Figure 2-6. Wind power plant. A linear array of modern wind turbines along a canal in the Netherlands. The wind turbines supply bulk electricity to the utility network served by the giant gas-fired power plant in the background.

sands of such wind machines were installed on California wind farms (see figure 2-7, The dawn of modern wind power).

These were wind turbines that just a few years before were being installed in backyards in the United States and Denmark. The biggest machines of that era produced about 50 kW, with rotors from 13 to 15 meters (44 to 50 ft) in diameter. Today commercial wind turbines are 10 to 30 times more powerful.

While most wind-electric generation in North America is produced by giant wind power plants, this is not the case in northern Europe. Denmark's and Germany's experiences with wind energy are vastly different from that of North America.

Two-thirds of the wind-generated electricity in Denmark and Germany is produced by wind turbines in small groups or clusters. Many homeowners, farmers, and small businesses in northern Europe operate their own medium-size wind turbine or share in the operation of a cooperatively owned group of turbines.

There are other differences as well. While North Americans were erecting 5 kW and 10 kW wind turbines in their backyards during the early 1980s, the Danes were installing 55-kilowatt machines in theirs. Even today Danish or German farmers will install a 900 kW turbine on their land, while their Yankee counterparts will be limited to a wind turbine of less than 100 kW, often less than

Many homeowners, farmers, and small businesses in northern Europe operate their own medium-size wind turbine or share in the operation of a cooperatively owned group of turbines.

machines less than 5 meters (16 ft) in diameter. The larger wind machines are more difficult and dangerous to install, and manufacturers seldom offer them for owner installation.

Working Together

There's another way for individuals to reduce the cost of owning a wind system: working together. It's an approach common in northern Europe, particularly in Denmark. Collective action is a way for small investors to combine their financial clout. Joining together enables Danes to acquire the most cost-effective equipment possible, whether it's to process cheese, bake cookies, or generate electricity.

Cooperatives—The Danish Approach

Cooperative wind development is a natural outgrowth of Danish cultural and agricultural interests, according to Asbjørn Bjerre of Danmarks Vindmølleforening (Association of Danish Windmill Owners). The objective of the Folketing, or Danish parliament, in providing incentives for wind cooperatives, says Bjerre, was to encourage individual action toward meeting Danish energy and environmental policy. Through this program nearly any Danish household can effectively generate all its own electricity with wind energy. It worked, and the concept has also caught on in Germany and the Netherlands.

Danish law encouraged mutual ownership of wind turbines *(fællesmølle)* by exempting owners from taxes on the portion of the wind generation that offset a household's domestic electricity consumption. A wind co-op would then buy a wind turbine, site it to greatest advantage, sell the electricity to the utility, and share the revenue among its members. This enabled a group to buy the most cost-effective turbine available, even though it may have generated more electricity than any individual member needed.

Kennemerwind

Denmark has no monopoly on cooperatives. Many of the first wind turbines installed in the Netherlands were installed by co-ops, though conditions were far less favorable than in Denmark. One of the largest is Coöperatieve Windenergie Vereniging Kennemerwind. The group operates 10 turbines in all, 9 of which are part of a group of 15 turbines along a canal in Noord Holland.

Kennemerwind has no bank loans or debt. It raises all of its capital from members, most of whom invest as little as 50 euros (about $50), though some have invested as much as 10,000 to 15,000 euros. The co-op views its members' investment as a 15-year loan to be repaid. While the driving force behind the co-op's 650 members is their desire to produce clean energy, Kennemerwind consistently pays an annual dividend of 7 percent to shareholders. Members can reinvest their dividends, and nearly all do.

Kennemerwind has a contract with Nuon, a private utility. This includes a guaranteed tariff of about 0.075 euro per kWh plus a 0.015-euro-per-kilowatt-hour tariff that depends on the price of fossil fuel.

From 1989 through 2002, the co-op generated more than 15 million kilowatt-hours. With the addition of several new Lagerwey turbines in the mid-1990s, Kennemerwind produces from 1.5 million to nearly 2 million kilowatt-hours yearly, enough electricity to meet the needs of 500 to 650 Dutch households. During the life of the co-op, the wind turbines have earned more than a million euros.

Kennemerwind. The four Lagerwey turbines (right) along the Noord Holland Kanaal are part of the Kennemerwind co-op. Each turbine generates 150,000 to 200,000 kWh per year.

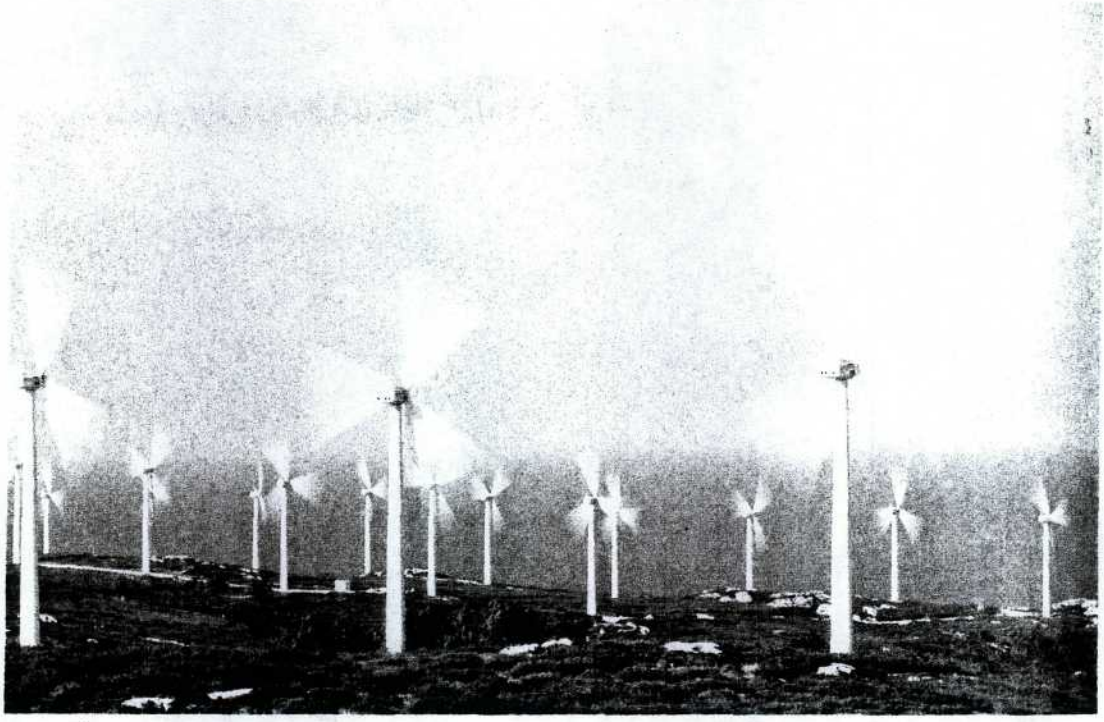

Figure 13-10. Visual uniformity. This pleasing array of Ecotecnia turbines on Spain's Galician coast near Malpica is partly attributable to the visual uniformity of the turbines.

industrial blight and a call to arms. Concern about the visual effect wind machines may have on a landscape and the communities of which they are a part should not be dismissed lightly.

Much has been written about the place of wind turbines in the landscape and how to minimize their visual intrusion. For more on the topic, see *Wind Energy Comes of Age, Wind Power in View,* and *Wind Turbines and the Landscape.* What follows are some general guidelines. Most fall under the rubric of "Be a good neighbor."

Medium-Size Turbines

While medium-size and larger wind turbines are installed as single units, like small wind turbines, more often they're installed in clusters or large arrays—wind farms. When there are more than one or two turbines in visual proximity to each other, it is critical to provide visual uniformity of turbine, tower, color, and direction of rotation. This is the single most important step planners can take to successfully integrate wind turbines into the community. The turbines need not be identical, but they must appear similar (see figure 13-10, Visual uniformity).

As with any business, some wind projects succeed and some fail (see figure 13-11, Headless horsemen). The community has a right to demand that operators repair or replace any "headless horsemen"—towers without turbines on top. If the turbine is not returned to operation, then the turbine, tower, and support equipment should be promptly removed, and the site restored to its pre-project state.

Avoid visual clutter by designing arrays with open spacing. Don't place the turbines too close together. One Tehachapi wind farm operator placed his turbines so close together that their rotors tangled and the turbines had to be repaired, then moved.

There are already too many billboards littering the countryside. Wind turbines