

## Detailed Canadian Large Wind Turbine Industry Labour Forecast - 2015

CanWEA engaged the Delphi Group to develop a detailed estimate of the Canadian wind energy sector labour demand for the next decade. Delphi's approach was to develop a flexible quantification tool for estimating the specific Canadian demand for each skill set required within the large wind turbine supply chain over the next 10 years. This approach provides both an estimate of labour demand, as well as a tool that can be easily modified based on changes in policy, technology or Canadian capacity.

As a default case, the tool was used to estimate the jobs created in the broad categories of manufacturing, planning, development, design, installation, operation and maintenance in the Canadian wind industry assuming that 10,000 MW of cumulative wind generating capacity is installed in Canada by 2015. The total number of jobs created globally as a result of Canadian wind project installations was projected based on data from the European Wind Energy Association for the number of manufacturing, planning, development, design and installation jobs (12 job/years) created per MW of capacity installed annually and the number of operation and maintenance jobs (0.4 jobs) created per cumulative MW of capacity installed. A labour efficiency improvement factor of 2% annually is also built into the forecast.

The quantification of jobs actually created in Canada is based on conservative estimates of the present and future Canadian share of the major activity categories. These estimates are derived from existing information on Canadian participation in the domestic large wind turbine supply chain. Of particular importance, the default case conservatively projects very modest capacity development in the manufacturing segment of activity, which represents roughly 10 jobs/years per MW of capacity installed annually. Turbine manufacturing represents roughly 70-75% of the job creation potential for wind projects. Therefore, any increase from the conservative default case in Canadian large wind turbine manufacturing capacity over the forecast period would lead to a significant increase in the future labour demand. Present Canadian manufacturing capacity is mainly in nacelle assembly and the manufacture of rotor blades, towers, nacelle covers and electrical components. It should be noted that the labour forecast tool does not quantify policy and industry advocacy jobs, however they are a requirement for the industry, exist today and will likely experience a continued and increasing demand.

The following table summarizes the labour forecast tool results for the default case. Specifically, the table provides a listing of the skill categories required for the wind industry and the quantities of people projected and the type of training required for each skill category. The table also provides a listing of the training options for each skill category. Jobs related to the operation and maintenance of installed wind projects are considered permanent whereas jobs related to equipment manufacturing, project planning, construction and installation will depend on the rate of annual wind project installations.

Category of Employment	Estimated Person-years	Sub-category (Description)	Approximate % of Category	Required Training	Training Options
<b>Manufacturing (Job-years) - Total</b>	<b>5,300</b>				
<b>Mechanical Trades and Technologists</b>	2,080	(Involved in manufacturing of mechanical components of wind turbines including towers, gearboxes, nacelles, blades etc.)	100%	<ul style="list-style-type: none"> <li>- College mechanical trade or technologist training programs</li> <li>- Some experience in manufacturing environments would be an asset</li> <li>- Some experience with large scale machining and composite materials would be an asset</li> <li>- Some experience with aeronautical and gear box systems would be an asset</li> </ul>	<ul style="list-style-type: none"> <li>- Standard programs and work experience</li> <li>- McGill University offers a wind engineering course through their Department of Mechanical Engineering</li> <li>- The University of Waterloo is developing a wind energy research facility</li> <li>- McMaster University offers graduate level research opportunities in vertical axis turbines [2, 6-7].</li> </ul>
<b>Electrical Trades</b>	40	(Involved in the manufacturing and assembly of turbine electrical systems including controllers, generators, grid interconnection systems, substation design etc)	100%	<ul style="list-style-type: none"> <li>- College electrical and electronics trade training programs</li> <li>- Some experience in manufacturing environments would be an asset</li> </ul>	<ul style="list-style-type: none"> <li>- Standard programs and work experience</li> <li>- The University of New Brunswick offers graduate level opportunities in power electronics and control systems for wind turbine systems.</li> <li>- The University of Waterloo is developing a wind energy research facility [2, 6-7].</li> </ul>

Category of Employment	Estimated Person-years	Sub-category (Description)	Approximate % of Category	Required Training	Training Options
<b>General Labor with On the Job Training</b>	1,830	(Involved in general preparation, assembly and inventory management of manufactured electrical and mechanical wind turbine components.)	100%	<ul style="list-style-type: none"> <li>- High school education</li> <li>- Some basic hands-on training</li> </ul>	<ul style="list-style-type: none"> <li>- On-the-job training</li> </ul>
<b>Mechanical Engineers with Design Skills</b>	800	(Involved in the design, testing and certification of mechanical components of wind turbines including towers, gearboxes, nacelles, blades etc.)	100%	<ul style="list-style-type: none"> <li>- University degree in mechanical engineering</li> <li>- Specialization or experience in aeronautical and gear box component and system design would be an asset</li> <li>- Experience in manufacturing environments would be an asset</li> </ul>	<ul style="list-style-type: none"> <li>- Standard programs and work experience</li> <li>- L'Université de Montréal, École Polytechnique, Montreal, offers courses in vertical axis wind turbines, aerodynamics and icing through its mechanical engineering department</li> <li>- L'École de Technologie Supérieure, in Montreal, offers courses in wind turbine aerodynamics, wind turbines in cold climate [2, 6-7]</li> </ul>



Category of Employment	Estimated Person-years	Sub-category (Description)	Approximate % of Category	Required Training	Training Options
<b>Electrical Engineers with Electrical and Control System Design Skills</b>	20	(Involved in the design, testing and certification of turbine electrical systems including controllers, generators, grid interconnection systems, substation design etc.)	100%	<ul style="list-style-type: none"> <li>- University degree in electrical engineering</li> <li>- Specialization or experience in electrical and control systems design would be an asset</li> <li>- Experience in manufacturing environments would be an asset</li> </ul>	<ul style="list-style-type: none"> <li>- Standard programs and work experience</li> <li>- Post graduate research opportunities in innovative power electronic converters and advanced control strategies for variable speed wind turbine systems are available through Sustainable Power R&amp;D Group at the University of New Brunswick (UNB), in Fredericton. [2, 6-7]</li> </ul>
<b>Management, Administration and Sales</b>	530	(Involved in the supervision and business administration of manufacturing operations and marketing of wind turbines and turbine components.)	100%	<ul style="list-style-type: none"> <li>- Management experience in a manufacturing environment</li> <li>- College degree or experience in administrative roles</li> <li>- Experience in technical sales and marketing</li> </ul>	<ul style="list-style-type: none"> <li>- Skills primarily acquired through work experience</li> </ul>

Category of Employment	Estimated Person-years	Sub-category (Description)	Approximate % of Category	Required Training	Training Options
<b>Planning, Development, Design, Installation, Operation and Maintenance - Total</b>	<b>5,300</b>				
<b>Mechanical Trades and Technologists</b>	<b>1,390</b>	<p><b>Wind Turbine Technician (Mechanical)</b>                      (Involved in assembly, commissioning, maintenance and repair of wind turbine mechanical systems and components for existing wind projects.)</p>	<p>&gt;90%</p>	<p>- College mechanical trade or technologist training programs                      - Some experience with aeronautical and gear box systems would be an asset                      - Large wind turbine specific training would be an asset</p>	<p>- Standard programs and work experience                      - Internal training is available through major large scale wind maintenance service providers                      - Cégep de Gaspésie et des Îles de la Madeleine offers a 6 month, 1,395 hour, wind energy technician course                      - St. Lawrence College, in Kingston, is expected to offers a similar course soon                      - Certification in engineering or as a millwright with a wind energy generation focus is available through Centennial College in Toronto                      - Lethbridge College, in Lethbridge, Alberta, offers a pre-employment electrician/wind turbine technician program.                      -Sault College in Sault Sainte Marie will offer a wind energy training course starting in the fall of 2007 [2, 6-7].</p>

Category of Employment	Estimated Person-years	Sub-category (Description)	Approximate % of Category	Required Training	Training Options
		<p><b>Measurement Tower Installer/Technician/Builder</b> (Involved in the construction, installation and maintenance of anemometric equipment)</p>	<10%	<ul style="list-style-type: none"> <li>- College technologist training program</li> <li>- Some experience with field test equipment would be an asset</li> <li>- Specialized on-the-job training would also likely be required</li> </ul>	<ul style="list-style-type: none"> <li>- Standard program, work experience and on the job training</li> </ul>
<b>Electrical Trades</b>	2,190	<p><b>Wind Turbine Electrical and Systems Technicians</b> (Involved in assembly, commissioning, maintenance and repair of wind turbine electrical and control systems and components for existing wind projects.)</p>	73%	<ul style="list-style-type: none"> <li>- College electrical or electronics trade or technologist training programs</li> <li>- Some experience with power and control systems would be an asset</li> <li>- Large wind turbine specific training would be an asset</li> </ul>	<ul style="list-style-type: none"> <li>- Standard programs and work experience</li> <li>- Internal training is available through major large scale wind service providers</li> <li>- Cégep de Gaspésie et des Îles de la Madeleine offers a 6 month, 1,395 hour, wind energy technician course</li> <li>- St. Lawrence College, in Kingston, is expected to offer a similar course soon</li> <li>- Lethbridge College, in Lethbridge, Alberta, offers a pre-employment electrician/wind turbine technician program.</li> <li>- Certification in engineering or as a electrician with a wind energy generation focus is available through Centennial College in Toronto [2, 6-7]</li> </ul>

Category of Employment	Estimated Person-years	Sub-category (Description)	Approximate % of Category	Required Training	Training Options
		<p><b>Power Technician/Tradesmen</b> (Involved in the maintenance and repair of power transmission and conditioning equipment for existing wind projects.)</p>	27%	<ul style="list-style-type: none"> <li>- College electrical (power) trade training programs</li> <li>- Some experience with power systems and transmission would be an asset</li> </ul>	<ul style="list-style-type: none"> <li>- Standard programs and work experience</li> </ul>
<b>Mechanical Engineers</b>	60	<p><b>Wind Project Engineer</b> (Involved in the design, layout and planning of wind projects.)</p>	65%	<ul style="list-style-type: none"> <li>- University degree in mechanical engineering with a focus on aerodynamics or electrical engineering with a focus on power systems</li> <li>- Some extra university level course in wind project specific areas</li> <li>- Relevant work experience would be an asset</li> </ul>	<ul style="list-style-type: none"> <li>- Standard programs and work experience</li> <li>- L'École de Technologie Supérieure, in Montreal, offers courses in wind turbine aerodynamics, wind turbines in cold climate and wind flow inside wind parks</li> <li>- L'Université de Montréal, École Polytechnique, Montreal, offers courses in vertical axis wind turbines, aerodynamics and icing through its mechanical engineering department</li> <li>- L'Université du Québec a Rimouski offers a master's program in wind energy with a focus on electrical engineering. The program offers courses, such as project management, storage of wind energy and wind resource assessment [2, 6-7].</li> </ul>

Category of Employment	Estimated Person-years	Sub-category (Description)	Approximate % of Category	Required Training	Training Options
		<p><b>Wind Resource Assessment Specialist</b> (Involved in the characterization and validation of the wind resource at a project site.)</p>	23%	<ul style="list-style-type: none"> <li>- University degree in mechanical engineering</li> <li>- University level courses in wind resource assessment</li> <li>- Field experience would be an asset</li> </ul>	<ul style="list-style-type: none"> <li>- L'Université du Québec a Rimouski offers a master's program that includes courses in wind resource assessment</li> <li>- Dalhousie University, in Halifax, offers courses in wind energy resource assessment and small wind turbines [2, 6-7]</li> <li>- Ecole de technologie superieur, in Montreal, offers wind resource assessment research positions for MA and PhD level students</li> <li>- The University of Moncton offers wind resource assessment research positions for MA and PhD level students</li> </ul>
		<p><b>Project Due Diligence Specialists</b> (Involved in due diligence evaluation of proposed wind projects on behalf of project financiers.)</p>	12%	<ul style="list-style-type: none"> <li>- University degree in mechanical engineering</li> <li>- University level courses in wind resource assessment</li> <li>- Due diligence experience and wind experience would be an asset</li> </ul>	<ul style="list-style-type: none"> <li>- Standard programs and work experience</li> </ul>



Category of Employment	Estimated Person-years	Sub-category (Description)	Approximate % of Category	Required Training	Training Options
<b>Electrical Engineers with Electrical and Control System Design Skills</b>	90	<b>Power Engineer</b> (Involved in the planning, design and certification of wind project power transmission and conditioning systems.)	>90%	<ul style="list-style-type: none"> <li>- University degree in electrical engineering with a focus on power systems</li> <li>- Work experience in the power sector, especially in wind, would also be an asset</li> </ul>	- Standard programs and work experience
		<b>Wind Measurement Equipment Designer</b> (Involved in the design, testing and certification of anemometric equipment.)	<10%	<ul style="list-style-type: none"> <li>- University degree in electrical engineering with control systems focus</li> <li>- University level courses in wind resource assessment</li> <li>- Field measurement systems work experience would be an asset</li> </ul>	- Standard electrical engineering program and a some wind resource assessment training.

Category of Employment	Estimated Person-years	Sub-category (Description)	Approximate % of Category	Required Training	Training Options
<b>Civil/ and Geological Engineers</b>	80	<b>Civil Engineer</b> (Involved in the planning and design of foundations, roads, buildings and other support infrastructure for wind farm projects.)	>90%	- University degree in civil engineering - Work experience with remote and large construction projects would be an asset	- Standard programs and work experience
		<b>Civil/Geological Engineer</b> (Involved in the testing and characterization of ground conditions for wind turbine foundation planning.)	<10%	- University degree in civil or geological engineering - Work experience with soil testing for large construction projects would be an asset	- Standard programs and work experience
<b>Construction Labour and Tradesmen</b>	380	(Involved in general construction activities such as road, foundation and transmission corridor building.)	100%	- College construction trades programs - High school diploma - Construction work experience	- Standard programs and work experience
<b>Transport and Installation Trades</b>	630	<b>Large Equipment Transportation Specialist</b> (Involved in the transport of large wind turbine components such as tower segments, rotor blades and assemble nacelles.)	39%	- Heavy equipment operation certificate - Large equipment assembly Experience	- Standard programs and work experience

Category of Employment	Estimated Person-years	Sub-category (Description)	Approximate % of Category	Required Training	Training Options
		<b>Large Equipment Craning Specialist</b> (Involved in the craning , assembly and installation of large wind turbine components.)	61%	- Large crane operator certification programs - Experience in large-scale component construction projects.	- Standard programs and work experience
<b>Management, Administration and Sales</b>	440	<b>Business Planning Specialist</b> (Involved in the financing and business planning of wind projects.)	<10%	- Graduate degree in business - Experience with wind project development and financing	- Standard programs and work experience
		<b>Technician Management and Administration</b> (Involved in the management and administration of mechanical and electrical technicians performing maintenance and repair services.)	49%	- Work experience in management and technical services	- Work experience

Category of Employment	Estimated Person-years	Sub-category (Description)	Approximate % of Category	Required Training	Training Options
		<b>Experienced Wind Farm Project Construction Supervisor</b> (Involved in the supervision and management of wind project construction.)	<10%	- Experience in power, especially wind, project construction	- Work experience
		<b>Wind Farm Operation Management and Administration</b> (Involved in the management of day-to-day operation of installed wind projects.)	20%	- Operations management experience in power generation sector - College degree or experience in administrative roles	- Standard programs and work experience
		<b>Electricity Sales and Marketing</b> (Involved in the marketing and sale of electricity generated from active wind projects.)	20%	- Experience in electricity sales	- Work experience

Category of Employment	Estimated Person-years	Sub-category (Description)	Approximate % of Category	Required Training	Training Options
<b>Other Specialized Professions</b>	40	<b>Community Communications Specialist</b> (Involved in communicating with community stakeholders during project permitting and throughout the operation of wind projects.)	<10%	<ul style="list-style-type: none"> <li>- A college or university level degree in public relations</li> <li>- Experience with wind project related issues</li> </ul>	- Standard programs and work experience
		<b>Wind Experienced Lawyers</b> (Involved in drafting of legal agreements for various aspects of wind farm projects such as power purchase agreements, land leases etc.)	29%	<ul style="list-style-type: none"> <li>- Law degree programs</li> <li>- Experience related to the power sector would be an asset</li> </ul>	- Standard programs and work experience
		<b>Civil Engineering Technician</b> (Involved in surveying and field measurements for infrastructure planning.)	<10%	<ul style="list-style-type: none"> <li>- College degree in civil or geological surveying</li> <li>- Work experience in geological field studies would be an asset</li> </ul>	- Standard programs and work experience

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		<p><b>Civil/Geological Technician</b> (Involved in drilling for field tests for characterizing ground conditions for turbine foundation planning.)</p>	<p>&lt;10%</p>	<ul style="list-style-type: none"> <li>- College civil engineering technician degree</li> <li>- Work experience in large scale construction would be an asset</li> </ul>	<ul style="list-style-type: none"> <li>- Standard programs and work experience</li> </ul>
		<p><b>Environmental Scientist</b> (Involved in completion of wind project environmental impact assessment.)</p>	<p>16%</p>	<ul style="list-style-type: none"> <li>- University environmental science programs</li> <li>- Experience in environmental impact assessment would be an asset</li> </ul>	<ul style="list-style-type: none"> <li>- Standard programs and work experience</li> </ul>
		<p><b>Environmental Technician</b> (Involved in gathering data and conducting field studies for environmental impact assessments.)</p>	<p>20%</p>	<ul style="list-style-type: none"> <li>- College programs in environmental field testing</li> <li>- Environmental impact assessment field experience would be an asset</li> </ul>	<ul style="list-style-type: none"> <li>- Standard programs and work experience</li> </ul>
		<p><b>Biologist (Flight Path and Habitat Specialization)</b> (Involved in wildlife impact assessment for overall wind project environmental impact assessments.)</p>	<p>14%</p>	<ul style="list-style-type: none"> <li>- University biology programs with focus on ornithology and wild life habitat</li> <li>- Experience in wildlife impact assessment would be an asset</li> </ul>	<ul style="list-style-type: none"> <li>- Standard programs and work experience</li> </ul>



Category of Employment	Estimated Person-years	Sub-category (Description)	Approximate % of Category	Required Training	Training Options
<b>Total Employment</b>	<b>10,600</b>				