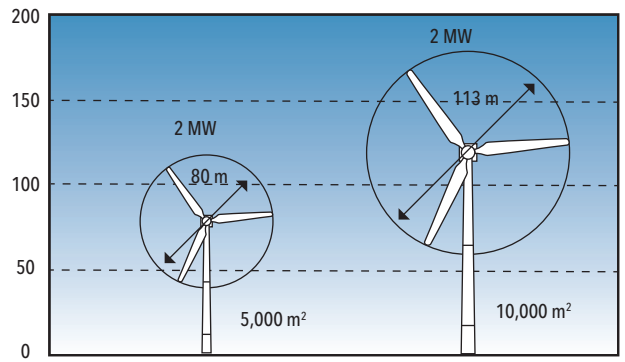

Year		2000	2014
Diameter	m	80	113
Swept Area	m^2	5,000	10,000
Hub Height	m	80	130
Capacity	MW	2	2
Specific power	W/m^2	400	200
Specific area	m^2/kW	2.5	5.0
Diameter/height		1.0	1.2

Figure 8-1. Silent wind power revolution. By the late 2010s, there was a silent revolution underway in wind turbine design. Manufacturers began introducing wind turbines with very large rotors relative to their generator ratings, in some cases doubling specific area. They also were installing the turbines on increasingly taller towers relative to their rotor diameter. Together, both factors dramatically increased relative performance in terms of capacity factor and full-load hours. Under moderate wind conditions, the turbine on the right will generate twice the amount of electricity as the turbine on the left, even though they both produce the same peak power.

- Less opposition to wind as less high-wind, high-value sites are now required,
- Less demand on grid operators,
- Less demand for new transmission capacity or capacity upgrades, and
- Wind turbines with large rotors relative to their generator size will allow easier integration of wind energy into the grid, and allow us to put the wind turbines where the people are, that is, near our cities, towns, and villages.

Why this is so requires some explanation.

What Is a Wind Turbine?

In essence, a wind turbine is a rotor to capture the wind and a generator to produce electricity. Physics professor and wind energy authority Vaughan Nelson has emphasized for more than three decades that it is the area of the wind stream intercepted by a wind turbine—the swept area—that largely determines how much energy the wind turbine will capture. Obviously, the generator is a critical component, but it is not the most critical component in what makes a wind turbine—a wind turbine. It is the rotor powered by the wind that separates a wind turbine from a steam generator, for example.

Generator Ratings

Wind turbines are designed with a specific combination of rotor and generator for a specific wind resource. In *Wind Energy*, wind turbines are often described by their rotor diameter—a shorthand for their swept area. However, the media, utility engineers, and even some in the wind industry mistakenly use the generator size in kilowatts (kW) or megawatts (MW) to describe the size of a wind turbine. The wind turbine's generator will produce its "rated power" at a certain wind speed. The wind doesn't always blow at this speed, and this is where descriptions such as this complicate our understanding of what a wind turbine will produce.

Swept Area Trumps Generator Ratings

Let's consider the tale of two wind turbines on the market in the early 2000s: the V82 and the V80. Vestas's V82 is an 82-meter (270-foot) diameter wind turbine capable of generating 1.65 MW. Vestas's V80 is an 80-meter (260-foot) diameter wind turbine variously rated from 1.8 MW to 2.0 MW. Vestas's V82 is a larger—more powerful—wind turbine than the Vestas V80.

How can this be? The V82 intercepts ~ 5% more of the wind stream than the V80. For low and moderate wind sites, the V82 will out produce the V80. At higher wind sites where the V80's larger generator will be used more often, the V80 will generate slightly more than the V82