Chapter 4

Barriers to the Use of Renewable Energy Technologies

Renewable energy technologies have an enormous potential in the United States and that potential can be realized at a reasonable cost. Market research shows that many customers will purchase renewable power even if it costs somewhat more than conventional power.[1] However, both economic theory and experience point to significant market barriers and market failures that will limit the development of renewables unless special policy measures are enacted to encourage that development.[2] These hurdles can be grouped into five categories:

- commercialization barriers faced by new technologies competing with mature technologies
- price distortions from existing subsidies and unequal tax burdens between renewables and other energy sources
- failure of the market to value the public benefits of renewables
- market barriers such as inadequate information, lack of access to capital, "split incentives" between building owners and tenants, and high transaction costs for making small purchases

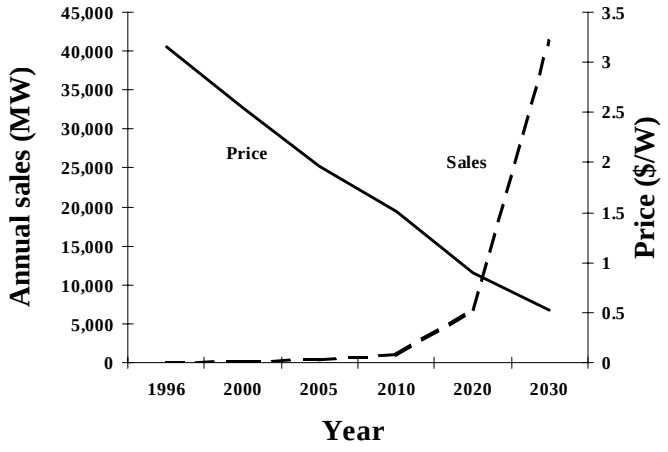
Commercialization Barriers

To compete against mature fossil fuel and nuclear technologies renewables must overcome two major barriers to commercialization: undeveloped infrastructure and lack of economies of scale.

Infrastructure. Developing new renewable resources will require large initial investments to build infrastructure. These investments increase the cost of providing renewable electricity, especially during early years. Examples include

- *Prospecting*: Developers must find publicly acceptable sites with good resources and with access to transmission lines. Potential wind sites can require several years of monitoring to determine whether they are suitable.
- *Permitting*: Permitting issues for conventional energy technologies are generally well understood, and the process and standards for review are well defined. In contrast, renewables often involve new types of issues and ecosystem impacts. And standards are still in the process of development.
- *Marketing*: In the past, individuals had no choices about the sources of their electricity. But electricity deregulation has opened the market so that customers have a variety of choices. Start-up companies must communicate the benefits of renewables to customers in order to persuade them to switch from traditional sources. Public education will be a critical part of a fully functioning market if renewables are to succeed.

Figure 11. Projections of Crystalline Silicon PV Module Sales and Prices



Source: Technology Characterizations, 1997, Residential PV, Table 2.

- *Installation, operation, and maintenance*: Workers must be trained to install, operate, and maintain new technologies, as well as to grow and transport biomass fuels. Some renewables need operating experience in regional climate conditions before performance can be optimized. For example, the optimal spacing of wind turbines is likely to be different on New England ridgelines than on agricultural land in the Midwest.

Economies of Scale. Most renewable energy technologies are manufactured on assembly lines, where mass production can greatly reduce costs. As of the late 1990s, manufacturing costs for photovoltaics had declined 20 to 25 percent for each doubling of production volume, as illustrated in figure 11.[3] The Spire Corporation, which makes assembly lines for manufacturing photovoltaic modules, says that costs for photovoltaic modules can be reduced from about $2.25 per watt to $1.80 per watt merely by scaling up photovoltaic factories so that instead of manufacturing 10 MW of photovoltaics per year, they make 25 MW per year.[4] Economies of scale are also likely to lead to cost reductions for wind, fuel cell, and biomass technologies. Unfortunately, as long as relatively few units are produced, prices will remain high. This leads to low demand, and therefore low production volumes. This chicken-and-egg problem is especially difficult with technologies that have long lives.[5] However, scaling up manufacturing of new technologies too quickly can create its own problems, such as shortages of skilled labor and bottlenecks in parts supplies.

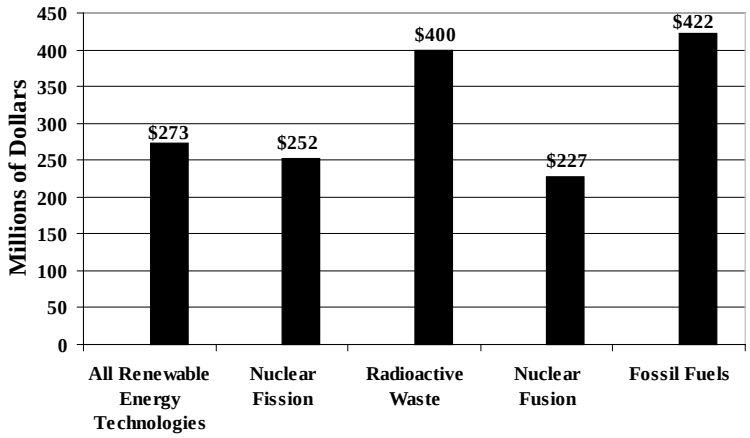
Unequal Government Subsidies and Taxes

Compared with renewables, nuclear and fossil fuel technologies enjoy a considerable advantage in government subsidies for research and development.[6]

- A 1980 Pacific Northwest Laboratory report found that, of $516 billion spent on energy subsidies through 1978, 50 percent had gone to oil, 25 percent to electricity, and 25 percent to nuclear, hydro, gas, and coal.[7]
- A 1992 Energy Information Administration study found that, during fiscal year 1992, direct federal subsidies totaled $8 billion, with renewables (except ethanol for transportation) receiving about one-third as much as coal and less than one-quarter as much as natural gas. Another $3.1 billion in indirect subsidies went to the oil industry.[8]
- For fiscal year 1996, Congress appropriated $422 million for fossil fuels, $227 million for nuclear fusion, $252 million for nuclear fission, $400 million for nuclear waste (only half of which is paid for by nuclear waste fees on generators), but only $273 million for all renewable energy technologies combined[9] (see figure 12).

In addition to receiving subsidies for research and development, conventional generating technologies have a lower tax burden. Fuel expenditures can be deducted from taxable income, but few renewables benefit from this deduction, since most do not use market-supplied fuels. Income and property taxes are higher for renewables, which require large capital investments but have low fuel and operating expenses. A 1996 study by Resources for the Future found that the total tax burden of natural gas facilities is only 0.507¢/kWh (in 1993 dollars), compared with 1.521¢/kWh for biomass generators.[10] Even if the renewable energy production tax credit were counted (no biomass plants had qualified as of 1998), the tax burden would be over 50 percent

Figure 12. FY 1996 DOE Energy Budget



Source: "DOE Releases Annual Energy Budget", Public Citizen, March 1996.

higher than for a natural gas plant.[11] The tax burden for wind energy is approximately as high as for biomass.[12]

A study by the Energy Information Administration found that renewable energy development is further inhibited by a "depletion allowance" for oil, natural gas, and coal suppliers, which resulted in a federal tax revenue loss of $745 million in 1992. The depletion allowance allows companies to deduct the "loss" of fuels that have been mined or drilled.[13] Furthermore, tax law allows fossil fuel producers to write off certain exploration and development costs rather than capitalizing and depreciating them over time. These write-offs, in combination with other incentives, encourage domestic exploration and development. While this has resulted in increased production within the United States and lower oil prices, it may also have both diverted capital from more productive activities, such as energy efficiency investments, as well as constrained the growth of renewable energy.

Market Failure to Value Public Benefits of Renewables

Many of the benefits of renewables described earlier in this primer are public benefits that accrue to everyone—what economists call "public goods." For example, those who choose renewables reduce pollution for everyone and provide an environmental benefit to the public at large. A customer who is willing to pay more for electricity from renewables still has to breathe the same air as the neighbor who might choose not to pay more. Public goods do not motivate everyone who benefits to pay for them, if they can choose to be "free riders" who benefit from the contributions of others.

Employment, fuel diversity, price stability, and other indirect economic benefits of renewables also accrue to society as a whole.[14] For example, for a large industrial customer, it may make more sense to risk moving to another region in response to increases in fuel prices rather than pay more for renewables to stabilize regional prices. While this strategy may benefit the individual firm, it is likely to hurt the region's long-term economic competitiveness. In the same way, firms that can pass on increases in energy costs to customers may also lack an incentive to diversify fuel sources, even though investment in renewables would stabilize prices over the longer term.

Research and development that produces societal benefits, but has little effect on a company's bottom line, will be especially undervalued in restructured markets. Although R&D is likely to continue in a competitive electricity industry, and the desire to provide customer choice is likely to accelerate some innovations, research will probably shift to those areas with the fastest payback and those that allow companies to beat out competitors in the short term. Private funding is likely to dwindle for research with benefits that are primarily public or that do not result in a relatively quick payback, primarily to the funder.

Some research indicates that people will be willing to pay more for public benefits than economic theory would suggest. But investment in technologies where much of the payback does not accrue to the individual making the investment will always be less than the optimal investment for society.[15] Two-thirds of electricity produced is used by commercial and industrial customers. While some of these customers may also pay more for cleaner electricity sources, many will not.[16]

For these reasons, renewables will be unable to compete on a level playing field with conventional generation until new policies are adopted to internalize the public costs of these fossil fuel sources. Emission fees or caps on total pollution, with tradable emission permits, are examples of ways to internalize the costs of pollution, creating a more level arena for renewables. (Such mechanisms are discussed below in Chapter 5.)

Market Barriers

Renewable energy technologies face considerable barriers in market transactions.

Lack of Information. Customers may have insufficient information to make informed choices. Most utilities provide little or no information about their emissions or the fuels they use. Because renewable technologies are relatively new, most customers know little about them. Many customers, for example, may think that solar and wind technologies are unreliable because they are available only when the sun is shining or the wind is blowing. They are unlikely to be aware

that these intermittent technologies can be highly reliable when combined with other options.

Institutional Barriers. Commercial and industrial customers are also generally unfamiliar with renewables and have institutional barriers to purchasing renewables. Industrial energy managers are trained only to find low-cost solutions. Industrial environmental managers look for ways to reduce in-house pollution and are unlikely to consider pollution associated with their electricity purchases.

Even local electricity companies may be unfamiliar with renewables. Most utilities have not studied how renewable resources could fit into their systems or what local resources are available. For example, few have investigated how the output of solar and wind technologies matches their system peak load.

Small Size. Renewables projects and companies are generally small. Thus they have fewer resources than large generation companies or integrated utilities. These small companies are less able to communicate directly with large numbers of customers. They will have less clout negotiating favorable terms with larger market players. And they are less able to participate in regulatory or legislative proceedings, or in industry forums defining new electricity market rules.

High Transaction Costs. Small projects have high transaction costs at many stages of the development cycle. For example, it costs more for financial institutions to evaluate the credit-worthiness of many small projects than of one large project. It costs marketers more to negotiate contracts with many small projects, and to market to and sign up residential customers, who are the most likely segment to pay more for renewables.

High Financing Costs. Renewables developers and customers may have difficulty obtaining financing at rates as low as may be available for conventional energy facilities. In addition to having higher transaction costs, financial institutions are generally unfamiliar with the new technologies and likely to perceive them as risky, so that they may lend money at higher rates. High financing costs are especially significant to the competitive position of renewables, since renewables generally require higher initial investments than fossil fuel plants, even though they have lower operating costs. A study by the Lawrence Berkeley Laboratory found that financing costs can greatly affect the price and competitiveness of wind energy, since most of the cost is in capital and little is in operation. The study also found that financing costs for solar panels could result in solar generation prices as low as 15.2¢/kWh for publicly owned utilities and as high as 43.1¢/kWh for a private developer using project financing.[17]

Split Incentives. When renewables are used locally to provide power to individual buildings and businesses through photovoltaics, fuel cells, or small wind turbines, they encounter additional market barriers. Landlords own some of the most cost-effective building sites, but are unlikely to install equipment just so tenants can realize energy savings. And tenants may not have the right to modify the property or the interest in making a long-term investment.

Few utilities consider the full value of distributed generating technologies. A small renewable energy system located in a neighborhood with growing electricity use can help avoid investments to upgrade transmission or distribution lines to the neighborhood. But utility generation planning departments generally consider only the cost of generating electricity with a distributed technology, not the potential savings in transmission and distribution costs. Transmission and distribution planners consider only the costs of alternative transmission and distribution technologies. Because planning is done in separate departments, no one looks at the potential integrated value of a solar module in avoiding all three: generation and transmission and distribution expenditures. Renewable technologies are sometimes cost-effective when this integrated value is considered. In a restructured industry where distribution, transmission, and generation are all in separate companies, planning for distributed generation may be even less likely than previously, unless policymakers provide significant incentives.

Transmission Costs. Renewables may also be charged higher transmission costs than conventional technologies or may be subject to other discriminatory grid policies. For example, a system that requires generators to reserve a block of capacity in advance may

force an intermittent generator, like solar or wind, to pay for the maximum output they can generate at any moment. Most of the time, however, an intermittent resource generates at less than its maximum potential capacity. Since a wind farm produces, on average, only about a third of the time, it could have to pay three times more per kilowatt hour transmitted than a conventional plant designed to generate at full capacity all the time.

Another problem is predicting the exact time and quantity of power for delivery, since wind speeds or sunshine can be difficult to predict more than a day or two in advance. The Federal Energy Regulatory Commission recommends a penalty if energy deliveries vary 1.5 percent from scheduled amounts.[18] Remotely located renewable resources may also have to pay heavily in transmission pricing schemes that charge according to distance or in those that charge "pancaked" rates, which depend on the number of utility territories crossed.

Green Market Limits. Given the numerous barriers facing renewables in the competitive market, how big the green electricity market is or could become is uncertain. Some initial signs are encouraging; others are less so. Survey after survey shows strong customer preference for green electricity.[19] Market research also shows distinct market segments of customers interested in buying environmentally preferable products generally. Green markets for other products—including food, paper, cleaners, clothing, computers, furniture, and homes—are also emerging. Of all new products introduced in 1996, 12 percent made environmental marketing claims, according to one market researcher.[20] In some cases, green products have transformed markets; for example, phosphate-containing detergents are no longer available in Europe.

Some electricity choice pilot projects have shown encouraging results. In Massachusetts, for example, 31 percent of residential customers exercising choice in a carefully controlled pilot program picked a product advertised as green.[21] In an Oregon pilot, 15 percent of customers choosing among four options chose a 100 percent renewables product.[22] And some business customers have shown interest in picking green options over the lowest-price options. In Traverse City, Michigan, small commercial customers voluntarily contributed as much money toward a wind turbine as residential customers did.[23] IBM, Coors, and other large industrial customers are participating in a Colorado wind energy program.[24] Toyota has chosen a 100 percent renewables product for its four California offices.[25]

Other signs are less hopeful. Many fewer people actually choose to buy green electricity than say they would if they could. Where utilities have offered "green pricing," no more than 3 percent of all residential customers have participated—in some cases less than 1 percent.[26] One important reason why participation rates have been much lower than survey responses is that people have a strong preference for everyone to contribute to renewables. In an October 1998 poll of Texas Utilities customers, 88 percent said they would be willing to pay more for renewables. However, 79 percent preferred that all utility customers pay at least some of the added costs, whereas only 17 percent wanted to rely only on green-pricing.[27] More importantly, commercial and industrial customers—which use nearly two-thirds of all the electricity that's generated—are more likely to be concerned about price than about the environment.[28]

Newly deregulated markets where customers do not have to choose suppliers may face considerable inertia. Fifteen years after long-distance telephone deregulation, 54 percent of customers have never exercised choice and more than two-thirds are still with AT&T.[29] While environmental factors will induce some customers to switch electricity suppliers, many customers are likely to find the complexity of weighing price and environmental factors more confusing than telephone choices. And, since marketing costs to induce switching are likely to be high, they will probably absorb a substantial part of the green premium customers are willing to pay.

The most optimistic green marketers expect that as many as 20 percent of residential customers and 10 percent of commercial customers will buy green electricity five years after competition has been introduced in a given market.[30] Such results could lead to meaningful new renewable resource development, especially in

markets where there are not large amounts of existing renewables that need market support. However, they would still mean that 80 to 90 percent of customers were not contributing to renewable electricity generation, even though they could be receiving benefits of clean air, fuel diversity, price stability, and increased economic development from renewables. Policy mechanisms are needed to maximize these public benefits, as well as to ensure the development of as robust a green market as possible.

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[2] See David Moskovitz, *Renewable Energy: Barriers and Opportunities, Walls and Bridges*, World Resources Institute, July 1992.

[3] Utility Photovoltaic Group, *The Utility Experience Base with PV Systems*, Part 2, June 1994, p. 21.

[4] Paul Maycock, "Spire PV Module Manufacturing Cost at $1.78/Watt," *PV News*, Jan. 1998, p. 3

[5] For example, suppose a wind turbine installed today looks more expensive than a natural gas plant for the first five years, but is projected to be less expensive than the gas plant as fuel prices rise over the 20- to 30-year life of the wind turbine. Suppose also that wind turbines are projected to be much cheaper five years from now than they are today, based on increasing wind production volumes. In this case, a developer might select the gas plant, which is cheap in the short-run, and wait for the less expensive wind turbines to emerge later. But if all developers wait, the production volumes would not be achieved and the wind costs would never come down.

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[8] *Ibid.*

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[10] Dallas Burtraw, *Renewable Energy Tax Issues*, Resources for the Future, US Department of Energy, Office of Utility Technologies Analysis Workshop, July 23, 1996.

[11] Note that this credit is available only through July 1999, and only for closed-loop facilities, none of which are currently under construction or planned. Efforts are under way to try to extend and expand the tax credits.

[12] Dallas Burtraw, US Department of Energy Office of Utility Technologies Workshop, Washington D.C., July 23, 1996. See also Alec F. Jenkins, California Energy Commission, Sacramento, California, Richard A. Chapman, Consulting Engineer, San Jose, California, Hugh E. Reilly, Sandia National Laboratories, Albuquerque, New Mexico, *Tax Barriers to Four Renewable Electric Generation Technologies*, www.energy.ca.gov/development/tax_neutrality_study and Stanton Hadley, Lawrence Hill, and Robert Perlack, *Report on the Study of the Tax and Rate Treatment of Renewable Energy Projects*, Oak Ridge National Laboratory, ORNL-6772, December 1993. This study found net tax penalties for utility-owned solar and hydro, but net incentives for utility-owned wind and biomass energy crops, thanks to production tax credits that expire in 1999. For nonutility generators, which are responsible for most renewables development, all renewables have net tax penalties compared with conventional sources, even with production tax credits.

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[20] Marketing Intelligence Service, Naples, NY, cited in Land and Water Fund of the Rockies and Community Office for Resource Efficiency, *Promoting Renewable Energy in a Market Environment: A Community-Based Approach for Aggregating Green Demand*, May 1997, p. 9

[21] Steven Rothstein and Jeffrey Fang, Green Marketing in the Massachusetts Electric Company Retail Competition Pilot Program, National Renewable Energy Laboratory, NREL/TP-260-23507, October 1997. The pilot program was only conducted in four towns, one of which was a very liberal college town. Participants in the pilot were self-selected. Consequently, many of those choosing to participate did so because of interest in the green products.

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