Renewing Futures Labour Market Information System

Table of Contents

Executive Summary

The Renewing Futures Labour Market Information (RFLMI) system consists of six models that gather data from a variety of sources and combine measures to arrive at an assessment of labour markets for twenty-six key occupations. These assessments, and the measures in the related models, are projected over the period from 2012 to 2022 in nine regions and for three scenarios. Components of the system are described here and preliminary estimates and projections are provided for an initial review.

The six system components are:

1. ***The RF Inputs model,***
2. ***The Provincial Occupations Modelling System (POMS),***
3. ***The Electrical Generation, Transmission and Distribution model,***
4. ***An Inventory of Post-Secondary Programs,***
5. ***The Prism – JEDI model, and***
6. ***The RF LMI Occupation model.***

The RF Inputs model is an extension of the Technology Profiles and Market Assessments in the Technology Review report. This starting point estimates the cumulative total and annual changes in installed capacity in six renewable energy sectors, in each province and for each scenario. Scenarios are designed to span the range of likely outcomes for RE construction and operations:

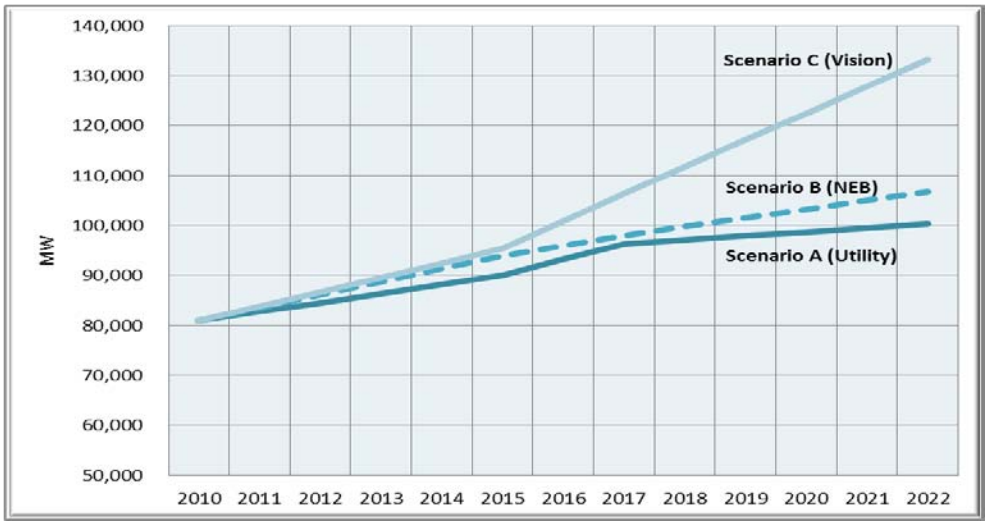
Scenario A – A utility scenario based on the plans of Provincial Utilities for connecting RE sources to the grid.

Scenario B – is based on the 2011 National Energy Board projection for electricity capacity and generation by Province and by RE sector.

Scenario C – is built up from the projections, potential and announced policy targets of the industry groups and provincial governments.

Scenario C is intended to represent the upper boundary of capacity installation and related labour requirements. Exhibit A illustrates the range in MWs of installed capacity. The ultimate objective of the RF effort is to assess the availability of skilled labour and the labour requirements of the RF plans from 2012 to 2022.

Exhibit A
Installed Capacity in Canada, all RE, 2012 to 2022, three scenarios



Source: Prism Economics and Analysis, Electricity Human Resources Canada

The Provincial Occupations Modelling Service (POMS) is an existing service provided by Stokes Economic Consulting that provides detailed measures for labour markets in all Provinces, for 80 industries and over 500 occupations. POMS analysis for the 26 key ERE occupations is another basic starting point.

The Electricity Generation, Transmission and Distribution model was first created as part of the 2011 report "Power in Motion"; using input from the POMS model and other labour market analysis to prepare labour market assessments for nineteen key occupations in the Electricity industry. This model represents a portion of the RE workforce and a further pool of labour from which RE employers will recruit. The Electricity Model has been updated with new historical data and projections and provides a further source for RE HR analysis.

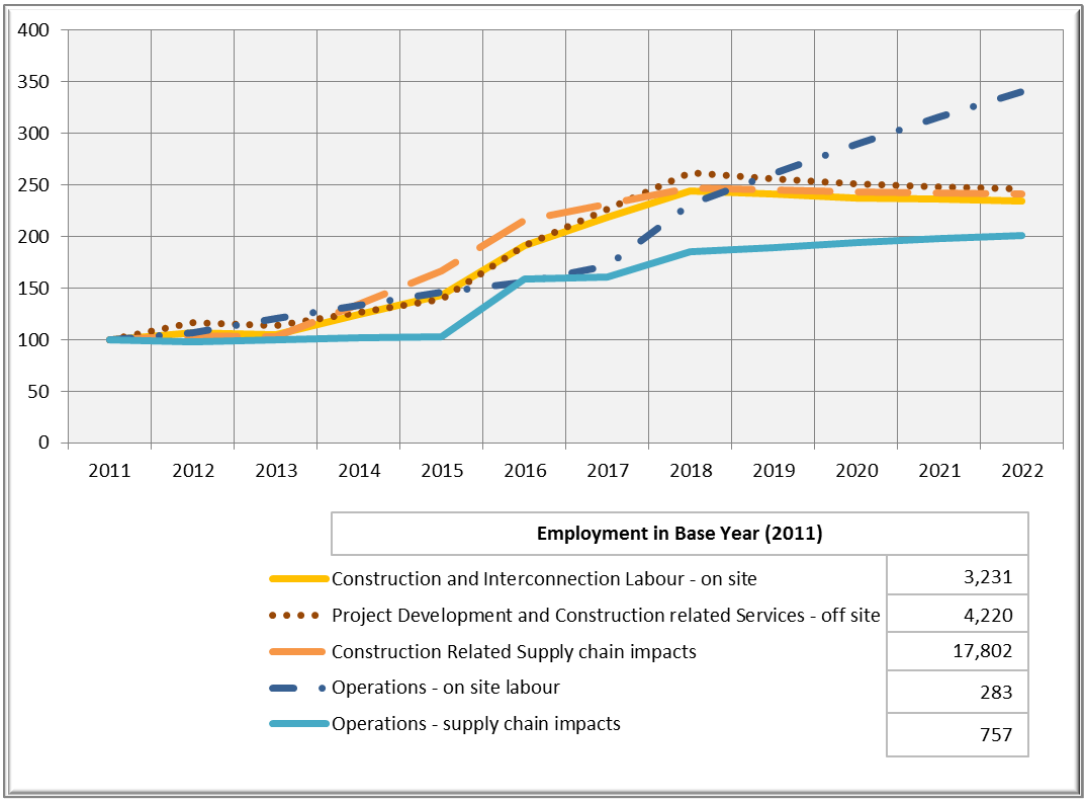
An inventory of post-secondary programs that cover RE related skills and technology has been prepared to add depth to "supply side" analysis. The inventory tracks university, college, apprenticeship and private programs and certifications that are preparation for the twenty six key occupations in RE.

The Prism–JEDI model represents a bridge from the RF Input model to the labour market assessments. The model estimates jobs in groups of occupations for each RE sector based on projected changes in installed capacity for each scenario. Calculations are based on an adapted version of the models, estimating employment in renewable energy, developed by the National Renewable Energy Laboratory (NREL) in Colorado. The NREL has developed a series of spreadsheet based models (Jobs and Economic Development Impact (JEDI) models) for each RE technology. These models have been adapted to Canadian conditions and used to estimate jobs for each scenario, sector and Province.

Output from each of these five sources is used to prepare partial estimates of the level of employment in the key RE occupations and to prepare a series of growth profiles for these occupations for RE activity in each Province.

These growth profiles reveal the key dynamics that will drive labour requirements and recruiting patterns for RE employers. Exhibit B highlights these patterns at the national level for the "vision" scenario.

Exhibit B
Employment Drivers – Supply Chain Profiles, Canada, Scenario C (Vision)
Index 2011 = 100



Source: Prism Economics and Analysis, Electricity Human Resources Canada

Index numbers set equal to 100 in 2011, track the cumulative growth in employment at five key points of RE activity. These patterns reveal the likely pressure points and the extent of long term labour requirements at the upper bounds of the projections. The largest workforce will be in the "Construction Related Supply Chain Impacts" which are primarily the manufacturing and distribution of the components of the generation systems. This area and other construction related activity will rise by more than 150% by 2019 and remain at that peak level after 2020. This more than two-fold increase in labour requirements will be spread across the key RE occupations and the challenge for RE stakeholders is preparing to meet these demands.

The RF LMI Occupation model draws together all the components described above to develop partial employment estimates and full labour market profiles for twenty-six key occupations that were identified by employers and other stakeholders in the industry survey and interviews. Occupational profiles cover broad labour market conditions for all industries in each province and then drill down to more detailed analysis at the level of the electricity industry and then for RE employers. Labour market conditions include demographic profiles that project new entrants, retirements and mobility including immigration. Information on post-secondary training programs is matched to the occupations and used to develop strategies for skill shortages. Occupational profiles developed in the RFLMI model serve as the basis for developing HR management strategies for the industry and for individual employers.

1. Introduction

Renewing Futures (RF) is an initiative of Electricity Human Resources Canada and it aims to assess the capacity of Canada's workforce to design, manufacture, build and connect a growing investment in renewable energy. Analysis in support of the assessment includes; a technology review, key informant interviews, an employer survey, an inventory of postsecondary training and certification programs and projections of industry conditions. Synthesizing all this into insights for human resource managers, planners and policy makers is a key challenge. The final outcome is a national human resources strategy that support investments, policies and related decisions to make optimal use of all Canada's workforce.

Insights are gathered from a very broad range of sources and measures, many of which must be projected into the future. Wherever possible the research process for RF relies on measures and analysis that can be revisited and reviewed to test the importance of assumptions, technologies and other key drivers. A labour market model that gathers measures for all the key dimensions is a core tool that makes the synthesis transparent to the users.

This report describes the Renewing Futures labour market information (RFLMI) model and introduces RE stakeholders to many drivers, factors and measures that will determine the requirements and availability of key occupations needed to build and operate Canada's expanding RE system. The key objective of the model is to link measures and related projections of employment in key occupations to key drivers.

2. Scope and Methodology

This section sets the stage for introducing the RFLMI model by considering the scope for the research and various alternative methodologies that could be applied.

Scope

The dimensions of the model are set by the agreed scope of the Renewing Futures initiative and the extent of reliable data. In its core conception, the model targets a description of conditions across:

Electricity Related Renewable Energy (RE) Sectors

- Wind
- Solar
- Bioenergy
- Geothermal
- Small and large Hydro
- Marine
- Utilities - storage, distribution and Smart Grid systems

Electrical Power Industry

- Generation, Transmission and Distribution
- Electrical Power Construction

Provinces

- Newfoundland and Labrador
- New Brunswick
- Prince Edward Island
- Nova Scotia
- Quebec
- Ontario
- Manitoba
- Saskatchewan
- Alberta
- British Columbia

Occupations

- engineering managers
- electrical engineers
- mechanical engineers
- civil engineers
- environmental and other engineers
- electrical engineering technicians and technologists
- civil engineering technicians and Technologists
- mechanical engineering technicians and technologists
- electricians
- power system electricians
- power engineers and power station operators
- electrical power line and cable workers, including substation technicians
- design technicians
- welders
- installers
- construction trades helpers and labourers
- machinists
- machine operators

- plumbers, pipe / steam fitters and refrigeration and air conditioning mechanics
- crane operators
- heavy equipment operators
- estimators
- financial administration and accounting
- lawyers, legal administration and policy
- supervisors and managers
- sales and marketing
- supervisors and managers
- information system analysts and consultants

Supply Chain

- Research, Project Planning, Design (Construction and Installation, off-site)
- Manufacturing and Distribution (Equipment and Materials)
- Construction and Installation, on-site
- Operation and Maintenance, on-site and
- Operation and Maintenance, off-site.

Each dimension embraces a range of economic activity. Decisions defining these always raise questions and prompt trade-offs. These questions and trade-offs are discussed here.

Renewing Futures has chosen a specific scope of analysis that includes ***Electricity Related Renewable Energy or (RE)***. The scope includes all activity across the supply chain that is linked to electricity generation, in each sector, connected to the grid. From the perspective of statistical classifications, this activity will include work in many industries including; manufacturing, construction, professional services and other industries outside the existing electricity industries[1].

A similar analysis for the 2011 "Power in Motion" study included a scope that covered the Electrical Power Generation, Transmission and Distribution and the Electrical Power Construction industries. Measures of activity (e.g. employment, power capacity, generation, etc.) in these sectors are a natural reference point for the model. But these measures are also incomplete as, for example, they *exclude* work contracted out to consulting engineers, IT firms and others. It turns out that the work in these other industries can be a critical part of investing and adapting to new technologies.

Human resource managers tend to prefer analysis at a provincial (or even regional) level. As the regions grow smaller the statistical reliability diminishes. *To manage this trade off in the RF LMI model, it was decided to work with all provinces as much as possible with the exception of PEI which is combined with New Brunswick.*

Analysis begins with twenty-seven occupations (or groups of occupations) that have been identified as important to the industry either in the employer survey or in other research. A smaller group of

[1] The most important classification systems for this work are the North American Industrial Classification System, including the new 2012 version and the National Occupational Classification (NOC). Wherever possible the analysis targets 4 digit NAICS industries and NOCS occupations. These are important reference points for relating measures used in the study back to traditional economic statistics.

occupations is selected for more detailed analysis where there are limitations in related measures; for example tracking post-secondary programs that prepare new entrants.

Finally, measures across the supply chain are critical for RE analysis. Electricity generation is a capital intensive process that employs relatively few people during operations. Employment impacts for RE work are concentrated in project planning, design, construction, installation and, in particular manufacturing and distribution. Indeed, the approach to RE taken in the European Union (EU) seems at times to be entirely focused on the capacity of local manufacturers to gain, develop and sustain a global advantage in RE technologies, manufacturing and export markets. This activity is associated with the largest share of employment. Employers often operate across many links in the supply chain; making the allocation of employment difficult.

While this scope is ambitious, it reflects the needs and preferences of key stakeholders including employers and trainers. Data limitations and reliability require that some dimensions be dropped in certain circumstances.

Methodology

Employment impacts are often seen as a key objective of national policies and programs that promote RE investments. There has been a corresponding focus on the measurement of these impacts as an outcome of government policy. The Renewable Energy Technology Deployment (RETD) project at the International Energy Agency includes an effort to create standards for these measures and promote a common understanding of what is happening in the economy. The RETD group has reviewed labour market research and employment impact analysis through the Economic and Industrial Development – Employ project. After reviewing several studies, the findings from this work have emphasized a distinction between two types of research; gross and net employment impacts.[2] The Renewing Futures analysis of labour markets presents a unique approach that includes the gross impacts and then adds an entirely new dimension.

Economic analysis of employment impacts from RE investment can apply a range of models and approaches that assess the incremental change in the economy. The broadest approach includes a wide range of impacts that span the entire economy and reflect the impact of changes in energy markets that precede and reflect root causes of RE investments. This approach is called the “Net Impact” methodology and it is the most complex analysis. This approach reflects policy choices and energy market changes that substitute one energy source for another. In this view, the policy implications of RE investments would need to set employment losses in other sectors against gains from RE activity. Energy policy, for example, that seeks to replace coal or nuclear capacity with RE could be assessed with this approach so that employment losses in the former sectors can be set against gains from added RE. These and other complex and economy wide impacts are the focus of “net impact” analysis.

[2] See for example “Review of Approaches for Employment Impact Assessment of Renewable Energy Deployment, Economic and Industry Development, EID” – Employ, Franhoffer ISI, Rutter + Partner, Energy Economics Group

A narrower approach is used to assess only the "gross impacts" of RE investments on the jobs created as the new electrical capacity is developed, designed, manufactured and installed. The RFLMI model uses this approach for the demand side of the analysis. Attention here focuses on the detailed distribution of jobs across the supply chain and across regions. Models are designed to measure three types of added jobs; direct, indirect and induced. Direct jobs are related to the immediate effect of spending on the project. These impacts include jobs created from the investment spending of the procurement of goods and services and construction in the first round of activity. Indirect spending includes the second round of jobs created as suppliers increase their activity in response to the first round of orders and activity. Indirect impacts are largest in the manufacturing and distribution areas as the demand for steel, electronics and other components increases in response to original equipment manufacturers (OEM) orders. A large share of RE system investments is for the generation systems components and these create a large number of indirect jobs. Often, the development of the manufacturing system to supply RE components is a primary objective of RE policies.

Direct and indirect employment impacts are covered in the RFLMI model.

Induced impacts are related to third and further rounds of job creation that are attributed to the ripple effect of spending across the entire economy. This would include jobs created as a consequence of higher profits and incomes, consumer spending and investments as the economy grows. Induced impacts are ***not*** included in the RFLMI model.

Traditional employment analysis studied by the RETD programs, does not consider the potential for labour and skill shortages in the process. Canada's experience with shortages, in part related to strong resource development and other investments, have added this dimension to the mandate of the Renewing Futures initiative. Indeed, the analysis of the capacity of the Canadian workforce to meet the expected labour requirements is the priority objective of the work. This is not the usual focus of the employment analysis considered in other jurisdictions.

In this regard the Renewing Futures approach covers analytical ground not anticipated in the RETD process. Our focus is on the state of demand *and supply* in the key labour markets for the occupations needed for RE investments.[3] Requirements covered in the model include both direct and indirect impacts – but the analysis goes one step further to consider the available workforce (the supply side) and the supply / demand balance for labour in other, competing sectors.

[3] International studies have included the impact of RE deployment on labour markets and the available workforce. See for example the ILO report "Skills and Occupational Needs in Renewable Energy" International Labour Office, Geneva, 2011

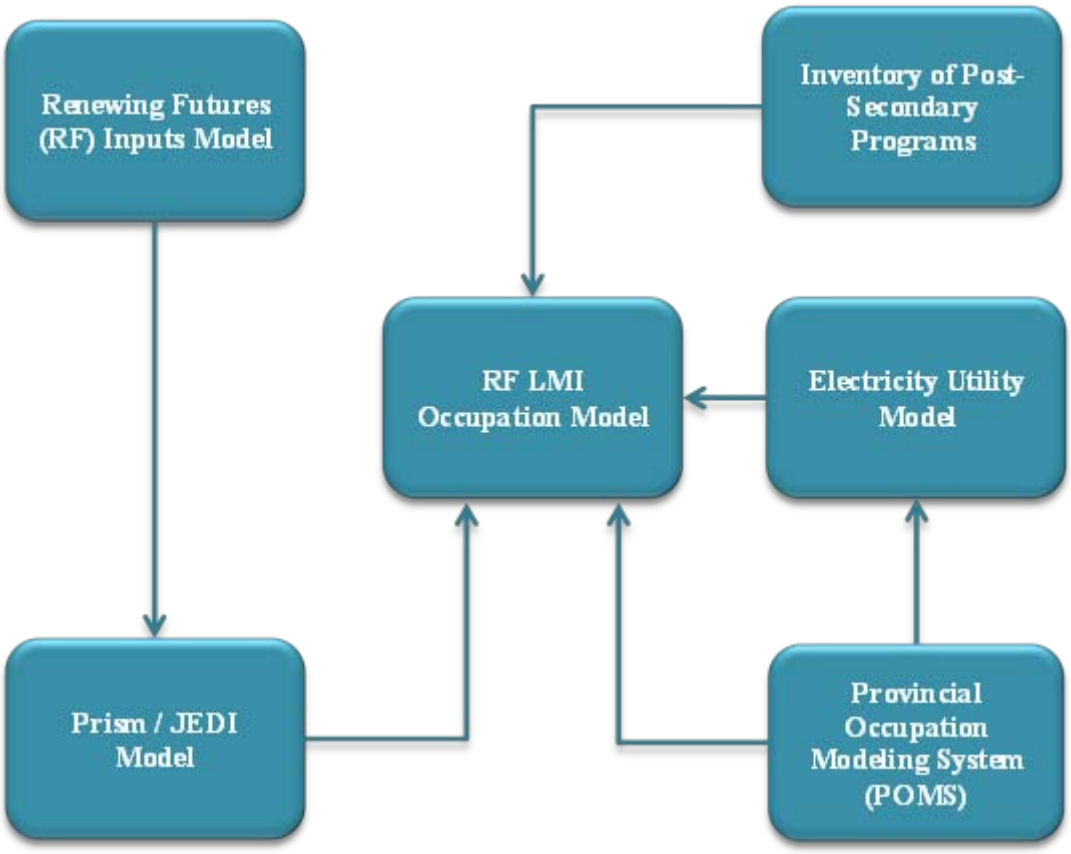
3. Model Description

Human resources, and related labour market effects, in the electrical power industry, fall into two distinct parts; building and operation. The operation of electrical power generation and distribution systems is a capital intensive and stable process. A small group of highly skilled workers can manage vast systems for long periods once they are established. Long term employment arrangements, for utilities operating the systems, encourage employers to invest in training and certification systems that solidify a base of specialized skills. In contrast the design, project planning, equipment manufacture and construction of large scale electricity generation systems create cyclical and specialized waves of large labour requirements. Employment associated with this work is significant and spread among utilities / operators, related companies, contractors and consulting firms.

These latter features come closest to describing the RE sector in its current stage of development. Growth and change in the installed capacity of the RE systems create the major human resources and labour market issues that are to be considered here. A later, operational, stage emerges for RE and it has its own distinct HR challenges. Preparing a workforce to operate and maintain the operational stage is also an important part of the RF mandate.

The Renewing Futures Labour Market Information (RFLMI) model tracks the growth and operation of both the conventional and RE generation and distribution systems. The model draws together measures from five related systems. This section describes each of these five “input” sources and the RF LMI model that synthesizes the results. Exhibit #1 summarizes the structure:

Exhibit #1
Five Components of the RF LMI Model



Provincial Occupation Modelling System (POMS)

The Provincial Occupational Modelling System (POMS) was developed by Stokes Economic Consulting as an extension to an economic forecasting model that they have maintained for years. The key features of the modelling system are:

- A bottom up approach to projecting economic activity that starts with industries at the provincial level,
- Detailed analysis of demographic change by age groups including; retirement, immigration, interprovincial mobility and entry, and
- Extensive detail and granularity for labour markets.

The system fills a need for Canadian labour market information that is created by the limited sample size and coverage of key Statistics Canada labour surveys and the census. POMS creates historical estimates

and projects long term forecasts for over 50 industries and over 500 occupations in all provinces.[4] A unique demographic structure characterizes annual changes in the labour force by retirement, mortality, new entrants, international immigration and net in-migration.

POMS measures for each selected occupation include two dimensions of demand or labour requirements (expansion demand related to economic growth and replacement related to retirement and mortality) and three dimensions of labour supply (the change in unemployment, new entrants from the regional population age 15 to 30, immigration and other in-mobility).

POMS was used as a building block for the electricity industry model developed in the "Power in Motion" study; covering key occupations in the Electricity Power generation, transmission and distribution and Electrical Power Construction industries. This analysis has been updated here and creates the basis for market assessments for large hydro generation and for new features of distribution including storage, integration and supply / demand management.

Inventory of Post-Secondary Programs

This component of the RFLMI model has been created by updating some features of the "Power in Motion" analysis and creating a new inventory of post-secondary programs offered across Canada to the workforce for key occupations. The inventory captures the extent and the scope of university, college, apprenticeship and private programs that teach elements of each RE sector.

RF Inputs Model

This model forms the bridge that connects to the Technology Review prepared in the first stage of the Renewing Futures project. The Technology Review was broken into two parts; Technology Profiles of each of the six ERE sectors and Market Assessments for each province.

The RF input model draws from each part of the Technology Review. First, it takes the analysis of mature technologies and research on the installed cost per MW from the Technology Profiles. Second, it takes the projections of MWs of installed capacity in each of three scenarios from the Market Assessments. These findings are expanded into annual estimates of MWs of installed capacity in each province, sector and scenario from 2011 to 2022. The MWs of installed capacity are the key driver for labour requirements; setting the patterns of year to year change that determines employment in operations and construction.

Scenarios capture a wide range of possible patterns of installation of new electrical capacity reflecting alternative views of policy, technology, market conditions and other factors. Growth is the key characteristic driving business opportunities and risks for planning. Employment ramps up as projects are planned, designed and built and then drops as work is completed. These cycles create variable conditions and associated risks and uncertainty for employers and the workforce. The magnitude of

[44] For more information see http://www.workforceoutlooks.ca/index.html . The POMS system captures all the four digit level industries in the North American Industrial Classification System and in the National Occupational Classification system. This is the most detailed analysis available for Canadian labour markets.

these changes is determined in the design of the three scenarios and they define upper and lower limits to labour requirements.

A. The *Utility Case* (Scenario A) 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 the capacity of systems, are key decision makers. Projections of installed capacity for each RE sector have been developed in this scenario using this source.

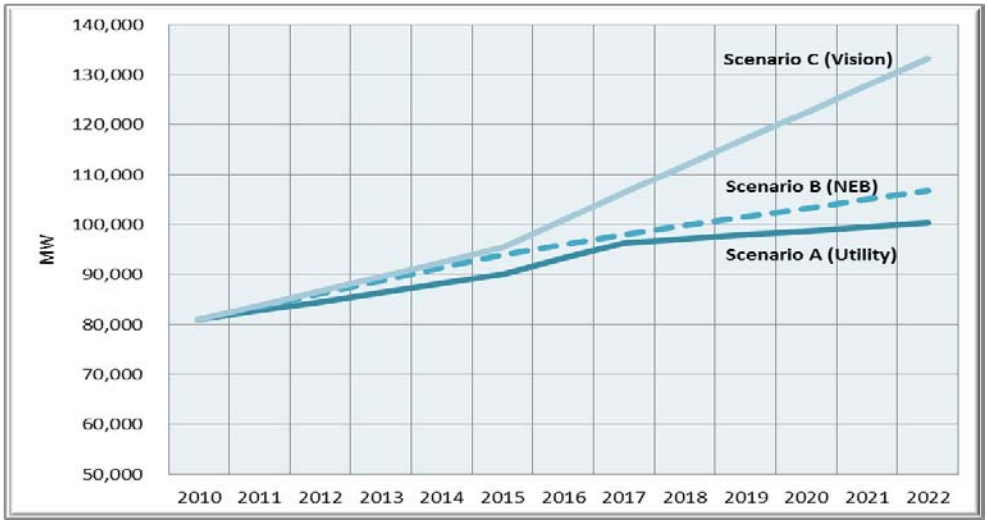
B. The *Reference Case (Scenario B)* is based on the National Energy Board (NEB) 2011 "Energy Supply and Demand Projections to 2035". With some modification and added details this document identifies one perspective on the growth of RE installed capacity. This is not the only projection available, but it is 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 (Scenario C)* 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.

Exhibit #2 provides an overview of the total installed capacity in RE. In each scenario the projections are built up on known plans for announced projects or targets of government policy. As projections move further into the future less is known about these projects and policies. Declining levels of new installed capacity later in the scenarios are partly a function of this uncertainty. More details on the preliminary findings from the system are covered in the *Preliminary Results* in section 4 below.

Exhibit #2

Installed capacity in Canada, all ERE, 2012 to 2022, three scenarios



Source: Prism Economics and Analysis, Electricity Human Resources Canada

Each annual increment to installed capacity is the core building block for labour requirements. Research on costs for installed capacity and the market ready technologies in each sector are combined with these estimates to project labour requirements. As noted in the Technology Review, there is a wide range of uncertainty around these elements. Exhibit #3 reports the assumed starting points for the installed cost of each technology ($ /KW) and expected annual changes across the scenarios.

Exhibit #3
Key Assumptions for Installed Capacity in the ERE Sectors, 2012 to 2022

ERE 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: Prism Economics and Analysis, Electricity Human Resources Canada

In order to accommodate the very high level of uncertainty and the importance of these assumptions in determining labour requirements, the model is designed to allow alternative solutions based on different estimates of key assumptions. In this way the RFLMI model is created as a tool for analysis as well as a basis for projections. The three scenarios are one aspect of this approach as the system allows for changes to the estimated MWs in each province and year. Other measures are introduced and the analysis is refined as the model adds estimates of employment in the next step: Prism / JEDI model.

Prism / JEDI model

The Market Assessment of installed capacity is converted into employment, using a series of spread sheet models developed at the National Renewable Energy Laboratory (NREL) in Golden, Colorado. NREL offers a series of Jobs and Economic Development Impact (JEDI) models on its web site.[5] These models have been developed to estimate labour requirements for renewable energy systems in all of the sectors included in the RF scope. Further, the models can be customized to reflect conditions in Canada by adapting a wide range of features. During the course of adapting the JEDI models to meet the needs of the RFLMI model, the consulting team reviewed;

- MWs of installed capacity,
- Project size,

[5] See http://www.nrel.gov/analysis/jedi/download.html on the NREL web site.

- Project features (e.g. on-shore versus off shore wind, residential retrofit, new residential, small and large commercial installations for solar PV),
- Cost of installed capacity (e.g. including labour costs),
- Annual change in costs (e.g. allowing lower costs reflecting technological improvements),
- Costs of generation system components and balance of system equipment, and
- Local content for manufactured components.

JEDI models are available and were adapted for use in the RFLMI system for:

- Wind on-shore
- Solar PV
- Small Hydro (run of river)
- Biofuels (Wood based)
- Geothermal
- Marine and Hydrokinetic

Once adapted to fit the provincial and sector specific conditions determined in the Technology Review, the JEDI models were used to determine employment at five points in the value chain:

1. Construction and interconnection labour, on-site
2. Project development and construction related services, off-site
3. Construction related supply chain impacts
4. Operations, on-site labour
5. Operations, off-site labour

Employment estimates at these five points on the supply chain form the basis for labour requirements for key occupations in each scenario, province and year. Parameters in the model create the resulting profile for labour requirements distributed across time, sectors, the supply chain, regions and occupations. Note, for example, that the PRISM / JEDI model distributes employment during the three construction phases across three years as projects are designed and built. The capital intensive nature of electricity generation means that a very large proportion of project costs are for the generation system components. This in turn implies that the indirect employment impacts, captured in "construction related supply chain impacts", are often the source of the most jobs. Much depends on where the components are built. The local content of manufactured components has been set, in each market, to reflect both government procurement policy and provincial manufacturing capabilities.

The Electricity Utility Model

This model was originally created as part of the "Power In Motion" study that was completed by Electricity Human Resources Canada in 2011. This model assesses labour market outcomes for nineteen key occupations that were identified by employers. Conditions for these occupations (in each province and employed in all industries) were linked to the overall labour market conditions described in the POMS model. These broad regional measures are assumed to reflect the market conditions that confront electrical utility recruiters and job seekers in each occupation.

The model also estimates employment measures for occupations for the Electricity Generation, Transmission and Distribution industry (NAICS 2211) with data taken from the 2006 Census. Census values are updated to 2011 levels using measures of the change in industry output and investment. These calculations estimate the extent of employment for each occupation in the utility industry and the related increase or decrease in the proportion of that industries workforce the overall workforce over time. Projections for utility based employment for each occupation were projected into the future based on a combination of output and investment forecasts.

The 2011 values and projections have been updated for the 2013 RFLMI model. The logic used in 2011 is repeated with the idea that ERE employers will draw some new recruits from with the broader regional pool of labour or from the utilities where skills and experience are more closely related to ERE requirements.

RF LMI Occupation Model

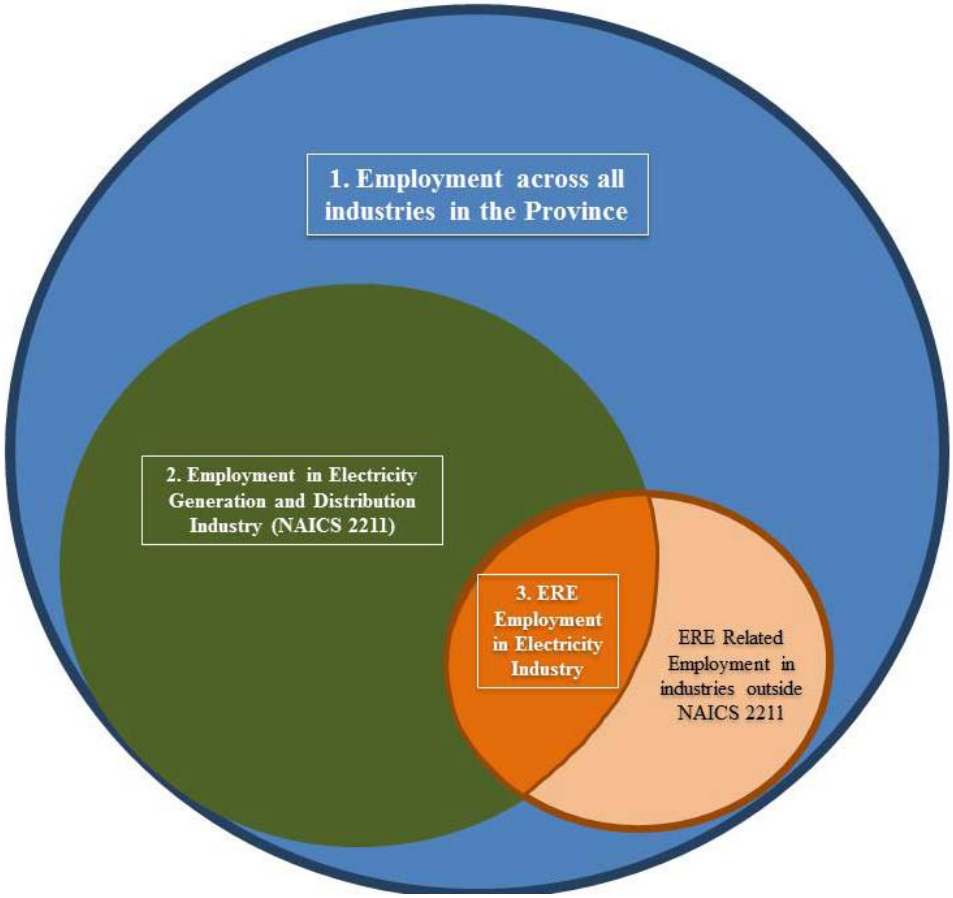
The final component of the system is the RF LMI Occupational Model. At this point the analysis gathers all the parts described above and focuses them on a series of twenty seven key occupations. These occupations have been chosen on the basis of the employer survey, findings in the "Power in Motion" study and other criteria. Labour market measures, for each occupation, are assessed at three levels:

1. Employment in all Industries, province wide,
2. Employment in the Electricity Generation, Transmission and Distribution Industry, and
3. Employment in the Electricity-Related Renewable Energy (RE) sectors and this includes;
    a. RE employees included in the electricity Generation, Transmission and Distribution industry
    b. All other RE employees

The model includes measures for each occupation at level 1 and 2. An estimate for 3a is obtained by dividing the workforce in 2 (the electricity industry) into large hydro and other RE based on the installed capacity of each sector. The first two levels repeat the structure of the electrical utility model described above. Note that the ultimate target for the RFLMI model is the RE workforce and that it lies both in the existing electricity generation, transmission and distribution industry and in other segments of the supply chain.

Exhibit # 4

RELMI Model: Three levels of labour market analysis for each occupation



1. Province wide, all Industries

First, labour markets that set HR conditions (e.g. compensation, training and certification standards, etc.) span each Province. Employers are most likely to recruit from the pool of available labour across the Province and the qualifications of the workforce are assessed against Provincial standards, certification and post-secondary programs. In most cases candidates for the key occupations, required for RE employers, are working (or seeking work) across many industries. The RE workforce is a very small part of that larger Provincial labour market. This means that the market conditions for each occupation is determined by supply and demand balances *outside* the narrower boundaries of RE employers. Note that these measures span all the segments in the supply chain.

The RF LMI model picks up the details in the POMS model, both for history and projections over the period from 2012 to 2022 and measures:

- Employment
- Labour Force
- Unemployment
- Normal Unemployment
- Replacement Demand
    - Retirements
    - Mortality
- New entrants (from the Provincial populations age 15 to 30)
- Net in-mobility
    - Immigration
- Labour market rankings for supply / demand balance

These measures and the associated projections describe changing market requirements and the shifts in the availability of the needed workers. Supply / demand balances can be traced back to key dynamics such as changing unemployment, the proportion of the Provincial workforce entering the occupation, the projected level of immigration and other factors.

2. Electricity Industry (Generation, Transmission, Distribution and Construction)

Employment of the key occupations in the electricity utilities is another reference point. To the extent that occupations have skills or experience that is specialized to RE needs, they will likely have been learned in this workforce. Employment in this industry was estimated as part of the "Power in Motion" study and this model, described above, has been updated for the RF LMI model. In particular, employment estimates for key occupations working in electricity generation, installation and distribution, outside the six RE sectors, are drawn from this traditional pool of labour. Specifically, the workforces for large hydro projects and for the distribution systems are analyzed from this perspective.

Statistics collected for these industries, and the associated analysis in the "Power in Motion" study, include some measures of the electricity related renewable energy (RE) workforce. By far the largest group counted here is the workforce employed in large hydro generation. This group is counted as part of the RE study and the RF LMI model estimates this group by assigning a portion of the total conventional industry workforce determined by the share of large hydro in the generation capacity in each province.

3. Electricity Related Renewable Energy (RE) Occupations

The third level of analysis assesses the workforce employed by the RE employers themselves. This is the most immediate focus of the Renewing Futures study. At this stage of the analysis the model projects the likely pace of change in employment in each occupation with RE employers. The pace (i.e. growth in employment to 2022) and distribution (i.e. across ERE sectors and the supply chain) of the change are the defining features of human resource issues.

In this model each key occupation is assigned a profile for change in each scenario. Employment growth to 2022 is set by the growth in (additions to) installed capacity in each sector and the distribution of jobs across the supply chain. Each of these components is set out in the PRISM / JEDI model solutions described above.

Ideally the model would specify the number of employees in each occupation working in the RE sector. Estimating this number is made difficult by the nature of the relationships of employers to RE construction and generation and the supply chain. The employer survey has shown that a majority of employers work in other industries, in more than one RE sector and in more than one segment of the supply chain. *Under these circumstances, building an estimate of the labour force dedicated to RE work across all the segments in the supply chain from the current statistical base is not possible. A large portion of the RE workforce works across RE sectors and / or across the supply chain and this mobility makes it difficult to assess their role in renewable energy work alone. Evidence suggests that much of the workforce employed in RE work at one time may well be transferred to work in other sectors at another time.*

A partial estimate of the RE workforce can be constructed by assigning a portion of the workforce in electricity generation, transmission and distribution to the RE sector based on the distribution of generating capacity across sources. In this way a partial estimate of employment in each key occupation can be allocated to the RE segment by multiplying total employment in the electrical power industry by the share of generation represented by large hydro and the other six RE sectors. This approach is used to create a Base Year estimate for 2011 of employment for the key occupations and all other occupations in the full electricity generation, transmission and distribution industry and in the estimated RE portion of the industry.

Exhibit # 5 provides a range of employment estimates based on the updated "Power in Motion" model and the 2011 share of electricity capacity in MW by sector.

Note that the estimates in Exhibit #5 are preliminary and can be refined as additional Census data and other sources are refined for further model use. Estimates for RE (excluding large hydro), in the right hand column, are only a partial accounting with a large part of the workforce employed in other industries. Most analysis of employment in renewable energy suggests that a very large part of the workforce is employed in manufacturing and distribution of the machinery, equipment and balance of plant components that are installed in the generating capacity. There is a global market for much of this material and extensive international trade. The biggest global providers are in Europe and Asia. Canada has several successful manufacturers and local producers with links to global suppliers. Much depends on the extent of local supply in each installation and this, in turn, can be linked to Government procurement and other energy or industrial policies.

Exhibit #5

Estimated Employment by Occupation, Canada, Electric Power Generation, Transmission and Distribution and Electricity Related Renewable Energy

		Base Year (2011)		
Occupations	Total All Industries	Electricity Generation, Transmission and Distribution*	Electricity-related Renewable Energy	
			Including Large Hydro	Excluding Large Hydro
Engineering	**164,868**	**9,583**	**5,845**	**671**
Engineer managers	19,946	622	379	44
Electrical	36,565	4819	2,939	337
Mechanical	40,180	2657	1,621	186
Civil	52,309	627	383	44
Environmental and other engineers	15,868	858	523	60
Trades, Technicians and Technologists	**1,209,803**	**39,953**	**24,371**	**2,797**
Electrical Engineering Technicians and Technologists	34,255	3940	2,403	276
Civil engineering technicians and Technologists	15,611	541	330	38
Mechanical engineering technicians and technologists	13,811	1014	619	71
Electricians	89,170	291	177	20
Power system electricians	5,654	5258	3,207	368
Power engineers and power station operators	8,069	7286	4,444	510
Electrical power line and cable workers	13,016	10,487	6,397	734
Plumbers	56,188	2,167	1,322	152
Welders	97,645	483	295	34
Installers	38,397	105	64	7
Trades helpers and labourers	168,428	2,720	1,659	190
Contractors and supervisors in electrical trades and occupations	125,114	868	529	61
Machinists	52,075	221	135	15
Machine operators	387,875	3,850	2,349	270
crane operators	14,305	95	58	7
heavy equipment operators	90,190	630	384	44
Office and Related	**561,203**	**3,795**	**3,231**	**371**
Estimators	14,460	160	98	11
Financial administration and accounting	192,665	1,377	840	96
Lawyers, legal administration	75,115	295	180	21
supervisors and managers	125,114	1,435	875	100
sales and marketing	153,849	529	322	37
information system analysts and consultants	16,537	1,502	916	105
Total RE Key Occupations		**53,331**	**33,448**	**3,838**
Total All other Occupations		**53,606**	**32,700**	**3,752**
Total Occupations	**1,935,874**	**106,937**	**65,231**	**7,486**

Employment data provided in Table 5 are partial estimates of the larger RE workforce. The table covers the portion of the workforce employed in the electricity industry; leaving another group working for other employers.

Summary

This section has described the six components of the Renewing Future Labour Market Information model. The model is designed to estimate the conditions driving employment and related HR issues for twenty six key occupations in the RE sector. Employment estimates and related market conditions are built up from four sources:

- The anticipated annual change in the installed capacity for RE generation by Province (MWs),
- The technologies and the labour requirements related to installed capacity in each sector and Province,
- The current inventory of post-secondary training programs preparing new entrants and upgrading the skills of the workforce, and
- Labour requirements and demographic conditions that define provincial labour markets for the occupations working in all industries.

The model is designed to accommodate the uncertainty that surrounds any current or future assessment of labour markets by including parameters and alternative inputs that can be varied to assess:

- Economic conditions and related growth paths for industry output and investments that drive the demand for electricity,
- Alternative projections of new installed capacity by RE sector and province,
- Features of the generation process that alter the labour requirements in each sector (e.g. economies of scale in generation, project size, labour costs, the expected rate of declining generation costs, etc.).

These features of the model are included to allow industry stakeholders to alter key aspects of the projections and to assess their impact on labour requirements and related HR planning risks.

4. Preliminary Results

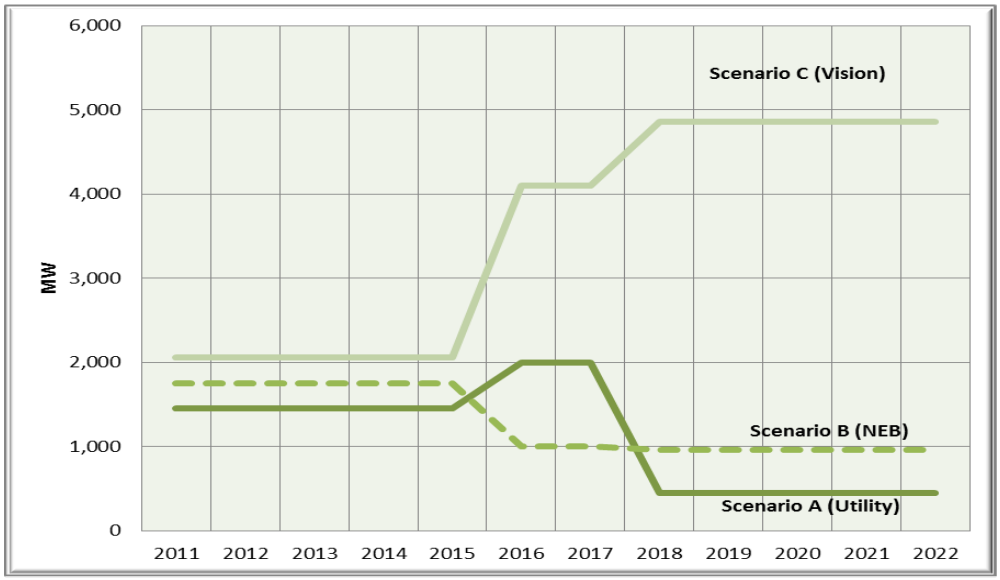
This section of the report adds tables and graphics that track preliminary results for the different model components and offers stakeholders a quantitative reference point for understanding and assessing the model results.

Projections for Installed Capacity

Exhibits 6 to 11 track the annual change and the cumulative total of installed capacity (in MWs) for the six electricity related renewable energy sectors in each of the three scenarios. Several features stand out. First, the additions to on-shore wind generation dominate in all scenarios and provinces with solar providing the next largest increments, but only in Ontario. Second, the annual investment in capacity rises to a peak in 2016 and then levels off or declines in most cases. Lower increments represent lower investment later in the scenario and this is related to the uncertainty about future prospects and the lack of project information. Since these profiles will drive labour requirements, this feature will focus attention, at least in the Vision Scenario, on the capacity of the available workforce during the peak years from 2015 to 2018. Third, activity is heavily concentrated in Ontario and this is a consequence of the focus on solar installations in that Province.

Exhibit #6

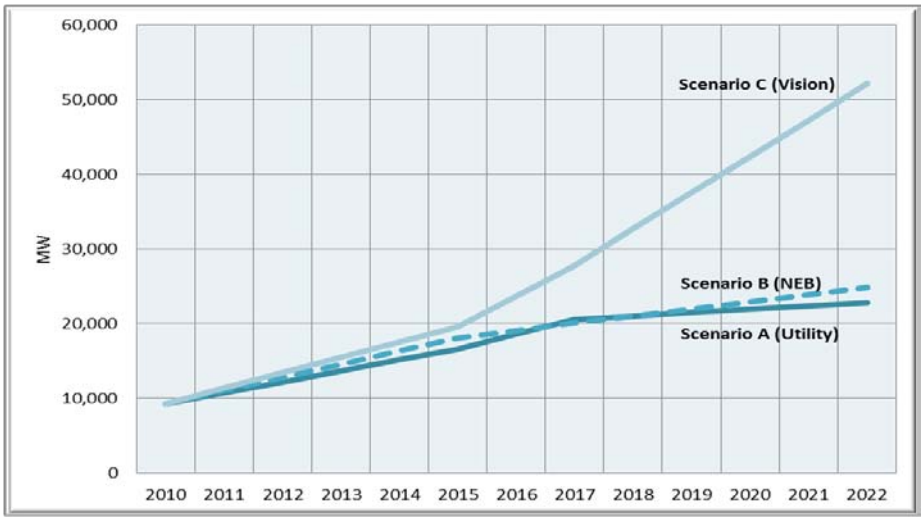
Annual Change in Installed Capacity, All ERE Sectors excluding Large Hydro, Canada, Scenario A (Utility), Scenario B (NEB), Scenario C (Vision), 2011 to 2022



Source: Prism Economics and Analysis, Electricity Human Resources Canada

Exhibit #7

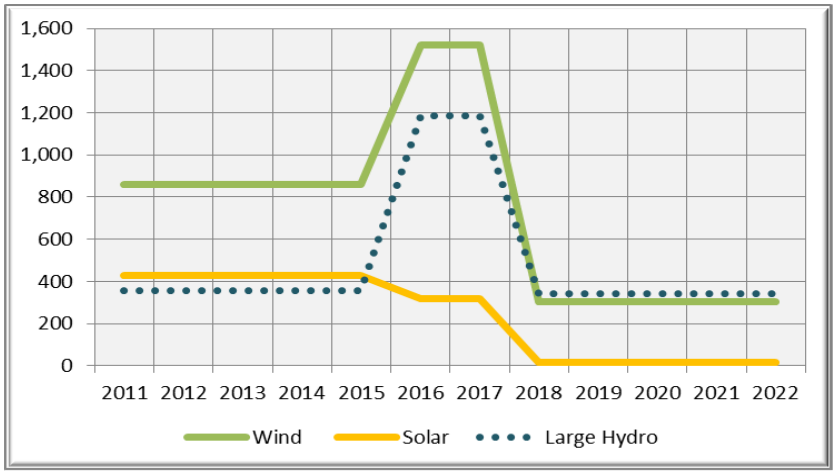
Total Installed Capacity, All ERE Sectors excluding Large Hydro, Canada, Scenario A (Utility), Scenario B (NEB), Scenario C (Vision), 2011 to 2022

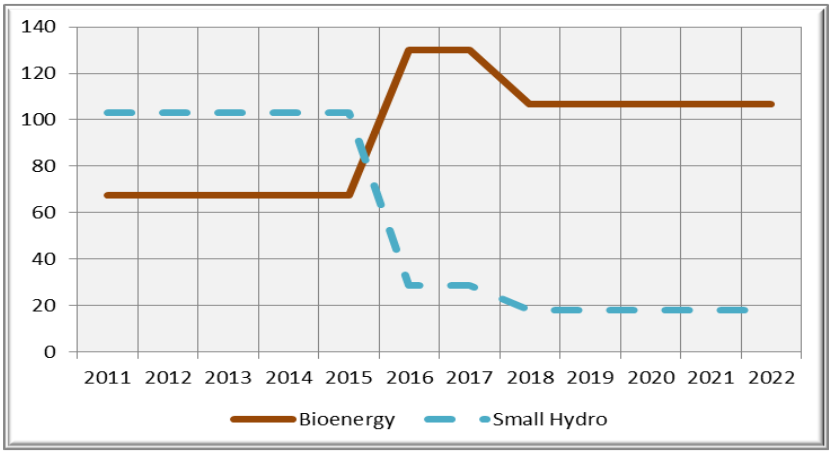


Source: Prism Economics and Analysis, Electricity Human Resources Canada

Exhibit #8

Annual Change to Installed Capacity, by ERE Sectors, Canada, Scenario A (Utility), 2011 to 2022

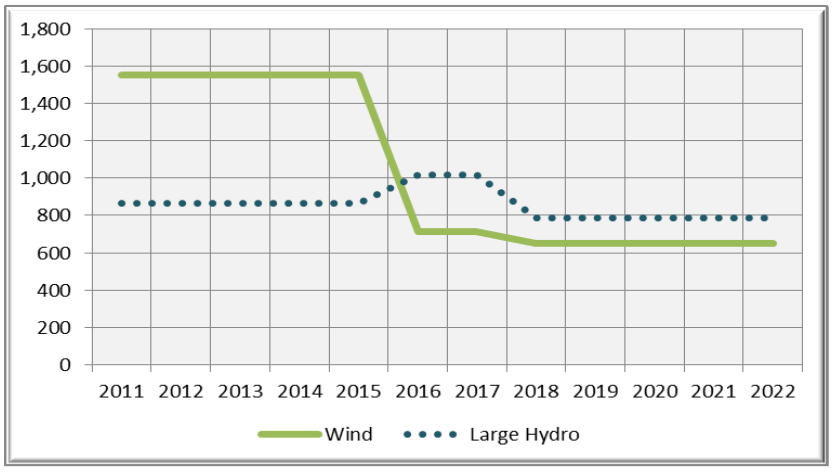


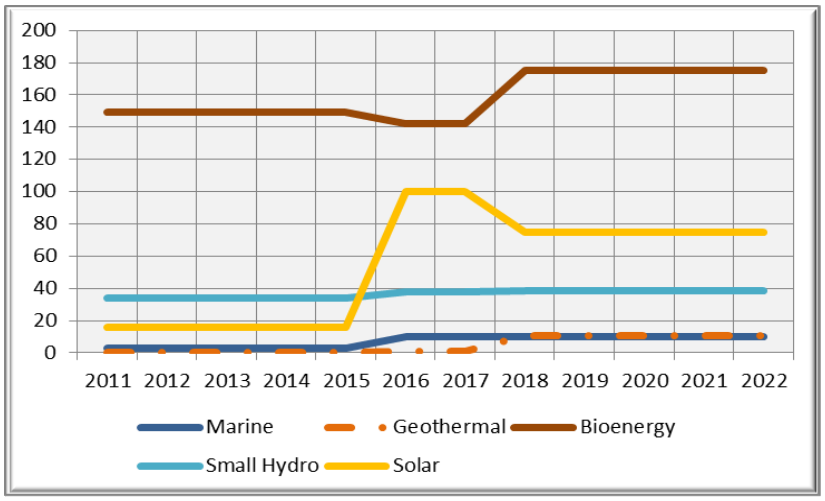


Source: Prism Economics and Analysis, Electricity Human Resources Canada

Exhibit #9

Annual Change to Installed Capacity, by ERE Sectors, Canada, Scenario B (NEB), 2011 to 2022

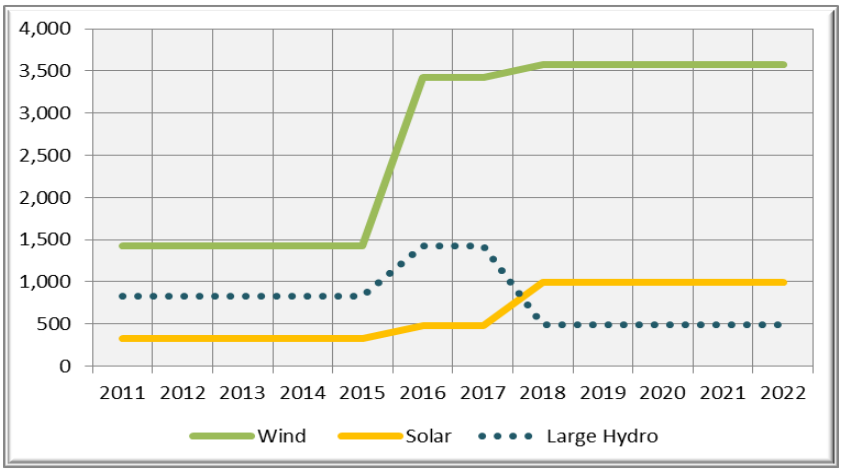


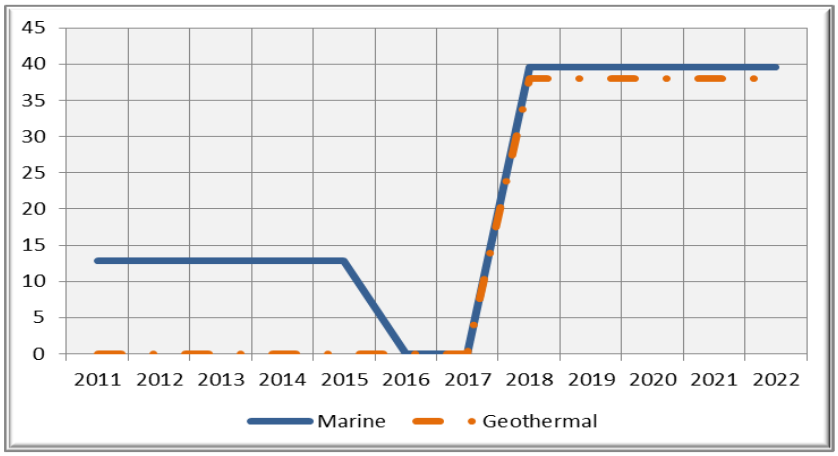


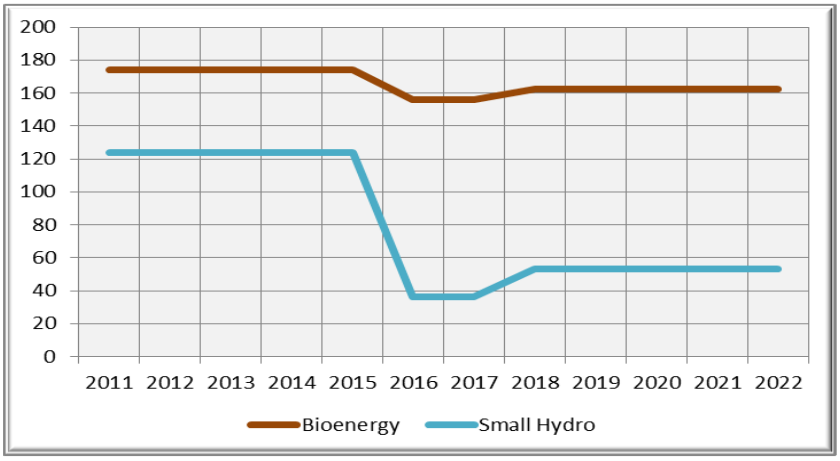
Source: Prism Economics and Analysis, Electricity Human Resources Canada

Exhibit #10

Annual Change to Installed Capacity, by ERE Sectors, Canada, Scenario C (Vision), 2011 to 2022



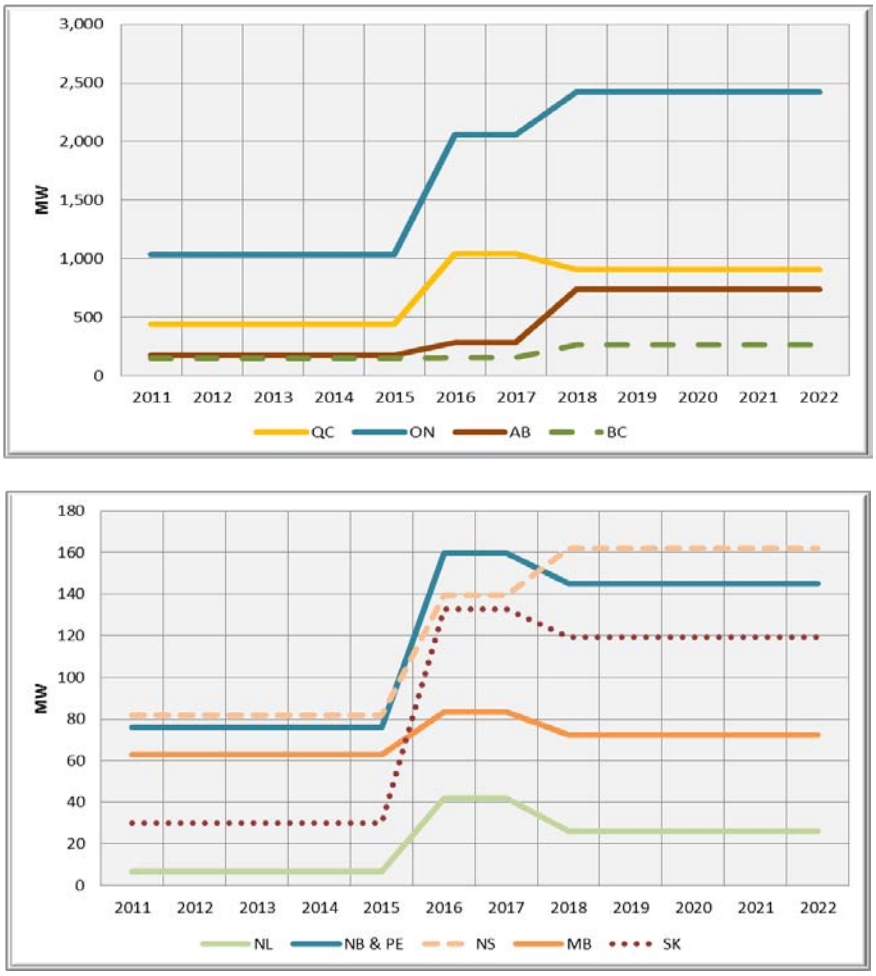




Source: Prism Economics and Analysis, Electricity Human Resources Canada

Exhibit #11

Annual Change to Installed Capacity, All ERE Sectors excluding Large Hydro, by Province, Scenario C (Vision), 2011 to 2022



Source: Prism Economics and Analysis, Electricity Human Resources Canada

Projections for Employment

The model description set out above divides the analysis of employment in each occupation into three levels:

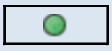
- All industries, by Region
- Electricity Generation, Transmission and Distribution, by Region
- Electricity-related Renewable Energy (RE), All Sectors, by Region

These three levels measure progressively smaller pools of workers. Exhibit # 4 (see page 17), offers a schematic representation of the coverage.

Preliminary estimates for the workforce at each level are described in the next three sections.

Provincial Labour Markets for Key Occupations

This section provides an example of the POMS analysis, in Exhibits 12, 13 and 14, for selected key occupations. The main advantages of the POMS model are measures of change in key elements of demand (expansion and replacement) and supply (new entrants and in-mobility including immigration). These measures provide a full assessment of factors driving the labour markets and recruiting conditions. Further, the measures are summarized in a labour market ranking that identifies tight, balanced and weak markets. Labour market conditions are represented in the Labour Market Assessment tables by the following symbols shown below.

Labour Market Conditions – Legend	
	**Weak** labour market conditions; unemployment rate exceeds historical norm
	**Balanced** labour market conditions; unemployment is at historical norm
	**Tight** labour market conditions; unemployment rate is below historical norm

Three examples of key occupations in the RE industry in Ontario are included here: electrical engineers, power system electricians and information systems analysts and consultants.

Exhibit #12

Labour Market Assessment, Electrical Engineers, Ontario

Electrical and electronics engineers, All Indusrtries	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Employment	**15,938**	**16,119**	**16,207**	**16,382**	**16,609**	**16,840**	**17,029**	**17,164**	**17,248**	**17,298**	**17,355**	**17,461**
% Change	-3.4%	1.1%	0.5%	1.1%	1.4%	1.4%	1.1%	0.8%	0.5%	0.3%	0.3%	0.6%
Change	- 560	181	88	175	227	231	189	135	84	50	57	106
Labour Force	**17149**	**17227**	**17279**	**17414**	**17600**	**17802**	**17994**	**18152**	**18262**	**18318**	**18370**	**18412**
% Change	-2.8%	0.5%	0.3%	0.8%	1.1%	1.1%	1.1%	0.9%	0.6%	0.3%	0.3%	0.2%
Change	171	220	179	118	88	63	63	63	63	63	63	63
Unemployment Rate	7.1%	6.4%	6.2%	5.9%	5.6%	5.4%	5.4%	5.4%	5.6%	5.6%	5.5%	5.2%
Normal Unemployment	5.6%	5.6%	5.6%	5.6%	5.6%	5.5%	5.5%	5.5%	5.4%	5.4%	5.4%	5.4%
Replacement Demand (Deaths & Retirements)	601	662	572	551	457	468	468	468	468	468	468	468
New Entrants	6.2	6.7	5.7	5.4	4.4	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Net In-Mobility	232	283	182	153	53	59	59	59	59	59	59	59
Labour Market Conditions*	●	●	●	–	–	–	–	–	–	–	–	–

Source: Prism Economics and Analysis and Stokes Economics Consulting

Exhibit #13

Labour Market Assessment, Power Systems Electricians, Ontario

Power system electricians, All Industries	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Employment	**1,616**	**1,673**	**1,723**	**1,775**	**1,810**	**1,856**	**1,885**	**1,915**	**1,935**	**1,936**	**1,935**	**1,940**
% Change	-6.3%	3.5%	3.0%	3.0%	2.0%	2.5%	1.6%	1.6%	1.0%	0.1%	-0.1%	0.3%
Change	- 109	57	9	11	10	13	12	7	5	1	- 1	5
Labour Force	**1884**	**1921**	**1931**	**1939**	**1944**	**1954**	**1964**	**1974**	**1980**	**1981**	**1978**	**1975**
% Change	-5.9%	2.0%	0.5%	0.4%	0.3%	0.5%	0.5%	0.5%	0.3%	0.1%	-0.2%	-0.2%
Change	171	220	179	118	88	63	63	63	63	63	63	63
Unemployment Rate	14.2%	12.9%	12.9%	12.7%	12.4%	12.1%	12.0%	12.1%	12.1%	12.1%	12.0%	11.7%
Normal Unemployment	12.2%	12.3%	12.3%	12.2%	12.2%	12.2%	12.1%	12.0%	12.0%	11.9%	11.8%	11.8%
Replacement Demand (Deaths & Retirements)	601	662	572	551	457	468	468	468	468	468	468	468
New Entrants	6.2	6.7	5.7	5.4	4.4	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Net In-Mobility	232	283	182	153	53	59	59	59	59	59	59	59
Labour Market Conditions*	●	–	●	–	–	–	–	–	–	–	–	–

Source: Prism Economics and Analysis and Stokes Economics Consulting

Exhibit #14

Labour Market Assessment, Information Systems Analysts and Consultants, Ontario

Information systems analysts and consultants, All Industries	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Employment	**79,677**	**81,767**	**82,440**	**83,209**	**84,314**	**85,550**	**86,577**	**87,379**	**88,015**	**88,692**	**89,427**	**90,408**
% Change	1.1%	2.6%	0.8%	0.9%	1.3%	1.5%	1.2%	0.9%	0.7%	0.8%	0.8%	1.1%
Change	880	2,090	673	769	1,105	1,236	1,027	802	636	677	735	981
Labour Force	**85,233**	**87,119**	**87,815**	**88,461**	**89,353**	**90,428**	**91,472**	**92,389**	**93,152**	**93,848**	**94,579**	**95,250**
% Change	0.4%	2.2%	0.8%	0.7%	1.0%	1.2%	1.2%	1.0%	0.8%	0.7%	0.8%	0.7%
Change	171	220	179	118	88	63	63	63	63	63	63	63
Unemployment Rate	6.5%	6.1%	6.1%	5.9%	5.6%	5.4%	5.4%	5.4%	5.5%	5.5%	5.4%	5.1%
Normal Unemployment	5.6%	5.6%	5.6%	5.6%	5.6%	5.5%	5.5%	5.5%	5.4%	5.4%	5.4%	5.4%
Replacement Demand (Deaths & Retirements)	601	662	572	551	457	468	468	468	468	468	468	468
New Entrants	6.2	6.7	5.7	5.4	4.4	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Net In-Mobility	232	283	182	153	53	59	59	59	59	59	59	59
Labour Market Conditions*												

Source: Prism Economics and Analysis and Stokes Economics Consulting

As discussed in the methodology section, these market measures are regarded as the base conditions that impact HR planning, recruiting and job search for RE employers and the workforce. The starting skills and experience for each occupation qualifies them as entrants to jobs in the RE sectors. Conditions in the larger labour market will determine the initial difficulty or ease of recruiting for entry level positions.

Electricity Industry Employment

Exhibits 15 through 17 represent the labour market segment for workers in the key occupations employed in the electricity generation, transmission and distribution industry. Statistics Canada restricts the release of data for specific occupations at the detailed industry level to the Census and to more frequent measures for larger provinces. To accommodate the needs of employers in the conventional electricity industry, further employment estimates and forecasts were developed as part of the "Power in Motion" labour study done by Electricity Human Resources Canada. These estimates have been updated here and represent another pool of labour that is a natural reference point for HR managers in the RE business.

Exhibit # 15

Employment Analysis for Electrical Engineers in Ontario, the Electrical Utility industry

Electric Utility Sector Employment	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Employment	**1623**	**1660**	**1717**	**1777**	**1817**	**1877**	**1918**	**1961**	**2014**	**2001**	**1935**	**1882**
% Change	-0.6	2.3	3.4	3.5	2.2	3.3	2.2	2.3	2.7	-0.6	-3.3	-2.7
Change	-55	18	9	17	22	23	19	13	8	5	6	10

Source: Prism Economics and Analysis

Exhibit # 16

Employment Analysis for Power Systems Electricians in Ontario, the Electrical Utility industry

Electric Utility Sector Employment	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Employment	**1549**	**1584**	**1639**	**1696**	**1734**	**1791**	**1831**	**1872**	**1922**	**1910**	**1846**	**1796**
% Change	-0.6	2.3	3.4	3.5	2.2	3.3	2.2	2.3	2.7	-0.6	-3.3	-2.7
Change	-55	35	54	57	38	57	39	41	50	-12	-64	-50

Source: Prism Economics and Analysis

Exhibit # 17

Employment Analysis for Information Systems Analysts and Consultants in Ontario, the Electrical Utility industry

Electric Utility Sector Employment	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Employment	**480**	**484**	**496**	**509**	**519**	**533**	**543**	**553**	**565**	**563**	**550**	**539**
% Change	1.2	0.7	2.5	2.8	1.8	2.8	1.8	1.9	2.1	-0.3	-2.3	-2.0
Change	-55	4	12	14	9	14	10	10	12	-2	-13	-11

Source: Prism Economics and Analysis

Projections for Employment in Key Occupations in RE

The final estimates measure employment for the designated key occupations in the RE industry. These estimates are for all RE sectors and the historical values are derived from the employment estimates presented above for the electricity generation, transmission and distribution industry. Employment by occupations in 2011 and 2012 is calculated with the assumption that the proportion of the industry workforce working in each sector is proportional to that sectors installed capacity in MW. This calculation would only measure the portion of the RE workforce that is part of the Electricity Generation, Transmission and Distribution Industry. This would include only the planning, operation and maintenance part of the supply chain. Survey results suggest that a significant part of the total RE workforce is working in other parts of the value chain.

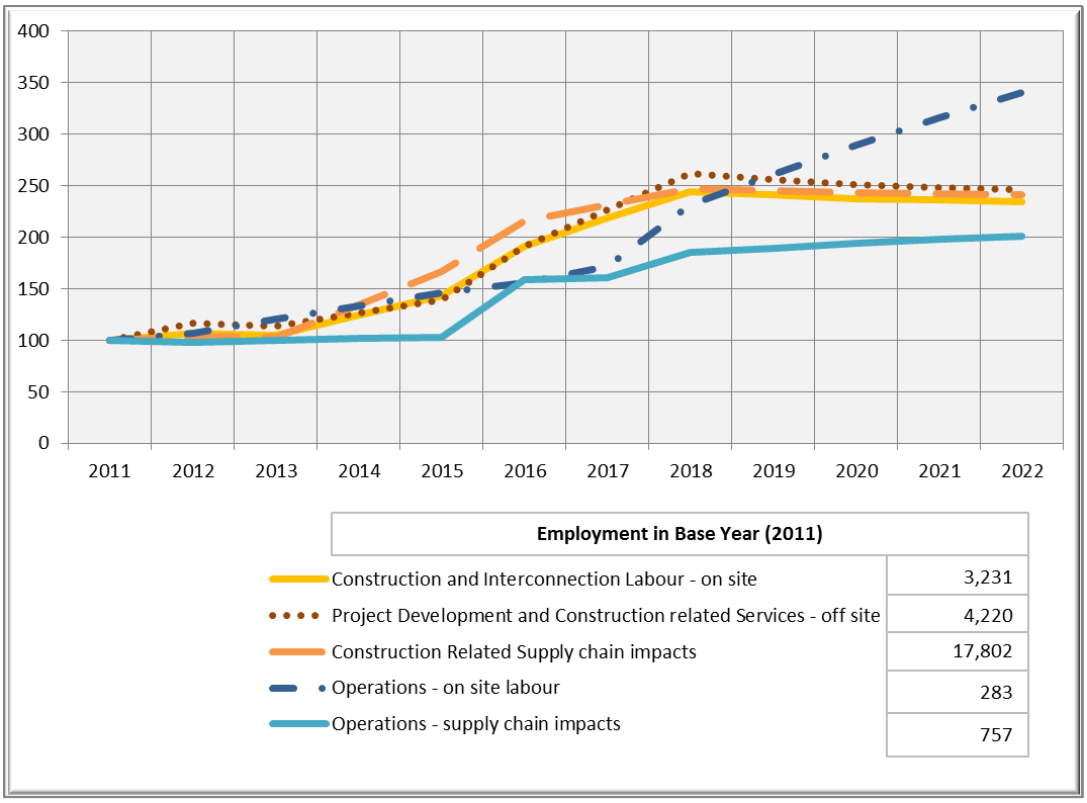
Thus the estimated and projected levels of employment for each occupation represent only a portion of the total workforce.

The projected pattern of employment growth from 2013 to 2022 is a critical measure that anticipates the ebb and flow of recruiting and job search. The rise and fall of investments in new installed capacity is a key driver here. Employment projections for major groups generated with the PRISM / JEDI model provide the pattern of employment growth for each key occupation. There are several dimensions to the drivers that are estimated and then used to project levels from 2013 to 2022. Each growth profile is captured in an index number set equal to 100 in the base year 2011. Factors driving the employment forecast profile for each occupation include:

- The mix and relative growth by sector and province,
- The point of employment on the value chain (e.g. installers work in the on-site construction segment), and
- The distribution of employment across time (e.g. construction off-site and on-site is spread over three years).

Exhibit #18 reports the historical employment estimates and employment projections in each scenario for the three selected occupations. Index numbers reflect accumulated change over time but not the size of the starting workforce. There are big differences here with a large majority of employment in the manufacturing and distribution segment. Much depends on the local and national content of the system components.

Exhibit #18
Employment Drivers – Supply Chain Profiles, Canada, Scenario C (Vision)
Index 2011 = 100



Source: Prism Economics and Analysis, Electricity Human Resources Canada

Employment profiles from 2012 to 2022 will vary for each occupation in each market. The overall trend suggests that employment will rise between 50% (in operations) and 150% or more in construction; more than doubling in some cases, from 2012 to 2018 and beyond. Exhibit #19 through 21 reports the forecast profiles for the selected occupations and illustrates the variability and overall growth that is

expected across scenarios. Cyclical variations across the years and the ultimate growth in employment from 2012 to 2022 are key measures for assessing:

- recruiting challenges,
- competition with employers seeking the key occupations in other industries and
- the requirements for training and certification systems.

At various points, usually later in the scenario, employment turns down in the construction related segments of the supply chain. This reflects lower increments to the overall installed capacity. It is important to keep in mind that the accumulated inventory of RE capacity continues to grow – and employment in the operational segments of the supply chain rise as well. In a growth oriented environment, like the future of the RE industry, attention focuses on the resources required at the margin. A slowing of growth, which is often just a pause in the expansion, results in a drop in employment in the biggest segments of the industry. An extended period of rapid and perhaps accelerating growth has expanded the manufacturing and distribution of equipment and components and related jobs in construction. The growth profiles in Exhibit #19 through 21 capture this dynamic.

Exhibit # 19

Employment in the Renewable Energy sector for Electrical Engineers, in Ontario

Renewable Energy Sector Employment	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Scenario A (Utility)	167	185	180	164	149	94	54	12	12	12	12	10
Scenario B (NEB)	167	114	111	116	119	118	111	104	101	99	109	73
Scenario C (vision)	167	175	197	233	267	303	344	403	449	493	521	546

Source: Prism Economics and Analysis

Exhibit # 20

Employment in the Renewable Energy sector for Power Systems Electricians, in Ontario

Renewable Energy Sector Employment	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Scenario A (Utility)	160	176	172	153	133	81	46	11	11	11	12	10
Scenario B (NEB)	160	87	86	102	117	127	120	114	112	110	145	86
Scenario C (vision)	160	166	162	185	207	283	332	379	371	363	361	355

Source: Prism Economics and Analysis

Exhibit # 21

Employment in the Renewable Energy sector for Information Systems Analysts and Consultants, in Ontario

Renewable Energy Sector Employment	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Scenario A (Utility)	50	57	56	49	43	26	15	4	4	4	4	3
Scenario B (NEB)	50	26	25	33	41	46	43	40	39	38	48	31
Scenario C (vision)	50	54	53	59	64	90	107	124	122	119	118	116

Source: Prism Economics and Analysis

Note that the levels of employment tracked in Exhibits 19, 20 and 21 only count the workforce within the utility sector. In many cases the targeted occupations are employed outside the industry and employment there will grow at the same rate noted here.

5. Conclusion

This report sets out the key features, major sources and preliminary analysis and forecasts of the RF LMI system. The model has been created to allow alternative values to be used for various inputs and parameters. These include, for example, the profile of year to year change in the installed capacity of RE, the labour intensity of each RE sector, work at each segment of the supply chain, local content for manufactured components and the relative growth of key occupations.