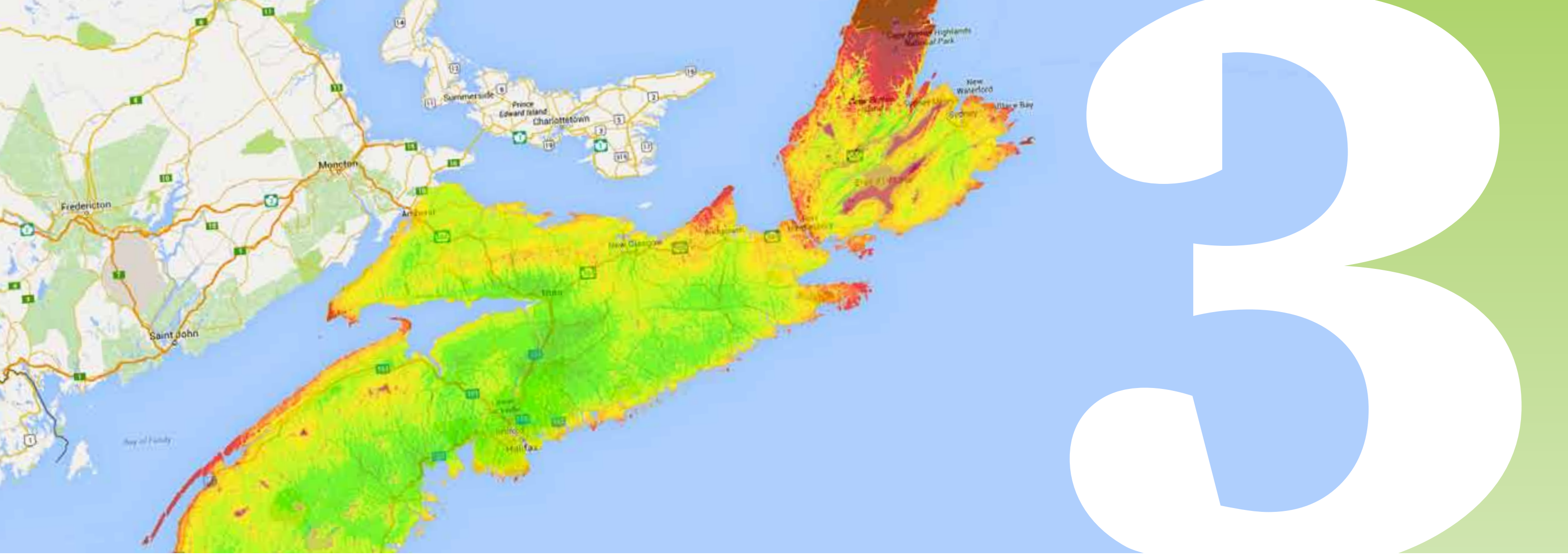


Above Photo: Nova Scotia Wind Atlas

Basics of Wind Energy Technology

How is electric energy harnessed from the wind?

Wind energy develops in response to temperature changes on the earth's surface and the rotation of the earth, as well as variations in topography and other factors. Nova Scotia has an exceptional wind regime; partly due to our strong coastal winds, we have some of the highest average wind speeds in Canada.

In 2007, the Province commissioned the Nova Scotia Wind Atlas.[1] This map shows the predicted wind speed at varying heights above ground level and is an important first step in identifying possible locations for wind energy projects before investing in site measurements. Because it was developed from computer models, site-specific measurements are required for any wind project planning.

The Nova Scotia Wind Atlas shows higher wind regimes in predictable locations – coastlines and highland areas. Feasible wind energy projects require a minimum average wind speed, which varies with the specific project. Wind conditions that are too fast or too gusty are not suitable for turbines. Every wind turbine has its own generation capability relative to a constant wind speed.

Like sailboats and airplanes, wind turbines are designed to function with the wind. Wind turbines vary in size, from a small turbine powering a municipal facility to many large turbines selling electricity to the grid.

Wind energy is a mature technology. In the past 20 years, there have been many advances in the industry to improve efficiency and reduce sound. Possible impacts are discussed specifically in Fact Sheets 6 to 8; this fact sheet presents the basics of the technology.

1 *www.nswindatlas.ca*

Get to Know Wind Energy

Wind Speed Units and Ranges: Wind speed is typically measured in metres per second (m/s).

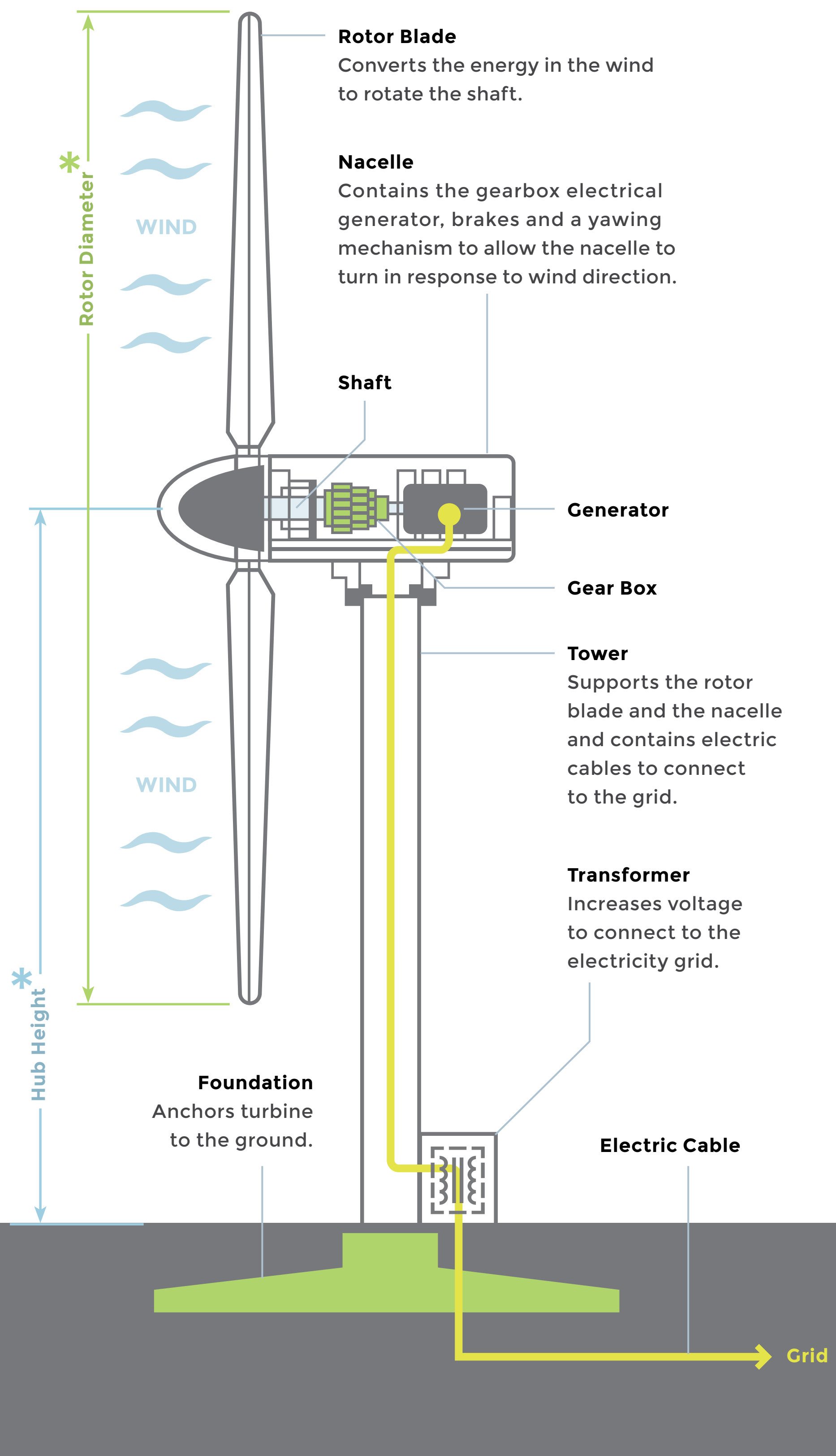
An average wind speed of 7 m/s is considered good for larger wind turbines; that is, at a height of about 80 m. This wind speed is comparable to driving 25 kilometres per hour (km/hr).

For smaller wind turbines, the rotor blades are lower to the ground – typically 30 m or less – where the average wind speed is lower, often under 4 m/s.

Smaller wind turbines cost less to install; however, due to the lower wind speeds, energy produced by smaller wind turbines is generally more expensive per Wh than energy produced by larger turbines.

How does a wind turbine generate electricity?

When wind passes over turbine blades, the resulting pressure differential causes them to spin, which turns the shaft connected to the generator. The generator converts the mechanical energy to electricity. Electricity can be supplied to the turbine owner and/or the grid once the voltage is adjusted.



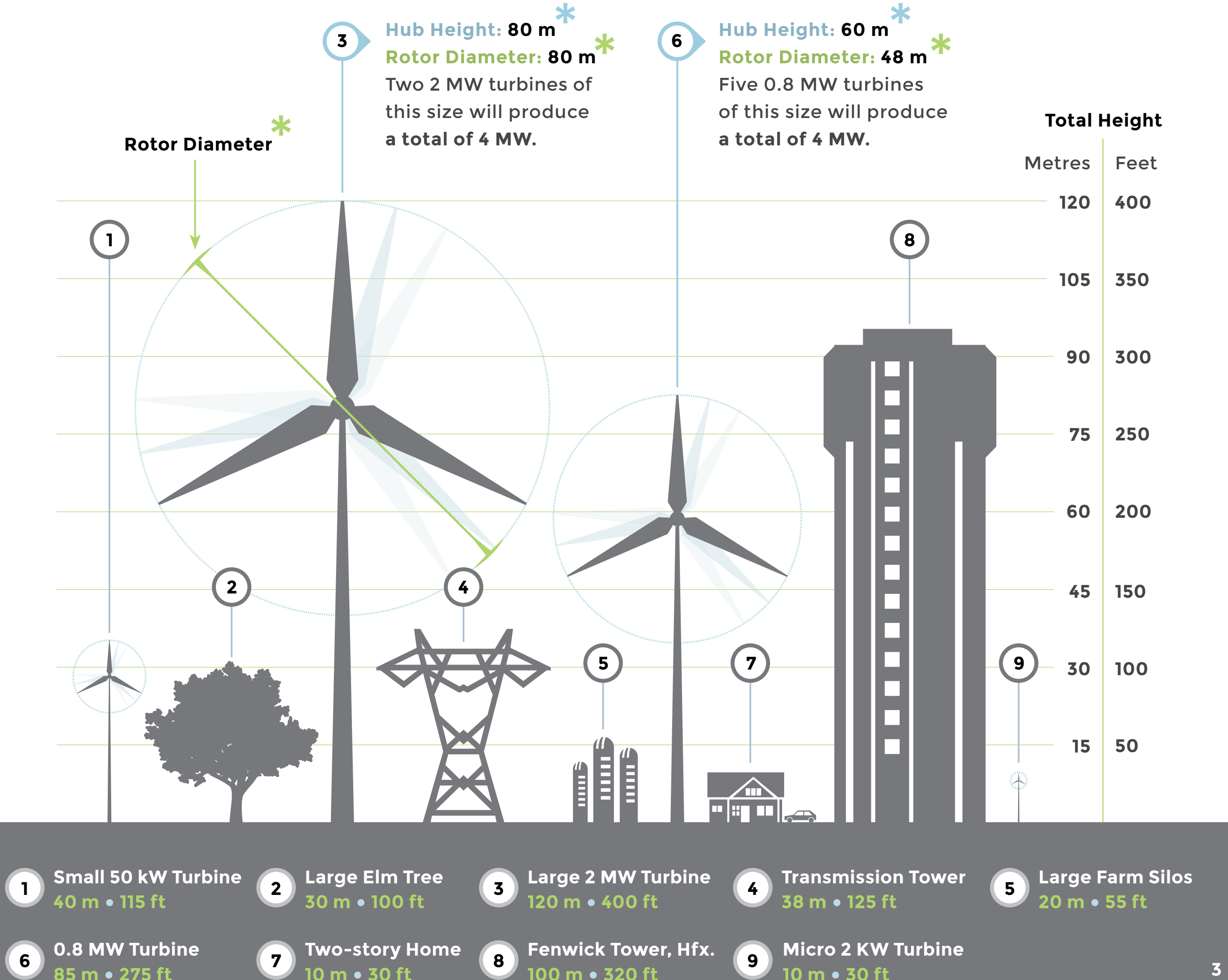
What are the different sizes of wind turbines?

Wind turbines are designed for a wide range of power outputs. Large turbines may have an output of 3 MW or more; in Nova Scotia, they are typically 1.5 MW or 2 MW. The Government of Nova Scotia defines smaller turbines as 50 kW or less.

Height of the tower, or "hub height", of a typical larger turbine is about 80 m. On some turbines the distance across the circle made by the spinning blades, or "rotor diameter", may be 80 m; in this case, the length of one blade is 40 m, so that for this size turbine, the blade tip crests at a peak height of 120 m. Energy output is related to wind speed and rotor diameter: the higher the wind speed and the greater the rotor diameter, the more electricity is generated.

As turbine height increases, larger rotor diameters are possible. This increases the swept area, allowing more energy to be captured from the wind. Energy output is proportional to the swept area: electricity generation increases with the square of rotor diameter.

Smaller turbines convert less energy from the wind because wind speeds are often slower closer to the ground and the swept area is smaller, but they can be more practical and offer many municipal applications. A local example is the 50 kW wind turbine providing a portion of the electricity for a water treatment facility owned by the Town of New Glasgow.



Get to Know Wind Energy

Nova Scotia consumes and generates about 10,500 GWh of electricity per year. As of March 2015, there was about 350 MW of installed wind capacity, representing about 10% of our overall electricity demand.

Every megawatt of wind turbine capacity reduces our greenhouse gas emissions by as much as 2,500 tonnes per year. This is the equivalent of electricity used in about 350-400 Nova Scotia homes.

Antigonish, Nova Scotia

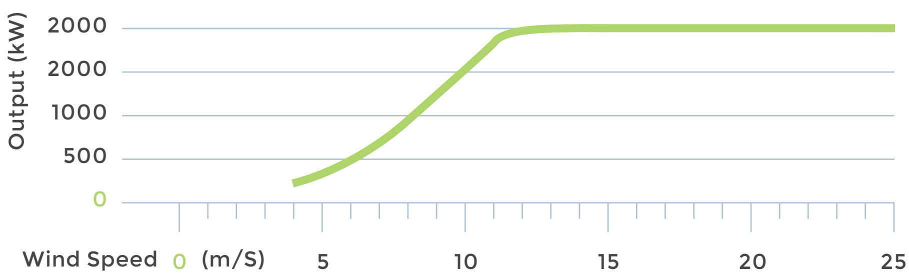
Watts Section, Nova Scotia

How efficient are wind turbines?

Wind turbines typically start spinning to produce electricity at wind speeds of about 3 m/s or about 10 km/hr. This is called the "cut-in wind speed". Ideally, operational wind speeds are steady, with constant direction. When wind direction changes, a modern wind turbine uses its yawing mechanism to rotate the nacelle on the stationary tower. At speeds that are too high, over 25 m/s or 90 km/hr, the wind turbine will shut itself down and stop spinning. This is called the "cut-out wind speed".

An ideal wind speed is typically 12 m/s or about 45 km/hr. The typical output curve for a wind turbine shows that, above a certain point, increases in wind speed will not increase power output. This upper limit is called the "nameplate capacity"; it is based on the capability of the wind turbine's electrical generator.

Chart 3A: Typical Turbine Power Curve



BASED UPON A TYPICAL WIND TURBINE BROCHURE

Under ideal operating conditions, a wind turbine with a 2 MW nameplate capacity will generate 2 MW of power. Operating conditions can be environmental and/or mechanical. If the wind turbine operated optimally for a year, it would generate 17 GWh of energy; like other forms of electricity generation, wind turbines do not typically operate at their highest efficiency – closer to about 6 GWh would be expected.

Over the course of a year, environmental and mechanical conditions vary. A well-sited wind turbine may generate about 35 to 40% of its nameplate capacity. This percentage is known as its "capacity factor". The capacity factor of thermal generating stations ranges from about 50 to 80%. Because of stoppages for maintenance or breakdowns, no power plant generates power 100% of the time.

To be conservative in planning wind energy projects, 30% is often used as the capacity factor. This estimate of power production makes conservative assumptions about environmental conditions like wind speed and mechanical components like the yawing mechanism.