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## Electric Power Generation: Non-Conventional Methods

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### 1.1 Wind Power

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*Gary L. Johnson*

The wind is a free, clean, and inexhaustible energy source. It has served humankind well for many centuries by propelling ships and driving wind turbines to grind grain and pump water. Denmark was the first country to use wind for generation of electricity. The Danes were using a 23-m diameter wind turbine in 1890 to generate electricity. By 1910, several hundred units with capacities of 5 to 25 kW were in operation in Denmark (Johnson, 1985). By about 1925, commercial wind-electric plants using two- and three-bladed propellers appeared on the American market. The most common brands were Win-charger (200 to 1200 W) and Jacobs (1.5 to 3 kW). These were used on farms to charge storage batteries which were then used to operate radios, lights, and small appliances with voltage ratings of 12, 32, or 110 volts. A good selection of 32-VDC appliances was developed by the industry to meet this demand.

In addition to home wind-electric generation, a number of utilities around the world have built larger wind turbines to supply power to their customers. The largest wind turbine built before the late 1970s was a 1250-kW machine built on Grandpa's Knob, near Rutland, Vermont, in 1941. This turbine, called the Smith-Putnam machine, had a tower that was 34 m high and a rotor 53 m in diameter. The rotor turned an ac synchronous generator that produced 1250 kW of electrical power at wind speeds above 13 m/s.

After World War II, we entered the era of cheap oil imported from the Middle East. Interest in wind energy died and companies making small turbines folded. The oil embargo of 1973 served as a wakeup call, and oil-importing nations around the world started looking at wind again. The two most important countries in wind power development since then have been the U.S. and Denmark (Brower et al., 1993).

The U.S. immediately started to develop utility-scale turbines. It was understood that large turbines had the potential for producing cheaper electricity than smaller turbines, so that was a reasonable decision. The strategy of getting large turbines in place was poorly chosen, however. The Department of