after 2016. This pattern of RE deployment for large hydro is consistent with the early years of projections in Scenario A and B in the current analysis, where between 2,000 and 5,000 MWs are added to large hydro.

Overall the analysis in Power in Motion covers the majority of the workforce in large hydro and a portion of the workers with RE employers, in the electricity industry.

Power in Motion findings highlighted the dominant impact of demographics and retirements – representing 77% of labour requirements - across the conventional electricity system. Expansion demand – largely driven by investments in refurbishment and some addition to large hydro – generates just 23% of labour needs. Overall, the report finds that labour requirements are "unprecedented" and concludes:

> Between 2011 and 2016, electricity industry employers will need to recruit over 45,000 new workers – over 40% of the current workforce. These are required to (a) replace retiring workers, (b) refurbish existing generation, transmission and distribution systems, and (c) build and operate the Next Generation of infrastructure including renewable energy. Of these new employees, 23,000 will be in the 19 critical electrical occupations covered in this report. To fill these vacancies, every employer is looking for candidates with special technical qualifications as well as sector experience and business knowledge.[42]

The LMI system developed for the Power in Motion report included a system of rankings for the 19 key occupations. A ranking is assigned to characterize conditions in each market and in each year from 2010 to 2016 for each occupation. At the national level **every annual rank** described market measures as signalling "*the need for employers across Canada to recruit in other industries.*" More than half of the time the findings report "*Where conditions there are also tight, the result will be a general increase in immigration – the only remaining source. Immigration became an important source for some electrical occupations in 2000-2008 when high rankings were common. Demographic conditions make it likely that immigration will again be a key strategy in tight labour markets.*"[43]

These rankings were driven in large measure by retirements and replacement demands as expansion demand was limited in the *Power in Motion* scenarios. This LMI model has been expanded and updated for this Renewing Futures report and conditions in the conventional industry are updated for some occupations in Section 6.

42 See "Power in Motion", Electricity Sector Council, 2011 page 37

43 Ibid.

A clear conclusion emerges here. Labour market shortages anticipated in *Power in Motion* in 2011 and covering key Renewing Futures occupations, were related to factors that persist across the current Renewing Futures scenarios. Retirements that impact the conventional electrical industry will have key impacts for RE employers. Indeed, the RE scenarios – especially Scenario C – add a large increment to expansion demand as well as requiring additional investment in interconnection and grid improvements at the utilities. Starting conditions in the conventional electricity industry include expected labour shortages.

Note that the shortages described in *Power in Motion* are mostly related to retirements. This leaves a particular type of gap as the retiring workforce has a specific depth of experience and specialized skills in the legacy systems.

Construction Looking Forward

Construction has been among the most rapidly growing Canadian industries for at least a decade and reports of labour shortages have been repeated almost annually. Each year BuildForce (formerly the Construction Sector Council) updates the Construction Looking Forward reports that track labour markets for thirty trades and occupations. There is a significant overlap with key Renewing Futures occupations and investments in major electric utilities and RE projects are a prominent source of construction activity.

The 2013 Construction Looking Forward report repeats many themes from the past including highlights for expected labour shortages. Forecast employment gains from 2013 to 2021, in the 2013 report, have decreased modestly from earlier projections as economic growth has moderated and faltered. The major trend is towards limited growth in residential employment and stronger gains in non-residential activity. To put construction industry prospects in context, the BuildForce projections adds 100,000 jobs in expansion demands from 2013 – 2021 with most of these jobs in non-residential construction. Replacement demand, related to retirements, is stronger with an addition of 219,000 workers needed between 2013 and 2020. Market rankings prepared in Construction Looking Forward are prepared in the same manner as in the Power in Motion report. Construction rankings in 2013 are moderately lower than in earlier years in most markets. Rankings are higher and markets are more likely to be tight in non-residential construction in the West. There is a shift in the forecast in non-residential construction

from institutional projects (e.g. hospitals and universities) to infrastructure (e.g. pipelines, transit and utility work). This shift captures added levels of investment in renewable energy work as well as continuing expectations for major electrical generation and transmission work. Industrial, resource and engineering construction remains a growing source of employment after ten to twenty years of growth.

Employment gains across industrial and engineering work engage many of the same trades as the RE work. Project timing is often critical in determining supply/demand balances. Some delays were reported in utility projects in the 2013 report, and work has been shifted to later in the scenario. Labour requirement for electricity projects are included in the BuildForce system and these projects include large hydro dams (e.g. Peace River Site C, Keeytask, Conawapa, Romaine, Gull Island, Lower/Upper Mattagami), transmission lines (e.g. Bipole III and projects in every province), nuclear plants (e.g. Darlington refurbishment) and wind and solar renewable projects.

Large hydro and transmission projects are often linked to resource development including mining and LNG plants in BC, oil and gas in Alberta, and mining in northern Quebec and Newfoundland and Labrador. Growing investments in resource projects in remote areas and related infrastructure have created a unique labour market and a specialized workforce that are employed in these "Centers of Resource Construction". This work includes large hydro and transmission projects and key occupations employed there include most of the engineering, engineering technologists and trades occupations included in the Renewing Futures analysis. There is also a significant expansion demand for these occupations in electricity related construction for utility systems in general and for solar and wind projects.

In short, the construction is both a competing and complementary employer. The workforce tracked in Construction Looking Forward includes industrial and engineering contractors specialized in electrical work for large hydro, transmission lines, distribution systems and RE installations. Indeed the boundary between the construction, the utilities and the RE employers is blurred by a wide variety of contracting out practices. It is not always clear whether employers are in construction, utilities or RE businesses. Supply / demand balances for a long list of key occupations (e.g. construction managers, supervisors, estimators, construction electricians, plumbers, crane operators, heavy equipment operators) are driven by the combined demands of all these employers. From the perspective of Construction Looking Forward, it is likely that major projects will create regular labour market shortages as they start and then release large numbers of skilled workers as they end.

Under these circumstances the critical human resources challenge is to maximize the mobility of the trades across provinces and among construction, utility and RE employers. This objective needs to be balanced against the coincident need to add specializations and experience to the mix. In both cases there is a significant overlap for the occupations and the employers working in construction and in electrical utilities and RE employers.

The Engineering Labour Market in Canada; Projections to 2010

Engineers Canada began a detailed study of labour markets in the early 2000s with the initial intent of better defining opportunities for immigrants with engineering credentials. The 2012 report "The Engineering Labour Market in Canada; Projections for 2020" is the third update of a forecasting system that tracks requirements, the available workforce and assesses supply demand balances.

The 2012 report begins with a projection of limited expansion demand for engineers based on restricted economic growth – especially in central and eastern Canada. Employment growth across the 2012 to 2020 period will reach just 16,000 jobs and all of these are in the west. Demographic trends are particularly important for engineers and retirement patterns will generate at least 95,000 hiring requirements over the forecast period.

There are distinct circumstances on the supply side. Immigration rose dramatically in the early to mid-2000s; bringing many new Canadians seeking work as engineers and bringing engineering credentials. Their arrival coincided with weaker markets and, in many cases, their qualifications did not meet local employer needs. Immigration has since declined, but remains a significant component of the available workforce. At the same time enrolments and graduations from Canadian university Engineering Faculties have been growing.

In the Engineers Canada forecast there are 80,000 new immigrants and Temporary Foreign Workers arriving to meet demand as well as over 100,000 graduates from universities entering the workforce.

Overall labour market assessments in these cases show generally balanced markets – with some oversupply in the East and tighter markets in the West. While overall labour shortages are not apparent, there are many examples of specific shortages in regions (e.g. B.C. and Alberta markets are consistently tight) and disciplines like mining, geological, petroleum and industrial/manufacturing.

These supply /demand circumstances create a chronic imbalance as there is an abundance of new graduates seeking entry level jobs and a shortage of specialized and experienced engineers with five to ten or more years of experience. These conditions are aggravated by the continuing rise in university enrolments and in retiring engineers. The former requires a rising number of jobs that offer training, mentoring and opportunities for growth. In some cases employers are reluctant to meet this need. The latter adds to the shortage of specialized skills and encourages access to Temporary Foreign Workers who arrive as employees and they have been pre-qualified.

Engineering labour markets then present RE employers with a variety of circumstances. Recruiting specialized and experienced engineers to lead project teams or manage new businesses will be a very large challenge as employers compete with consulting firms and utilities with strong employment advantages. Alternatively, RE work opportunities can be adapted to appeal to a large number of young engineers.

Oil and Gas

Oil and gas employment has been another big source of growth across the past decade or more. The Petroleum Human Resources Council, in the "Canada's Oil and Gas Outlook to 2022" report extends this growth across the coming decade. Much of the employment is concentrated in the West and in the continuing development of the oil sands. Prospects for conventional oil and gas production have also strengthened with new technologies adding to production from old reserves. There is a note of caution in the outlook related to transportation bottlenecks that could limit production, investment and employment growth.

From an initial base of 195,200 jobs in 2012, the Expected Growth case projects direct employment growth is 14,800 from, 2013 to 2022, with a steady improvement in transportation capacity. In the Low Growth case the gains are just 250 jobs. Oil and Gas employers also need to manage replacement demands of up to 70,000 in the Expected Growth case and 62,000 in the Low Growth case. These labour requirements are concentrated across some technical occupations that are key to RE employers. These occupations include electrical and mechanical engineers, power engineers and millwrights. In general, oil and gas industry labour requirements are specialized and would not be in strong competition with RE employers. Indeed, there may be some complementary as the expansion of oil and gas activity will add to electricity demand and create the potential for shared activity in areas like geothermal.

Information and Communication Technologies (ICT)

RE employers have a very specific stake in the ICT workforce. Work requirements at most points on the supply chain call for IT expertise to integrate specialized software systems. Nowhere is this more important than in the systems that are being added at interconnection points that tie new RE generation to the grid and new grid management and operating systems. In these cases recruiting focuses on IT candidates who have both advanced technical skills in specific software and industry experience that prepares them for project work on teams of professionals.

These conditions point RE employers to Information Systems Analysts and Consultants as the key occupation. Stakeholders describe the emerging role for this group as very important and anticipate their development as innovators and industry leaders.

In fact, Information systems Analysts and Consultants are the fastest growing IT occupations precisely because many employers have the same needs as RE. The combination of technical skills and industry experience are in high demand and RE employers will be competing with many other recruiters. Utility HR managers, responding to the Power in Motion research, signalled that the strongest hiring demands would be for Information Systems Analysts and Consultants adding another, closer, element of competition.

Conclusions

There are repeated references to skills shortages in the broader labour markets for most of the occupations needed by RE employers. While the highest risks seem to be in the West and related to construction projects, there are quite unique circumstances for many occupations. Human resources planning can be linked to each of these regional, industry and occupational LMI profiles to shape RE actions to take advantage of available candidates (e.g. graduating engineers and trades available as major projects end) and address key gaps (e.g. experienced engineering leaders).

6. HR Management and Key Occupations

This section moves to the most detailed level to consider HR management practices and the current situation through the findings from the survey and then the specific conditions for each of the eighteen key occupations.

Human Resource Management Issues and Practices

This section returns to the employer survey introduced in Section 4 and reviews in the findings for human resources management (HR) practices.[44]

44 Findings reported here refer to the Renewing Futures employer survey of over 1800 RE businesses. A sample of 349 respondents is described in more detail in a companion document Renewing Futures Employer Survey")

HR issues were far down a list of important concerns, identified in Exhibit #41, for survey respondents – well behind government policy, marketing and business development, finance and the state of the economy.

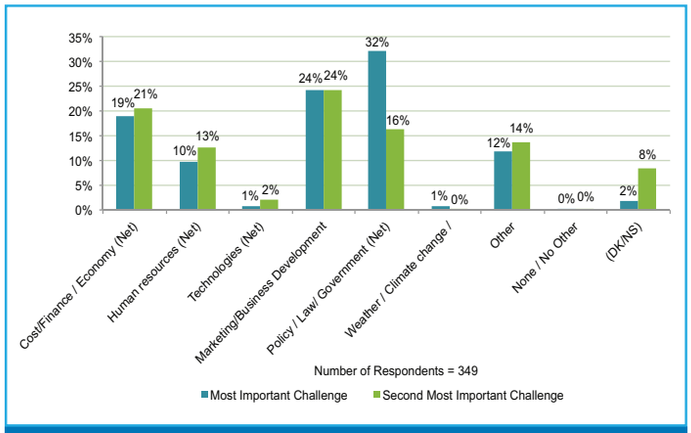
When asked about HR issues the respondents attached roughly equal importance to five or six issues. Exhibit #42 summarizes responses; showing no issue emerges as a distinctly higher priority or focus. But it is notable that recruiting emerges as the top choice.

The survey asked about the capacity of their firms to respond to these issues and respondents indicated that they are confident about how their firms are performing. They rate themselves from 6.3 to 7.6 in terms of HR performance.

Respondents were asked about their hiring experiences in the recent past and plans for the near future. Exhibit #43 gathers findings looking back at the past year. Almost two thirds report no change or a decline in hiring. Reflecting on the industry conditions described in Section 2, these responses are a surprise – or perhaps 2012 was an exception to the rule.

Exhibit #41: Key Challenges Facing Employers

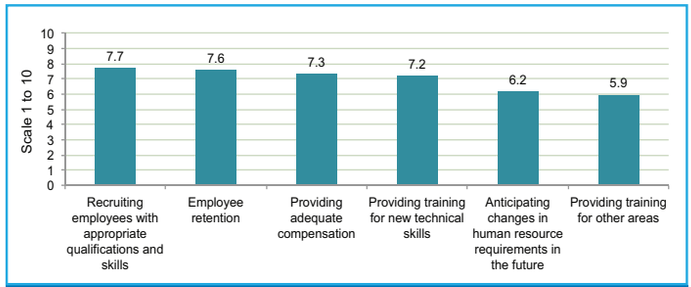
In general, what is the most important challenge facing your business today?



Source: Prism Economics and the EHRC Employer Survey

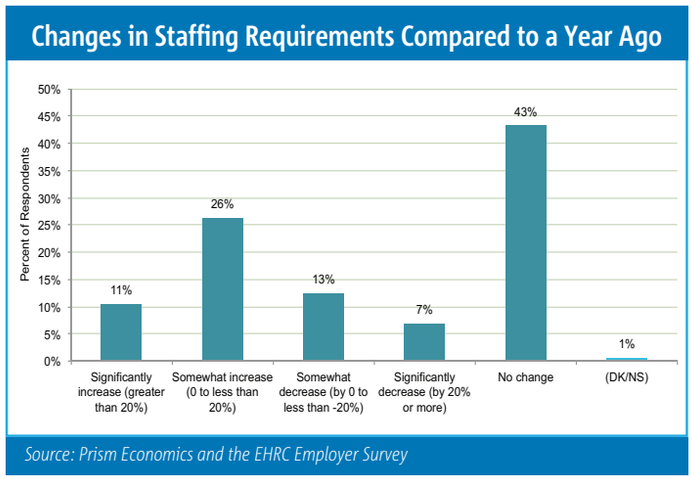
Exhibit #42: Human Resources Issues Ranked by Survey Respondents

How important are each of the human resources-related issues to your business?



Source: Prism Economics and the EHRC Employer Survey

Exhibit #43: Hiring Experience over the Past Year -- % of Respondents reporting.



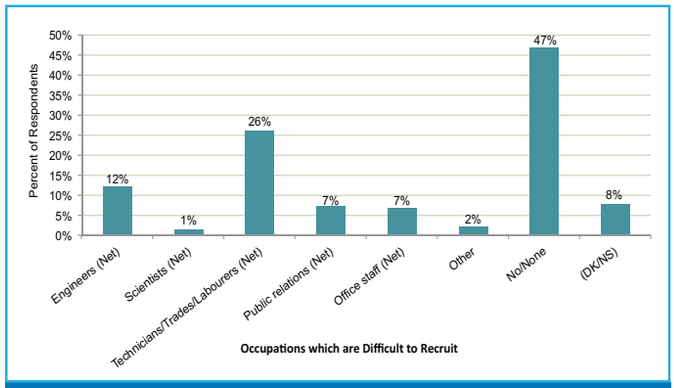
Source: Prism Economics and the EHRC Employer Survey

Given the experiences of 2012, it may not be surprising then, that respondents reported relatively few recruiting challenges in the recent past. Exhibit #44 covers their difficulty recruiting and almost half reported no problems. This finding, again, is not consistent with the labour shortage situation reported by RE employers in other countries and by so many industries in the last section.

A very different picture appears, in Exhibit #45, when the survey asked about hiring intentions for the coming two to three years. Proportions were reversed as almost two thirds of respondents report expectations of increases – *almost one third report expected gains over 20%*. These expectations are much closer to the growth perspective that is so common in RE. Further, respondents attributed the new hiring to two major factors: business growth and government energy policy.

When asked about the recruiting experience respondents (see Exhibit #46) attached roughly equal importance to variety of circumstances. These responses do not reveal any strong patterns; indicating rather that there are a series of roughly equal factors at work. In an attempt to extract more insights, the results for this question were divided among specialized and more broadly based firms, by sector, small and large firms – but no patterns emerge. Note, in particular, that there is little evidence that the more specialized employers identify a higher need for sector specific skills. But all respondents indicated a need for overall RE technical and non-technical skills.

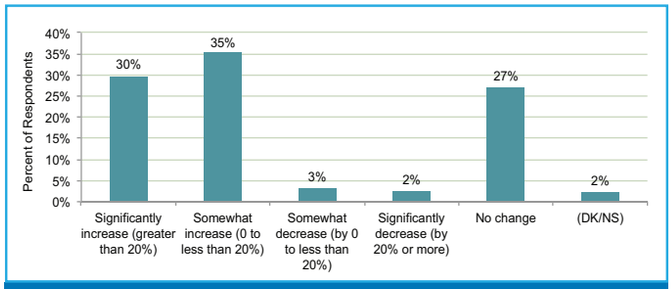
Exhibit #44: Employers Difficulty Recruiting



Source: Prism Economics and the EHRC Employer Survey

Exhibit #45: Hiring Experience over the Next Two to Three Year -- % of Respondents reporting Staffing Requirement over Next Two to Three Years

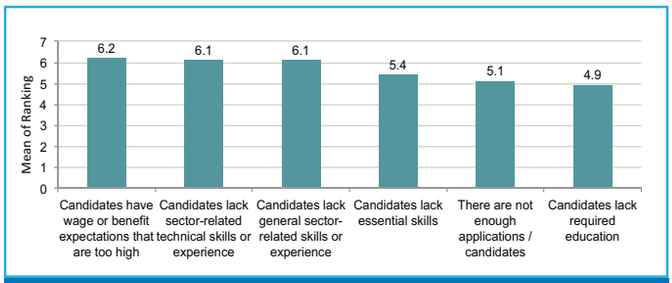
How do you expect that staffing requirements will change over the next two to three years?



Source: Prism Economics and the EHRC Employer Survey

Exhibit #46: Recruiting Experiences in Responding Firms

How well do these statements reflect your organizations' recruitment experience?



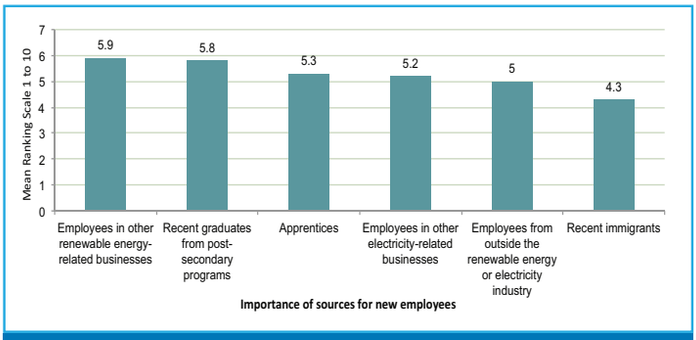
Source: Prism Economics and the EHRC Employer Survey

The survey then turned to hiring and other HR practices. Having established that they have a lot of hiring to do, the respondents then were asked to indicate where they would recruit. Exhibit # 47 indicates a preference for recruiting from other employers in the RE sectors or from the utilities ("poaching") as a major part of their plans. That employers target groups probably indicates their need to find experienced workers. Recruiting recent post-secondary grads and apprentices are roughly equally important and clearly would fill new entry positions. The relatively high preference for apprentices is notable and certainly related to the need for skilled trades.

Finally the survey turned to training. Exhibit #48 tracks the employer plans for providing training across a wide range of areas. Very large proportions of employers report extensive training in a very wide range of skills. These findings are particularly impressive given the size of the firms in the survey.

The survey asked about the sources for the planned training. There is a very strong preference for in-house and customized training with courses clearly tied to RE circumstances. Colleges, even though they are the dominant source in the post-secondary system, rank well below in-house and custom programs.

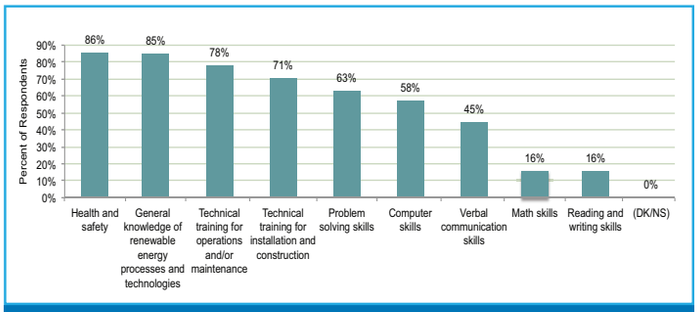
Exhibit #47: Recruiting Plans – Sources for New Employees



Source: Prism Economics and the EHRC Employer Survey

Exhibit #48: Areas of Training Provided by Employers

Does your company provide training in the following areas?



Source: Prism Economics and the EHRC Employer Survey

Exhibit #49: Sources of Training to be provided HR Management and Key Occupations

Training Capability	Percent
Provide on-the-job training	96%
Delivering or arranging for training in-house	79%
Maintain records of employee training	78%
Use courses from industry associations	78%
Use computer-based training instruction	73%
Use courses from suppliers of renewable energy technology	72%
Developing courses in-house	51%
Use courses from companies that specialize in or customize employee training	49%
Use courses from colleges or CEGEPS	47%
A training centre	24%
Online training	1%
Other	4%

Source: Prism Economics and the EHRC Employer Survey

Given the size of the responding firms and findings in earlier surveys of other industries and occupations – especially with regard to training – various tests were applied to validate the results. Survey analysis considered how these findings were distinct across occupations, firm size and other sample dimensions. Few differences emerge.

Findings reveal a strong training culture and a very high level of commitment to HR development.

Conclusions for Employers

The survey findings reveal a large group of small employers who are confident of their capacity to manage human resources and committed to training and other support systems. These firms see many other business issues as more important than HR and they have just experienced a period of relatively few problems recruiting. Further, they have well established plans for hiring – often from other RE employers. ***This picture signals flashing red lights for a national human resources strategy. The firms that will be the target beneficiaries for the strategy very likely do not see a problem!***

But there is a problem. All totalled, the employers in the sample cannot meet their new and ambitious hiring plans. Competitors recruiting the same occupations in other industries are developing strategies, expanding support and certification systems and programs to attract workers in anticipation of continuing shortages. Further, they will turn to a post-secondary training system with very fragmented programs and to apprenticeships that change slowly and have almost no specialization in RE skills.

The national human resources strategy must take account of all these realities and address many factors that are specific to each of the key occupations.

Findings by Occupations

While there is much diversity among RE employers, one common reference point stands out. All RE employers are focused on the same group of occupations. This section reviews the challenges and expectations that RE employers face for each occupation.

Analysis focuses on the impact of the labour requirements for Scenario C, the Vision Case that adds 620,000 person-years of employment in construction and installation and creates a cumulative 34,000 permanent jobs in operations both on the RE sites and across the supply chain. A small proportion (perhaps 10%) of these jobs are created in the utility industry itself and the remainder are distributed across the supply chain. Growth captured here represents, on average, a 150% increase (more than doubling) in RE employment in the Vision scenario. These gains anticipate hiring at a pace that will exceed most, perhaps all, other industries.

The Reference and Utility scenarios offer an alternative view of more modest expansion that creates between 185,000 and 190,000 person years of work in construction and between 19,000 and 21,000 jobs in operations by 2022.

Where the research findings are common to several occupations within each group, only summary comments are offered. Specific Provincial or sector highlights are noted for some occupations and separate reports have been prepared offering more details.

Leaders and Managers

This group combines senior engineering and utility managers with functional experts in information technology, finance and accounting and sales. Stakeholders indicated that these occupations play a critical role in the success of each RE business and the growth of the industry itself. These are the leaders who bring personal skills as well as introducing investors, technologies and ideas into the expansion process.

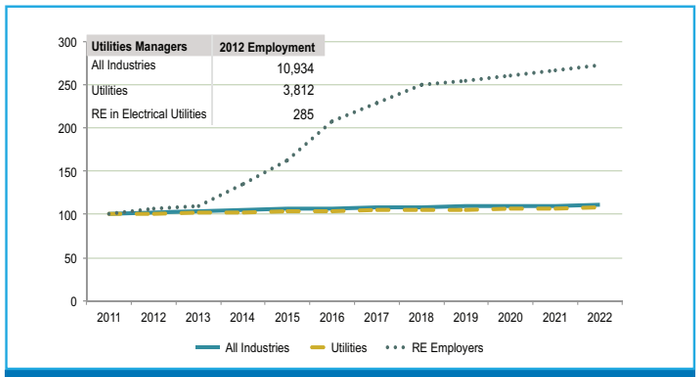
Utility and Engineering Managers

Employment growth, set out in Exhibit #50, for these two occupations is typical of the RE key occupations with only moderate expansion demands across all industries outside RE, stronger growth in utilities and then an over 250% increase in RE jobs in Scenario C. For employers outside RE, replacement demand (retirement) dominates as this is an older workforce. The dominant HR reality here is that there are no new entrants or post-secondary programs that will provide candidates for these jobs. Specialized skills and experience are essential. Ideally, candidates are drawn from inside the firm or industry with succession planning filling in as junior employers rise in the organization. While this HR pattern will work across larger employers and in utilities, the smaller RE employers face a pace of rising demand for managers and leaders that cannot possibly be met internally.

Exhibits #52 and #53 add new dimensions to the hiring challenge as they point to very high levels of replacement demand for both occupations; rising to annual demands above 4% of the workforce. This level of demand requires reaching beyond the local labour market. Unemployment declines while replacement demands increase across the scenario.

Exhibit #50: Employment Growth - Key Occupations

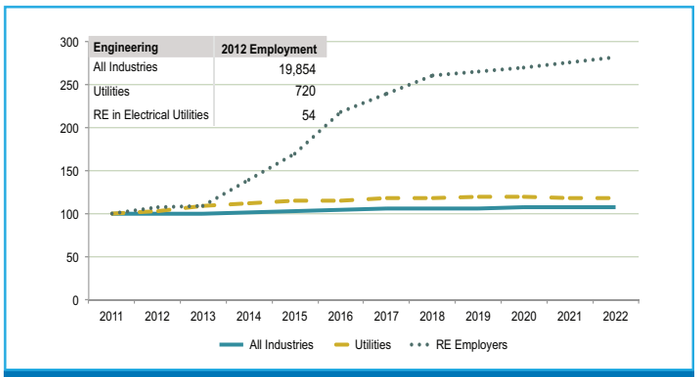
Utilities managers Employment
(Index=2011 = 100)



Source: POMS and Renewing Futures LMI system

Exhibit #51: Employment Growth - Key Occupations

Engineering Managers Employment
(Index=2011= 100)



Source: POMS and Renewing Futures LMI system

Exhibit #52: Labour Market Conditions

Utilities Managers, Canada, 2012-2022

All Industries	2012	2022	% Change
Employment	10,934	11,835	8.2
Labour Force	11,412	12,247	7.3
Unemployment (% of Labour Force)	4.2	3.4	
Replacement Demand	386	483	25.1
Replacement Demand (% of Labour Force)	3.4	3.9	
Net In-Mobility	558	536	-3.9
Net In-Mobility (% of Labour Force)	4.89	4.38	

Source: POMS and Renewing Futures LMI system

Exhibit #53: Labour Market Conditions

Engineering Managers, Canada, 2012-2022

All Industries	2012	2022	% Change
Employment	19,854	21,481	8.2
Labour Force	20,804	22,240	6.9
Unemployment (% of Labour Force)	4.6	3.4	
Replacement Demand	712	880	23.6
Replacement Demand (% of Labour Force)	3.4	4.0	
Net In-Mobility	645	947	46.8
Net In-Mobility (% of Labour Force)	3.10	4.26	

Source: POMS and Renewing Futures LMI system

The *Power in Motion* and Engineers Canada reports cited in Section 5 describe the unique challenges for recruiting these occupations. Specialized managers with five to ten or more years' experience are generally not available. The *Power in Motion* study describes how the management workforce in the large utilities includes a tier of young Baby Boomers who are poised to fill in for retiring, older Boomers. Big utilities are left with two problems. First, as they replace the retiring older Boomers, they face a shortage of more junior managers to fill in the succession plan. Second, they expect that a large portion of their older workforce will take advantage of pension fund benefits to retire from full time work, perhaps turning to part time or consulting employment. This process allows the industry as a whole to retain key expertise but the utilities must replace full time, senior managers with a complex succession plan.

Engineers Canada reports the use of Temporary Foreign Workers and other short term solutions to fill engineering management gaps. Given these HR difficulties in the broader labour market, RE plans for adding managers are a real challenge.

In both occupations, the measure of net in-mobility signals that RE businesses must look beyond traditional sources to find hundreds of managers with unique talents and dedication to alternative energy technologies. Poaching these managers from current employers appears to be a challenging strategy given the competing demands of larger and more established utility and engineering consulting businesses. A strategy to develop RE managers internally is clearly a priority, but cannot possibly meet the pace at which RE managers are required. This shortage of management talent is likely one reason for the diversification business strategy applied by RE employers. Limited management talent must be deployed across a range of business interests that spans the RE sectors and the supply chain.

RE managers work in small, diversified companies and are concerned about government policy, regulations, business development and financial / cost concerns. Given the size of most companies, managers are likely to have responsibilities for HR as well as general management. This includes organizing and managing teams of staff and experts on a project or contract basis. Respondents in the employer survey placed financial and cost concerns ahead of HR issues and there were repeated references to high compensation expectations. The implication here is that senior managers

may be limiting compensation expenses at a cost of higher turnover and limited continuity for their workforce. These management choices, seen from the perspective of the Renewing Futures research, will have detrimental long term implications as the quality of workforce skill depth and breadth is sacrificed. From an industry perspective, there is an important contradiction when managers turn to poaching in a rapidly growing industry where staff turnover and workforce skills are key issues. The human resources strategy needs to identify HR issues in a longer time frame, linking turnover, retention and skills development to industry growth and building the overall skills of the industry workforce.

Alternative approaches to developing management talent for RE jobs can be adapted to fit these conditions. One approach would be to focus on the growing pool of young Canadian engineering grads as the next generation of RE managers. This group could be prepared with RE specific programs that include more specialized training in undergraduate programs and Engineering in Training programs and mentoring on-the-job. At the same time RE employers could match their new engineering workforce with needed and experienced mentors. Mentors could be drawn from the ranks of the older engineers on pensions from the utilities. Rapid growth adds revenue to pay the needed salaries and creates accelerated career paths to attract new Canadian grads.

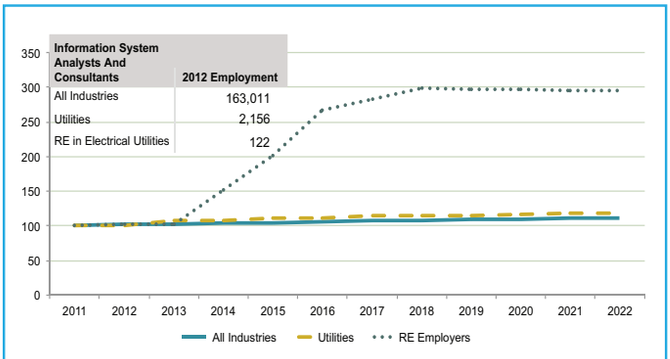
A national HR strategy must offer as many paths as possible to build and sustain a skilled workforce with a path of learning and promotion that promises a career. Rapid growth can move people along this path quickly and these opportunities will be unique and appealing in the broader macro-economic environment of slow growth and few career opportunities.

Information and Communication Technology

The most important technology advances that will impact the RE industry from 2012 to 2022 are in information and communication technology (ICT). New software systems will balance electricity supply from the RE generation point with final consumer demands. These innovations include a range of changes - from improvements in substation technology for remote distribution to grid expansion, modernization and Smart Grid systems. Adding IT skills all across the supply chain is a key factor enabling growth. Some of these IT skills will be added to the training and development of existing occupations including Electrical Engineering Technologists, Power System Electricians, Power System and Power Station Operators, Power Line and Cable Workers. The major responsibility for implementing these systems will be assigned to a new and specialized ICT workforce.

Information Systems Analysts and Consultants are the principal occupations filling these needs and they will be hired in large numbers across all industries and across the RE supply chain. Exhibit #54 tracks the above average growth rates for employment in this critical area. Note, in particular, the stronger than average increase in employment for this occupation in utilities. This change was anticipated in the *Power in Motion* study.

Exhibit #54: Employment Growth - Key Occupations
(Index 2011 = 100)



Source: POMS and Renewing Futures LMI system

This workforce has a unique combination of technical ICT knowledge and industry experience. For the RE employers the industry experience part of the job profile will include work on substations, the operating systems for the power generation and experience with the latest software for grid management and improvement on the utility side of the interconnection.

Having a large and growing workforce with increasingly specialized ICT skills is essential to the pace of deployment anticipated here. Exhibit #55 tracks the broader labour market indicators for these key specialists and it anticipates tight labour markets as employers in many industries compete for this combination of technical skill and industry experience. Replacement demands are less of a concern here as the workforce has a younger profile.

Exhibit #55: Labour Market Conditions
Information Systems Analysts and Consultants
Canada, 2012-2022

All Industries	2012	2022	% Change
Employment	163,011	178,952	9.8
Labour Force	173,270	187,756	8.4
Unemployment (% of Labour Force)	5.9	4.7	
Replacement Demand	3,506	4,468	27.4
Replacement Demand (% of Labour Force)	2.0	2.4	
Net In-Mobility	1,674	1,977	18.1
Net In-Mobility (% of Labour Force)	0.97	1.05	

Source: POMS and Renewing Futures LMI system

Evidence gathered from stakeholders suggests that the development of this workforce is now being led by the in-house training plans of the utilities and specialized ICT consultants and contractors. Needed skills are determined as a result of plans for grid modernization and related IT systems. Suppliers and the utilities themselves work together to refine the skills of ICT and other technical workers. While these responsibilities are likely shared by employers across the supply chain, Renewing Futures research found the only specific examples of this workforce development in the utilities.

The utilities, consultants and contractors who support the development of the distribution system, now carry the costs and responsibility for these critical added skills. But the entire RE industry relies on the rapid deployment of this workforce to enable the expansion of new RE systems. Stakeholders report that bottlenecks are apparent at the interconnection point between the grid and the RE systems. Employers in all RE sectors and across the supply chain have a stake in the development of this key group.

Changes noted here also impact the job descriptions, training qualifications and certifications for Power System Electricians, Power System and Power Station Operators, Power Line and Cable Workers. Stakeholders are managing these changes differently with utilities setting their own training and occupation standards in some cases and Provincial apprenticeship programs adjusting in others.

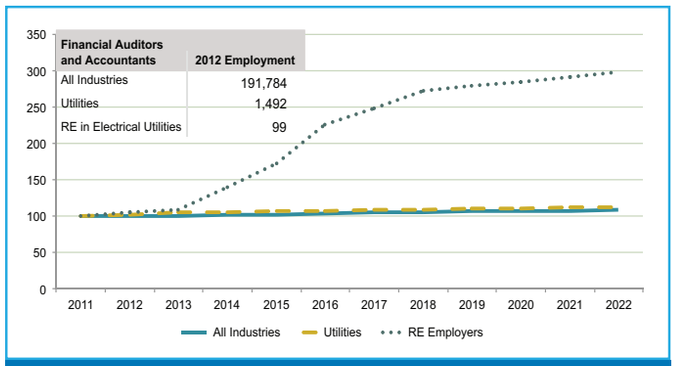
All RE employers have a stake in the rapid addition of ICT workers and related additions to the skills of the workforce in these crucial areas. Small employers working at points in the supply chain that are remote from the interconnection process may not appreciate their long term reliance on the development of this workforce.

Finance, Accounting and Sales Managers

The employer survey describes a large number of small businesses struggling to keep up with rapidly growing opportunities. Employers set marketing, business development, cost and financial management issues ahead of human resources. Meeting these challenges requires a strong work force including accounting and sales and marketing managers. These occupations were identified by stakeholders as critical to the firm's success.

The POMS model tracks labour market conditions for these occupations. Exhibits #56 through #59 report employment growth and market conditions from POMS. Each of these occupations has average age profiles and typical expansion and replacement demand projections. Unemployment rates are lower and decline more for financial auditors and accountants where there is more formal post-secondary training and rigorous certification that limits entry into the occupations. Recruiting for these positions will be more of a challenge and this is what stakeholders reported.

Exhibit #56: Employment Growth - Key Occupations
Financial Auditors and Accountants Employment
(Index 2011= 100)



Source: POMS and Renewing Futures LMI system

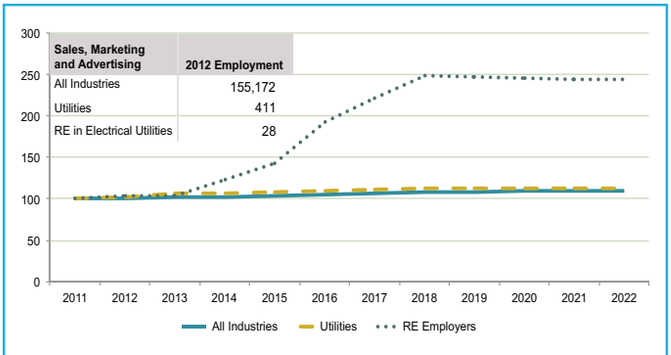
Exhibit #57: Labour Market Conditions
Financial Auditors and Accountants, Canada, 2012-2022

All Industries	2012	2022	% Change
Employment	191,784	208,925	8.9
Labour Force	201,908	216,965	7.5
Unemployment (% of Labour Force)	5.0	3.7	
Replacement Demand	4,644	4,939	6.4
Replacement Demand (% of Labour Force)	2.3	2.3	
Net In-Mobility	-744	1,938	
Net In-Mobility (% of Labour Force)	-0.37	0.89	

Source: POMS and Renewing Futures LMI system

Labour market conditions for sales and marketing managers are reported in Exhibits #58 and #59.

Exhibit #58: Employment Growth - Key Occupations
Sales, Marketing and Advertising Managers Employment
(Index 2011= 100)



Source: POMS and Renewing Futures LMI system

Exhibit #59: Labour Market Conditions
Sales, Marketing and Advertising Managers, Canada, 2012-2022

All Industries	2012	2022	% Change
Employment	155,172	170,030	9.6
Labour Force	162,450	176,036	8.4
Unemployment (% of Labour Force)	4.5	3.4	
Replacement Demand	4,674	6,502	39.1
Replacement Demand (% of Labour Force)	2.9	3.7	
Net In-Mobility	5,682	7,439	30.9
Net In-Mobility (% of Labour Force)	3.50	4.23	

Source: POMS and Renewing Futures LMI system

These occupations embrace a series of crucial skills that are needed in all business environments. They include all the basics for management that are necessary but not sufficient for success. Standard post-secondary training and certifications are expected, but the critical ingredient is depth and breadth of industry experience. RE businesses need to add industry specific knowledge to the workforce. For example, critical knowledge in finance would include understanding bank policy and investor needs for financing RE plans and installations. Market development skills include working in government relations as a proponent seeking funding and access to distribution systems as well as dealing with regulations and local interest groups around locations and community impacts.

The problem is that jobs are being added faster than workers can gather the needed experience. This adds yet another risk to the industry as a growing group of participants are working on deploying the RE systems with little or no prior experience.

Workers in finance and marketing from the utility sector would fill in some needed industry experience. Hiring them from their current employers is a challenge. Employers in construction and installation can turn to estimators, contactors and supervisors from electrical contractors for some relevant experience.

Ultimately the industry must take on the task of training new accountants, cost estimators, sales and marketing people with the needed RE knowledge through industry based training. This element of a strategy seems a natural extension of the current strength in training systems reported in the employer survey.

Engineers, Technicians and Technologists

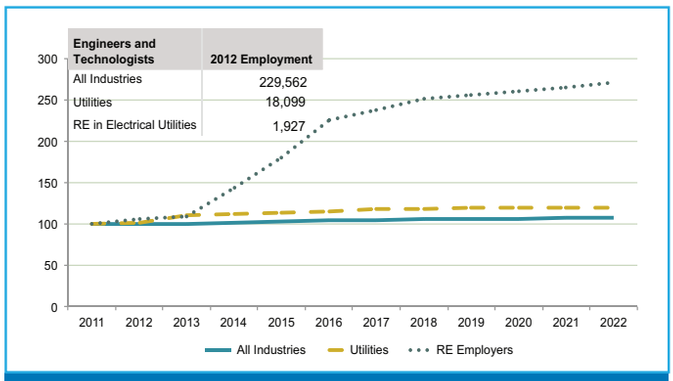
Another five key occupations are added here for engineers and technologists. These occupations were picked by employers as the third largest and most critical group in their workforce. Electrical and mechanical were identified as the largest engineering groups but there were significant numbers of other disciplines including civil, structural, chemical, environmental and solar. In many cases employers did not specify disciplines, rather indicated the general need for engineers. There were no specific references by survey respondents to engineering technicians and technologists.

Engineers and technologists are at the innovative core of RE deployment at every point across the supply chain. RE businesses are among the most engineering intensive employers in Canada.

Exhibits #60 and #61 track demand for Engineers and Engineering Technicians and Technologists in the three Renewing Futures labour markets. Exhibits aggregate together five disciplines that have essentially the same projected rates of employment growth.

Exhibit #60: Employment Growth - Key Occupations

Engineers and Technologists Employment
(Index 2011= 100)



Source: POMS and Renewing Futures LMI system

There is moderate evidence of skill shortages in Exhibit #60 and #61 – especially at the all industry and utility levels. Looking deeper into the Engineers Canada model, for example, shows higher expansion demands and tighter markets in the West and in disciplines like mining and petroleum engineering. There are also rising demands for Canadian engineers in international work that are not fully captured in Exhibits #60 and #61.[45]

Exhibit #61: Labour Market Conditions

Engineers and Technologists, Canada, 2012-2022

All Industries	2012	2022	% Change
Employment	229,562	248,525	8.3
Labour Force	245,205	261,450	6.6
Unemployment (% of Labour Force)	6.4	4.9	
Replacement Demand	5,499	5,950	8.2
Replacement Demand (% of Labour Force)	2.2	2.3	
Net In-Mobility	-1,409	1,701	
Net In-Mobility (% of Labour Force)	-0.57	0.65	

Source: POMS and Renewing Futures LMI system

Section 5 above described the engineering labour market as sharply divided with distinct shortages of experienced workers with five to ten or more years of experience and a relative abundance of new graduates. These conditions apply to the electrical and mechanical engineers that dominate needs for RE hiring as well as for other disciplines.

Labour requirements for engineering technicians and technologists will likely exceed the projected growth for engineers. Employers often turn to technologists as a substitute for engineers as new software systems allow for the transfer of traditional work. Further, as noted in the discussion of post-secondary programs, it is the college courses for engineering technicians and technologists that provide the vast majority of specialized training for RE skills.

Perhaps the highest priority task for RE recruiting will be adding to the ranks of entry level and experienced engineers and technologists from 2013 to 2022. RE hiring requirements will rise far faster than any other industry group. Further the specialized needs for RE skills add to their recruiting challenge.

Conditions described here suggest some specific hiring strategies that might help RE recruiters individually and the industry collectively as they plan growth. Strategic options include:

- An immediate focus on increased hiring of technicians and technologists from college RE programs,
- Work with the colleges to refine program content and create bridges that connect to apprenticeship and to undergraduate business and science programs,
- Adapt college RE programs as specialized training for young Canadian engineering graduates,
- Target new engineering graduates and offer them RE specializations as part of Engineers in Training (EIT) or in-house programs and create specific mentoring opportunities, and
- Recruit internationally trained engineers (ITE) and Temporary Foreign Workers (TFW) to fill short term needs and to mentor new Canadian grads.

These approaches not only fit with current labour market conditions for engineers in general, they also coincide with specific RE circumstances.

45 For more on these labour market conditions see Engineers Canada http://www.engineerscanada.ca/files/w_Engineering_Labour_Market_in_Canada_oct_2012.pdf

Enrolment in Canadian engineering programs has increased by over 20% from 2007 to 2012 and faculty plans are to continue this growth. This represents a large pool of skilled labour to meet the RE needs. But a large part of the enrollment is visa students and Canadians destined for work outside engineering. A large proportion of engineering graduates do not stay in the labour market because of a shortage of Junior Engineer jobs. Most employers want to hire experienced engineers, not recent graduates. RE employers fit this profile, but can adapt their hiring plans to take advantage of Canadian engineering programs.

The need for experienced engineers has been partially met, from 2007 to 2012, by increasing arrivals through the Federal Government temporary foreign workers (TFW) immigration program. These engineers have been recruited by Canadian employers before they arrive, have needed experience, and are admitted into Canada for limited periods. Rising needs for experienced and technical workers have encouraged extending the TFW program through new immigration programs that accommodate longer term needs by offering permanent immigrant status to TFWs under Provincial Nominee and other programs.

The number of internationally trained engineers (ITEs) arriving as permanent immigrants has been limited and this represents an underutilized pool of experienced engineers. There is a unique opportunity for RE employers, here. European and Asian suppliers have captured a large share of the global market for wind and solar system components. In some cases these businesses face slower growth and weaker markets. RE recruiters can focus their attention on ITEs with RE specialization and experience with global suppliers.

The current labour market situation for engineers and technologists offers three important advantages that will help RE recruiting. First, college programs teaching RE specializations are the biggest source of training and this creates a potential pool of specialized engineering technologists. Second, there is a large pool of young Canadian engineering graduates looking for careers in growing businesses. Third, there are specific Canadian immigration programs that encourage recruiting internationally trained engineers, arriving in Canada from South Asia, China and Europe where RE deployment is more developed.

RE employers can attract ITEs and TFWs, from big international RE markets, as a short term starting point and use their experience to mentor a new generation of Canadians. Migrants are exceptional people in terms of their motivation, perseverance, ambition and adaptability and they can bring needed experience from, for example, European RE projects.

There will be recruiting challenges here assessing credentials and general experience of ITEs. But there are programs and initiatives to help employers with challenges like assessment of international engineering credentials for selected countries. For example, international coordination of engineering accreditation has been initiated through the Washington Accord.[46] Further, there are independent agencies in Canada that provide assessments of foreign engineering certification and experience.[47]

Trades and Related

This final group of occupations covers a wide range of work from skilled journey persons, electrical power system operators to solar and wind installers. Work for this group is concentrated in the end of the supply chain; during the construction, installation and operation of the generating facilities and work in the utilities. Employers engaged in this work include consulting engineers, general and specialized contractors, developers and utilities.

46 From Wikipedia "The **Washington Accord** is an international accreditation agreement for professional engineering academic degrees, between the bodies responsible for accreditation in its signatory countries. Established in 1989, the signatories as of 2013 are Australia, Canada, Chinese Taipei, Hong Kong China, Ireland, Japan, Korea, Malaysia, New Zealand, Russia, Singapore, South Africa, Turkey, the United Kingdom, and the United States.[1] The agreement recognizes that there is substantial equivalence of programs accredited by those signatories. Graduates of accredited programs in any of the signatory countries are recognized by the other signatory countries as having met the academic requirements for entry to the practice of engineering.

47 Engineering groups across Canada offer support for employers recruiting ITEs and these programs are well suited to the needs of RE hiring plans proposed here. See, for example, the Ontario Society of Professional Engineers "Engineering Your Workforce Program" http://www.ospe.on.ca/?page=ITE_emp

Exhibits #62 and #63 cover labour market measures that span four key electrical trades:

- Power System and Station Operators
- Power System Electricians
- Electricians (Excluding Industrial and Power System)
- Electric Power Line and Cable Workers

And two more related groups of trades:

- Mechanical Trades
- Crane and Heavy Equipment Operators

And two very broad occupations:

- Construction Helpers and Labourers and
- Residential and Commercial Installers and Servicers

The six trades listed above are often recognized in apprenticeship programs and with journeyperson certifications (or equivalent). Where the trades are covered by the Red Seal (i.e. electricians, power line technician, plumbers, pipe / steam fitters, refrigeration and air conditioning mechanic and crane operators) there are national standards for the trade and the potential for interprovincial mobility.

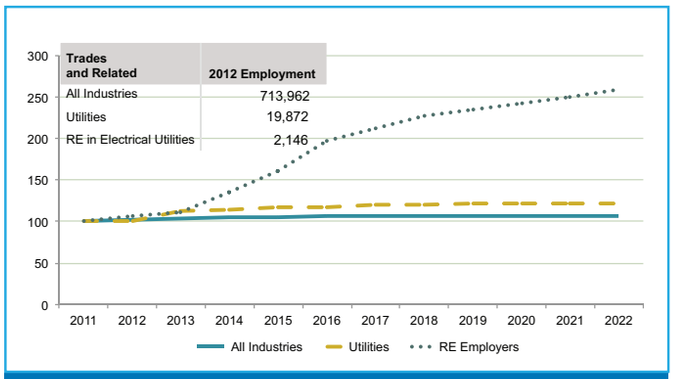
There are however, no consistent national approaches with provinces offering apprenticeships and journey person status for the other trades. Except for construction electrician, there are no compulsory trade designations for this group across Canada.

Analysis of all these occupations is built up in the Renewing Futures LMI models. Trends in employment growth and labour markets are very similar for each occupation and the measures in Exhibits #61 and #62 effectively summarize conditions.

Two important specialty occupations, solar installers and wind technicians, that are not as of yet identified in the standard statistical measures are included as well. Workers in these occupations are part the large construction helper and residential and commercial installer groups in the standard occupation classification and in statistical measures. But the construction helper and installers groups are so large, and cover so many types of work, that they are not a useful reference point beyond signalling very broad conditions.

Exhibit #62 tracks some interesting findings and summarizes important details that apply to specific trades.

Exhibit #62: Employment Growth - Key Occupations
Trades and Related Employment
(Index 2011= 100)



Source: POMS and Renewing Futures LMI system

Exhibit #63: Labour Market Conditions
Trades and Related, Canada, 2012-2022

All Industries	2012	2022	% Change
Employment	713,962	746,893	4.6
Labour Force	813,399	835,815	2.8
Unemployment (% of Labour Force)	12.2	10.6	
Replacement Demand	16,517	18,101	9.6
Replacement Demand (% of Labour Force)	2.0	2.2	
Net In-Mobility	12,184	225	
Net In-Mobility (% of Labour Force)	1.50	0.03	

Source: POMS and Renewing Futures LMI system

Labour market conditions vary for the occupations included here, but in general markets are tight with employers facing recruiting challenges. Demands for workers are already strong in the electrical utilities and related contractors where there are large ongoing and planned projects on refurbishing existing and adding new generation facilities as well as distribution systems in most provinces.

Labour requirements are concentrated in construction and maintenance work in the utility systems. Some of the broader occupation groups – including electricians, mechanical trades, equipment operators and trade helpers and installers, are in strong demand for infrastructure work outside electricity as water, pipeline and transit systems are drawing added investment. BuildForce analysis of construction markets and other sources, outlined in Section 5, conclude that there would be only a few labour markets and a few years when these occupations would not be in short supply.

General supply side observations confirm these tight market risks. For example, while apprenticeship registrations have been increasing for most of these trades, completions rates have been lagging so that the number of newly certified journeyperson joining the labour force lags behind requirements. The age profiles grow older and replacement demands increase as the skill levels rise for these occupations.

RE employers competing for these occupations will face ongoing competition mostly from the construction industry. A large part of the workforce covered here works for general or trade contractors who are active in RE projects and other work. These contractors groups are aware of the expected growth in the RE work and are planning to meet these demands. In the unionised sector this means collaborating with the building trades and other labour representatives to expand training programs and RE specializations. Aside from the CECA / IBEW / CSA initiative described above, this drive to increase the workforce is focused on the generic apprenticeship programs.

The real challenge for RE employers lies in the need to expand the more specialized skills at each skill level and each point along the supply chain.

Skills required for power system and station operators are increasing and job descriptions are changing. This is linked, in part, to advances in the software and other grid systems. Qualifications are now requiring full journey person skills and some advanced engineering technologist training at the college level. New depth is required from power system electricians and power line technicians both working on the grid and at interconnection points. These are all small trades largely employed by utilities and related speciality contractors. There are very limited opportunities to fill expected vacancies from outside the industry. The only real opportunity for leveraging existing skills would be to draw from the general population of journey person and apprentice electricians and upgrade their skills to meet RE needs.

Stakeholders described different and potentially contradictory expectations about how these needs will be met. There were, for example, descriptions of prefabricated or modular substation systems that required fewer skills on-the-job. While there is some disagreement about exactly what skills need to be added at the interconnection and grid points, it is clear that higher skills levels, more advanced qualifications and certification is needed. This perspective applies to all professional and trade occupations covered here including power system and station operators, power system electricians, general electricians and power line technicians. In each case technical knowledge, skills and qualification levels will rise to meet these needs.

Technical requirements are tied to distribution and grid systems that meet the RE supply chain at the interconnection point. RE employers have a major interest in these advances and they will play a part adding skills to their own workforce in the installation and operation of larger systems. Most of the workforce is employed by the speciality engineering firms, electrical contractors and utilities themselves. Rising labour requirements are not uniquely related to RE expansion but are also tied to expansion, refurbishment and modernizations of the distribution system in general.

There are equally challenging labour requirements on the RE side of the interconnection. The workforce for solar installers and wind technicians will grow by 2.5 times in the Vision case. This group carries the main workload for on-site construction and installation. The industry seeks added depth and breadth in the skills of the workforce. One objective here is improvements in safety and system quality.

There is no consensus about the training curriculum and related certifications that are required to accomplish this improvement. Safety training and basic descriptions of RE systems are the starting point. Stakeholders differ about the time required and subject content of training programs.

For solar PV installation there will need to be new training content that includes integrated building systems and other changes. While it is not necessary for this workforce to have journeyperson status, the training should advance the entry level worker to a point where they would qualify for advanced standing in either related apprenticeship programs or the college RE programs that target the engineering technical stream.

Stakeholders reported that the solar installer workforce often includes both new entry workers and apprentice electricians. Where this workforce is provided by a general or electrical contractor, the apprentices would be connected to employment of journeyperson electricians who would be installing inverters, transformers and connection to a substation of the grid. Much of the work would involve site preparation, erecting racks and panels and pulling low voltage cable. Working conditions that expose an entry level solar installer to work with the apprentices and the opportunity to be part of the broader installation would help to encourage them to seek a career in the industry.

Advances in wind systems will require added technical content in wind technician programs. Larger systems, new turbines and advanced building materials (potentially replacing steel) will all add to the complexity of installing and maintaining wind systems.

There is no consensus on the extent of rising labour requirements. There is no evidence that the industry is moving towards any common training or certifications. For the solar systems there has been little uptake across Canada for the NABCEP program from the U.S. This reflects, in part, features that are uniquely tied to the US market and neglect the potential for closer links to Canada's existing RE systems and apprenticeship. The wind sector needs to consider whether these system advances are best introduced as part of a wider participation in the BZEE program.

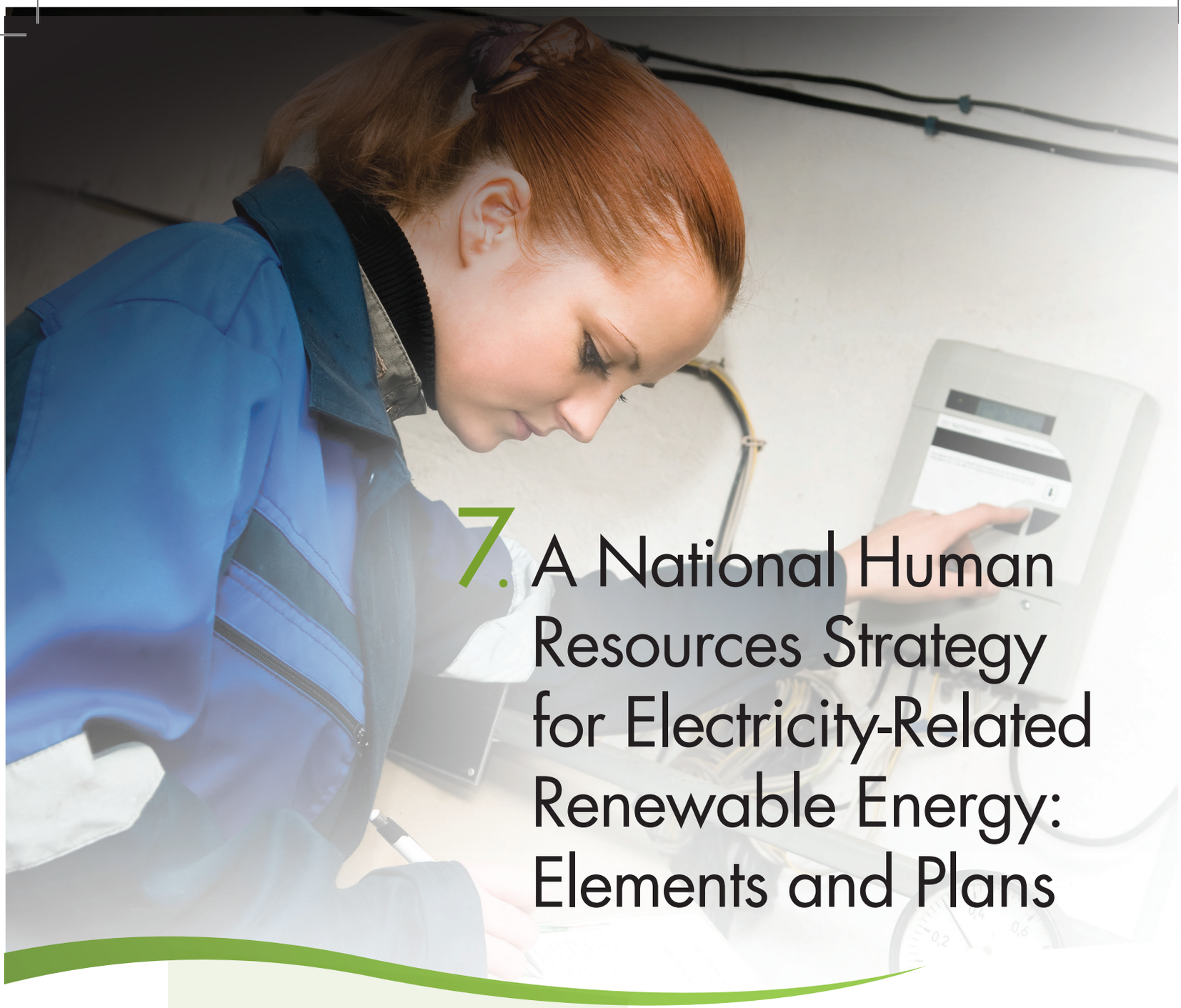
Rapid growth in hiring requirements for the key Renewing Futures trades and occupations seems certain. A range of employers will be hiring different occupations across the supply chain, but they all will face recruiting two to three times the current workforce in the Vision case. While a very large expansion of training will be needed, there is no common view on the content or the organization of the work. These findings apply equally to employers deploying RE systems and to the utilities that will need to expand and refurbish the distribution systems.

Conclusions for Occupations

Very large increases in labour requirements for RE deployment will bring recruiters into already tight labour markets. Employers have met previous labour demands by hiring from the rest of the industry but this is not a viable strategy for 2013 to 2022. Existing training and certification programs will need to more than double current capacity for RE workforce and there is no consensus on the content of programs or the need for certifications. In many cases there are barriers to the mobility of the workforce across provinces and industries. Narrow interests and competing systems for certification threaten to frustrate strategy while RE ***growth*** *creates an imperative to expand training programs.*

Conclusion for Section 6 – Human Resources Management and Key Occupations

This section of the report has considered the plans and practices of RE employers and the state of the labour markets that characterize the period from 2012 to 2022. Findings suggest that if employment grows as fast as projected in the Vision scenario, the industry will not be able to fill vacancies with properly qualified candidates. HR management plans must be adapted to meet the labour market challenges and the need for greatly expanded training and certification. This change has the potential to be disruptive. Industry stakeholders describe a need for improved safety, work quality and system reliability. A national human resources strategy for RE is needed to meet these challenges.



7. A National Human Resources Strategy for Electricity-Related Renewable Energy: Elements and Plans

Findings reported in the six sections above confirm that, in general, the Canadian workforce, in the key occupations needed for RE deployment, will not be able to meet future demands. Even in the more limited growth scenarios, recruiting the required numbers of skilled workers will bring RE employers into competition with hiring anticipated in other industries. In Scenario C, the Vision Case, projected requirements are two to three times current employment levels, and hiring on this scale presents a wide range of challenges.

These findings present an industry wide perspective; showing overall RE employment in contrast to competing industries and the overall labour market conditions. Seen from this perspective RE employers have a collective challenge ahead. Working together to build the needed workforce will secure support from government and training institutions. The RE sectors have a powerful story to tell Canadians as they present significant prospects for jobs associated with environmental improvements and careers that span a range of employers and a progression of advancement.

Elements of a national human resource strategy for RE employers have been developed and are available as a separate document. These elements are built around the advantages of collective action to attract, train and

employ the needed skilled workforce. Working together, RE employers can make long term investments in human resources that parallel the investments in systems to deploy new capacity. A plan that is supported by all the stakeholders will attract the support of government, and potentially, funding for training and certification initiatives.

Collective action is not assured. The case for a strategy must first clearly define and demonstrate specific advantages for each employer. Even then, creating an awareness of the problem, the solution and motivating action will be a major challenge.

RE employers are a widely diverse group of small companies spread across the supply chain and ten provinces. Each province has a distinctive energy profile and legacy that drive different priorities for RE deployment. Further, provincial governments have different approaches to training and regulation of occupations.

Factors Inhibiting the Strategy

Individual employers may not see the need for collective action on human resources as they focus on other concerns. The Renewing Futures employer survey documents their concerns about a long list of issues outside human resources, their confidence in their current management practices to deal HR issues and relatively ease in recent recruiting. Most employers are engaged in RE projects as a specialized contributor and the firm is also involved in other markets. Opportunities for more RE work may be apparent, but the immediate business concern is the competition for contracts. Success is seen as allowing employers to draw their needed team members from the pool otherwise accessed by competitors. Risks of delays or cycles in RE work are also managed by engaging needed specialists on a contract or short term basis. Their perceived stake in solutions to broader barriers to future RE deployment may be limited.

Provinces also have a limited incentive to focus on national HR plans or interprovincial labour mobility in RE related work. Their energy policy is set without regard to other provincial goals and investments. Provinces often highlight employment benefits as a goal of renewable energy policy. These governments clearly anticipate jobs in their own province. Prospects of recruiting from other provinces will not fit their goals.

Altogether, many stakeholders will see the opportunities, benefits, risks and uncertainties of future RE deployment as a zero sum game where their success is gained from the losses of competitors.

The strategic plan must transcend these narrow perspectives and demonstrate the need for collective action to meet a common challenge.

Factors Encouraging the Strategy

Findings in this report build the strong case for collective action. RE deployment on the scale anticipated by industry vision and policy goals will not be possible without a parallel investment in human resources. There are not enough skilled workers to build the expected RE deployment – even when growth is limited and risks are high. Competing demands for skilled labour in other industries – and their collective investments to meet their labour requirements – require a common RE approach.

A national strategy that embraces skills for all sectors is insurance against cyclical swings in investments and labour market instability as big RE projects start up and then wind down. And there are well established associations with strong membership – many already participating on the Steering Committee for this research – who form a solid foundation that spans provinces and sectors.

Goals and Actions

At this stage, EHRC and the Renewing Futures team is proposing initial ideas and strategic elements that will be confirmed and refined by industry stakeholders as the strategy is implemented. Findings in this report and this framework for a strategy have been presented to a series of industry stakeholders in regional engagement sessions. Initial support is apparent – but participants were not uniform in their views of the specific actions that would address challenges at the province or sector level. Specific strategic actions must be identified to engage a wide range of stakeholders.

The strategy needs clear goals that can be measured and timelines marking progress. Stakeholders agree that success means:

- More graduates from post-secondary programs in sufficient numbers and with qualifications that meet employer needs, and
- More bridges that connect programs, certifications and employers across sectors and provinces to provide mobility in job search and career prospects for advancement.

Strategic actions will be initiated for each occupation platform, by sector, and will focus on the specific needs and circumstances highlighted in the research findings. Initiatives will have specific elements that target practical actions and advantages for individual employers:

- Training and certification content that addresses needs,
- Plans for promoting the adoption and use of new HR features, and
- Certifications or designations that allow measures of completion and subsequent progress in labour markets.

Stakeholder groups are will be invited to consider initial strategic actions for each occupation group and sector based on the research findings.

Implementation and Next Steps

Over 400 RE stakeholders participated in the survey, focus groups and regional engagement sessions that were part of the RF research process. Their input provided guidance towards the development of key elements of a national HR strategy and will be crucial in the implementation of the strategy.

Implementation will need to build a growing community of supporters from each sector and province. Awareness and support can be built from a core group that includes representation from:

1. The Renewing Future Steering Committee and Electricity Human Resources Canada,
2. Employers/ associations (all sectors),
3. Organized Labour,
4. Post-secondary programs (all),
5. Government (all).

This core group could start the development of strategic action plans in a series of sub committees for:

1. Leaders/Management
2. Engineering/Technology
3. Trades
4. Wind Specializations
5. Solar Specializations

Each group would begin by reviewing these research findings in detail. In the event that their experience of HR conditions is sustained from this work, the groups could then prepare draft strategic actions built on those proposed here.

There is always a risk that investments in HR development will be frustrated if markets turn down and jobs to not materialize. This risk is present in the RE situation – but has a very low probability. Strong momentum supporting employment growth is tied to technological change and the environmental imperative. The much larger risk here is that Canada will not have the skilled workforce needed to deploy new RE capacity. Renewing Futures offers the basis for managing that risk in the report findings and elements of a strategy presented here.

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Appendices and Supporting Documents

Bibliography and Sources

Appendices

1. The employer survey
2. The labour market model
3. An inventory of Post-secondary Training
4. Methodology

Sector Summaries

- Growth and Change
- Technology and the Value Chain
- Stakeholders
- Labour Markets
- Conclusions and Implications

Provincial Summaries

- Growth and Change
- Technology and the Supply Chain
- Stakeholders
- Labour Markets
- Conclusions and Implications

A National Human Resources Strategy for Canada's RE Sector

- **The need for a Strategy**
  - Growth, uncertainty and shared HR features
  - Mobility, flexibility and quality
- **A National Strategy**
  - Sectors
  - Provinces
  - Stakeholders
- **Building the Strategy**
  - Draft description
  - Validation
  - Building Consensus
- **Implementing the Strategy**

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