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National Policy Instruments:

Policy Lessons for the Advancement & Diffusion of Renewable Energy Technologies Around the World

Thematic Background Paper

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This is one of 12 Thematic Background Papers (TBP) that have been prepared as thematic background for the International Conference for Renewable Energies, Bonn 2004 (renewables 2004). A list of all papers can be found at the end of this document.

Internationally recognised experts have prepared all TBPs. Many people have commented on earlier versions of this document. However, the responsibility for the content remains with the authors.

Each TBP focusses on a different aspect of renewable energy and presents policy implications and recommendations. The purpose of the TBP is twofold, first to provide a substantive basis for discussions on the Conference Issue Paper (CIP) and, second, to provide some empirical facts and background information for the interested public. In building on the existing wealth of political debate and academic discourse, they point to different options and open questions on how to solve the most important problems in the field of renewable energies.

All TBP are published in the conference documents as inputs to the preparation process. They can also be found on the conference website at www.renewables2004.de.

Executive Summary

For renewable energy to make a significant contribution to economic development, job creation, reduced oil dependence, and lower greenhouse gas emissions, it will be essential to improve the efficiency of technologies, reduce their costs, and develop mature, self-sustaining industries to manufacture, install and maintain renewable energy systems. The goal must not be simply to install capacity, but to provide the conditions for creation of a sustained and profitable industry, which, in turn, will result in increased renewable energy capacity and generation, and will drive down costs. To achieve this end, a viable, clear and long-term government commitment is critical. Also essential are policies that create markets, and ensure a fair rate of return for investors.

During the past decade, the world has witnessed double-digit growth in the wind and photovoltaic (PV) industries, significant advances in these technologies, and dramatic cost reductions. Today half a dozen countries represent roughly 80 percent of the world market for these technologies. Those countries have demonstrated that it is possible to create vibrant markets for renewable energy, and to do so very rapidly; but the record also shows that the renewable energy policies of most countries have been unsuccessful to date.

Most of the renewable energy development experienced thus far has been driven by countries with feed-in, or pricing, systems. At the same time, a combination of policies is required, including standards, education, stakeholder involvement, and incentives to bring down the initial costs of investment and reduce risk, whether real or perceived. Ultimately, the effectiveness of policies in promoting renewable energy will depend on their design, enforcement, how well they address national circumstances, and the extent to which they are consistent and sustained.

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1. Introduction

For renewable energy to make as large as possible a contribution to economic development, job creation, lower oil dependence, and reduced greenhouse gas emissions, it will be essential to improve the efficiency of technologies, reduce their costs and develop mature, self-sustaining industries to manufacture, install and maintain those systems. Today's energy markets include a number of obstacles that frustrate efforts to achieve these goals. Among the obstacles are lack of access to the electric grid at reasonable prices, high initial cost compared to conventional energy sources, and the widespread lack of awareness about the scale of resources available, the pace of development of renewable technologies, or the potential economic advantages of renewable energy.

These barriers have been largely overcome in several countries, allowing a period of sustained double-digit growth in the solar and wind markets over the past decade, and providing policy models for other countries to adapt. These successful models show that a sustained renewable energy market can be developed quickly and efficiently if the right combination of policies is adopted.

This paper examines which policies have been most effective in promoting renewable energy. It focuses primarily on grid-connected electricity and vehicle fuels, and briefly on remote uses of photovoltaics (PVs) and heat systems, with the assumption that the policy recommendations can be carried over to other types and uses of renewable technologies. "Success" of policies is defined to cover positive impacts on a range of factors, including: the installed capacity and energy generation from renewable energy technologies; technological advances; reductions in cost and price; domestic manufacturing capacity and related jobs; and public acceptance.

1.1 Major barriers to renewable energy

While most renewable fuels are free, renewable energy projects have high up-front costs, and a number of factors combine to make many renewable energies more expensive than conventional energy. Distortions resulting from unequal tax burdens and existing subsidies, and the failure to internalize all costs and benefits of energy production and use, erect high barriers to renewable energy. Additional cost barriers range from the cost of technologies themselves (and the need to achieve economies of scale in production), to the lack of access to affordable credit, and the costs of connecting with the grid and transmission charges, which often penalize intermittent energy sources. Import duties on renewable technologies and components also act to make renewable energy more costly. As a result, many of the cost barriers to renewables are perceived rather than real.

In many countries, electric utilities maintain monopoly rights to produce, transmit and distribute electricity, or high costs or a lack of standards for connection and transmission discourage renewable energy projects. And everywhere, renewable energy must compete with financial and regulatory systems that have evolved to promote the development and use of fossil fuels and nuclear power, and that often discriminate against the use of renewable technologies.

In addition, lack of information about available renewable energy resources and about the current state of renewable energy technologies, or misperceptions, lack of experience or training, or negative past experiences with old technologies, and a lack of understanding about the benefits associated with renewable energy all act as barriers to their use. Each of these factors works to increase the perceived risks—technical and financial—of investing in renewable energy.

For the most part, the barriers that exist in developing countries are similar to those in the industrial world. However, specific national characteristics, particularly within the developing world, can play an important role in determining barriers from one country to the next. Additional barriers in many developing countries include long travel distances to remote areas, poor transport and communication infrastructure, lack of trained personnel, and low literacy rates (Martinot et al, 2002). In addition, the perceived risk of investing in renewable energy projects in developing countries is high due to uncertainties about political, regulatory, and market stability (Frost 2003). In the past, donor aid has inhibited commercial markets, often reducing perceived value of renewable technologies (if they are free), while focusing little on models of development that can be viable, sustainable and replicable. And if people expect to be connected to the grid soon, due to unrealistic plans for grid extension or political promises, there is no incentive to invest in alternatives (Martinot, 2003).

Finally, even government policies that are enacted to promote renewable energy can have negative impacts if they are inappropriate, inconsistent, or are too short-term.

1.2 Types of policies to be discussed

Governments have a number of options that they can use to promote renewables. The first is to support the use of voluntary measures, particularly through education and information dissemination. This option has varying and limited effects. Second are environmental standards or energy taxes. The third option is to promote renewable energies through direct support, which is the focus of this report. Generally, a mix of instruments is essential and a key to success. The combination of policies needed depends on the costs of the technology used, location and conditions.

There are five major categories of relevant policy mechanisms:

- Regulations that govern capacity access to the market/electric grid and production or purchase obligations
- Financial incentives
- Industry standards, permitting and building codes
- Education and information dissemination
- Stakeholder involvement

There is not necessarily a direct link between these policy mechanisms and specific obstacles to greater use of renewable energy, as some of the policy options tackle a combination of barriers. Each of these policy mechanisms is discussed below. An additional critical element is the need or a general change in government perspective and approach to energy policy.

Government investments in research and development (R&D) are important as well. Ultimately, however, it is only by creating a market (demand-pull, rather than supply-push) for renewable energy technologies that the technological development, learning and economies of scale in production can come about to further advance renewables and reduce their costs. And as markets expand and industries grow, more private money is drawn into private research and development, which is often more successful than public R&D. (Sawin, 2001) See also TBP 7.

1.3 Some key points to consider

Following are key points to frame the discussion below. The concluding section (chapter 6) includes more findings and policy recommendations.

1) Experience to date has demonstrated that considerable intervention in energy markets is required to introduce significant amounts of renewable energy into the mix. Every country that has succeeded thus far in developing renewable energy on a substantial scale has been committed over the long-term to this goal, with consistent policies that include a package of policy mechanisms (consisting of all of the above-mentioned types).

2) The effectiveness of government policies depends on how well they are designed and whether or not they are enforced. The use of a particular policy type does not guarantee success. In addition, policy makers must be cognizant of the projects and technologies they are trying to promote as such decisions determine the policy framework that is needed. For example, to promote technologies such as PV, solar thermal, heat pumps and wind turbines on a small-scale, distributed basis, support should be granted to the end customer; to promote large wind, biomass, geothermal, or marine technologies, the investment is more likely to be channelled through a large entity or company (Kleiburg, 2003). Further, each country has unique circumstances and must design its own system, and enact a combination of policies, based on needs, circumstances and available resources.

3) The experiences of countries such as Denmark, Germany, Japan, Spain and Brazil have demonstrated that the key to steady and significant cost reductions is the development of consistent and reliable markets. Such conditions allow for the entry and maturation of small- and medium-scale enterprises, which have provided the bulk of the technological innovation that has driven down renewable energy costs. In addition to the "global learning curve" that exists for technologies such as wind turbines and PV cells, there is a "national learning curve" as individual countries develop domestic industries that are able to manufacture, install and maintain renewable energy systems using local equipment and labor. Those countries that do not yet have sizeable industries in place can expect dramatic price reductions in the first few years after effective new policies are introduced.

4) Most of the policies discussed below involve some sort of subsidy, direct or indirect. Energy markets are not now and never have been fully competitive and open, and today's markets include substantial institutional barriers, as well as long-term subsidies for conventional energy, that act as obstacles to renewable energy. Even market-oriented countries such as the United States and United Kingdom now agree that subsidizing renewable energy makes sense. Support for renewables is important not only to incorporate the external costs (environmental, social and security) of energy production and use, and make up for decades of past support for conventional energy. It is also essential to account for the environmental, social and security benefits associated with renewables—including the reduced risk of fuel price volatility, a more diversified portfolio of energy options, a cleaner environment and better health, and job creation and economic development. Well-designed, modest production-based subsidies provided up front can work rapidly to close the cost gap between renewables and conventional energy systems.

5) To date, feed-in—or pricing—systems have been responsible for most of the additions in renewable electricity capacity and generation, while driving down costs through technology advancement and economies of scale, and developing domestic industries. The record of

quota systems is more uneven thus far, with a tendency of stop-and-go, and boom and bust markets. It is important to recognize that both quota and pricing systems involve subsidies. But pricing systems have provided increased predictability and consistency in markets, which in turn have encouraged banks and other financial institutions to provide the capital required for investment.

6) In developing countries, markets are apt to be particularly sensitive to the need for relatively uncomplicated access to the electric grid and low transaction costs. Pricing laws allow for ease of entry into the marketplace and tend to favor smaller companies and incremental investment, making them particularly suited to developing countries, where power markets are often small and dispersed. As in the industrial world, it is critical to focus on models of development that are viable, sustainable, and replicable, and that emphasize local participation and ownership; to date, donor aid projects have tended to reduce the perceived value of renewable energy while inhibiting commercial markets.

2. Regulations Governing Market Access

Access to the market, such as the electric grid, is imperative for renewables to gain a foothold, in industrial and developing nations. It is also important that systems not discriminate against, or give preference to, any particular kind of technology or generator with regard to access and charges for grid connections and transmission. In many countries, in both the industrial and developing worlds, there exist transmission-pricing penalties for intermittent generation. And, in many cases, where power markets have been opened to competition, investment in renewables (which are capital-intensive) has been hindered in the absence of strong policies to promote renewable energy. In general, the impacts of privatization have depended on the specific policies and regulations in place.

The regulatory framework is at least as important as subsidies for renewable energy. Two main types of regulatory policies have been used to open the grid to renewables. One guarantees price, another ensures market share through government mandated targets or quotas. The first is the fair access and standard pricing law, also called the renewable energy feed-in law.

2.1 Feed-in laws - pricing systems

Under the feed-in law—or pricing system, as it will be referred to from here on—electric utilities are obligated to enable renewable energy plants to connect to the electric grid, and they must purchase any electricity generated with renewable resources at fixed, minimum prices. These prices are generally set higher than the regular market price, and payments are usually guaranteed over a specified period of time. Tariffs may have a direct relationship with cost or price, or may be chosen instead to spur investment in renewables.

The precursor to the pricing law was enacted in California during the 1980s. The U.S. Public Utilities Regulatory Act of 1978 (PURPA) required utilities to interconnect with and buy energy from "qualifying facilities," including renewable energy plants, at incremental or avoided costs of production. In California, the implementation of PURPA involved the use of standardized long-term contracts with fixed (and, in some cases, increasing) payments for all or part of the contract term. The costs of the contracts were covered through higher electric rates for consumers. While these contracts proved costly, it is widely believed that the alternative (nuclear power) would have been even more expensive. The time length of the contracts (15 to 30 years for wind projects), combined with fixed energy prices for much of that time, assured producers of a market for their product and finally gave them something they could take to the bank to obtain financing. While most other U.S. states saw little development during the 1980s, California for a time became the world's leader in renewable energy use. (Sawin, 2001)

The early pricing laws in Europe, in Denmark and Germany, also required that utilities give small wind and other private generators access to the electric grid, and they guaranteed producers a minimum share of the retail rate—at least 85 percent in Denmark, and 90 percent in Germany. The German system was revised in 2000, and today most pricing laws provide a fixed payment for renewable electricity that varies by technology type, plant size, and occasionally by location (e.g., wind energy), and is generally based on the costs of generation. Payments guaranteed to new projects decline annually, and are adjusted every two years. The tariffs last for 20 years from date of project installation. German electric utilities now qualify for these payments as well. (Gerdes, 2000)

The costs of higher payments to renewables are covered by an additional per kilowatt-hour (kWh) charge on all consumers according to their level of use (e.g., Spain, Germany as of 2000), a charge on those customers of utilities required to purchase green electricity (e.g., Germany until 2000), or by taxpayers, or a combination of both (Denmark through feed-in rates and reimbursement of the carbon tax). Laws similar to Germany's pricing law have been enacted in Spain, and several other European countries, including France, Austria, Portugal, and Greece, in addition to South Korea. Recently, Brazil enacted a law that combines pricing laws and quotas (specific capacity targets).

It is important to note that pricing laws have not succeeded in every country that has enacted them. At the same time, to date, those countries that have experienced the most significant market growth and have created the strongest domestic industries have had pricing laws. In order to succeed, tariffs must be high enough to cover costs and encourage development of particular technologies; they also must be guaranteed for a time period long enough to assure investors of a high enough rate of return. The success of pricing laws is also determined by factors such as charges for access to the electric grid, limits set on qualifying capacity, and the ease of permitting and siting (influenced by the existence and specifics of national or regional standards).

A variation on pricing laws, "net metering," permits consumers to install small renewable systems at their homes or businesses and then to sell their excess electricity into the grid. This excess electricity must be purchased at wholesale market prices by the utility. In some cases, producers are paid for every kilowatt hour (kWh) they feed into the grid; in other cases they receive credit only to the point where their production equals their consumption. This option is available in Japan, Thailand, Canada, and at least 38 U.S. states, including Texas and California. It is of benefit to electricity providers as well as system owners, particularly in the case of PV, because excess power generated during peaking times can improve system load factors and offset the need for new peak load generating plants.

Net metering differs from the access and pricing laws in Europe primarily in scale and implementation. Success in attracting new renewable energy investments and capacity depends on limits set on participation (capacity caps, number of customers, or share of peak demand); on the price paid, if any, for net excess generation; on the existence of grid connection standards; and on enforcement mechanisms. Without other financial incentives, net metering is not enough to advance market penetration. Neither California nor Texas saw much benefit from net metering for wind power, let alone for more costly renewables like solar PVs, until other incentives were added to the mix. However, net metering might have a greater impact if private generators were to receive time-of-use rates for the electricity they put into the grid—particularly in the case of PVs, which generate electricity at peak demand times when the value of their power is highest. Mandated targets or quotas, discussed below, and net metering can be used simultaneously.

2.2 Quotas - mandating capacity or generation

While pricing laws establish the price and let the market determine capacity and generation, mandated targets work in reverse—the government sets a target and lets the market determine the price. Typically, governments mandate a minimum share of capacity or generation of electricity (generally grid-connected only), or a share of fuel, to come from renewable sources. The share required often increases gradually over time, with a specific final target and end-date. The mandate can be placed on producers, distributors or consumers.

The simplest form of quota system is one in which the government imposes a mandate on one producer/supplier. For example, during the 1990s, the Minnesota Public Utilities Commission ordered the electric utility Northern States Power to install successive amounts of wind energy capacity, thereby helping to open up the wind market in that U.S. state (Sawin, 2001). Quotas have also been used to promote the use of renewables off the grid, including alternative fuels. Several European countries now require that a specific share of diesel fuel contain biodiesel, and Brazil has become the world leader in ethanol production and use by requiring that ethanol make up a set share of all fuel sold (in combination with other support). Brazil's success with quotas is discussed in more depth below. (See Box 1)

The use of quotas for renewable electricity is a relatively new type of policy, first introduced in the late 1990s, so there is relatively little experience with quota systems to date. There are two main types of quota systems used today for electricity generation: obligation/certificate and tendering systems. The Renewables Portfolio Standard (RPS), widely used in U.S. states, is in the former category. Under an RPS, a political target is established for the minimum amount of capacity or generation that must come from renewables, with the amount generally increasing over time. Investors and generators then determine how they will comply—the type of technology to be used (except in the case where specific targets are established by technology type), the developers to do business with, the price and contract terms they will accept. At the end of the target period, electricity generators (or suppliers, depending on the policy design) must demonstrate, through the ownership of credits, that they are in compliance in order to avoid paying a penalty. Producers receive credit—in the form of "Green Certificates," "Green Labels," or "Renewable Energy Credits"—for the renewable electricity they generate. Such credits can be tradable or sellable, to serve as proof of meeting the legal obligation and to earn additional income. (Some countries have set floors and/or ceilings for the value that these certificates can achieve.) Those with too many certificates can trade or sell them; those with too few can build their own renewable capacity, buy electricity from other renewable plants (which generally involves a bidding process), or buy credits from others. Once the system has been established, government involvement includes the certifying of credits, and compliance monitoring and enforcement.

Under tendering systems, regulators specify an amount of capacity or share of total electricity to be achieved, and the maximum price per kWh. Project developers then submit price bids for contracts. The UK's Non-Fossil Fuel Obligation (NFFO) was an early example of this type of policy. Governments set the desired level of generation from each resource, and the growth rates required over time. The criteria for evaluation are established prior to each round of bidding. In some cases, governments will require separate bids for different technologies, so that solar PV is not competing against wind energy projects, for example. Generally, proposals from potential developers are accepted starting with the lowest bid and working upwards, until the level of capacity or generation required is achieved. Those who win the bid are guaranteed their price for a specified period of time; on the flip side, electricity providers are obligated to purchase a certain amount of renewable electricity from winning producers at a premium price. The government covers the difference between the market reference price and the winning bid price. Each bidding round is a one-time competition for funds and contracts. In contrast, under the RPS, companies and projects must constantly compete in the marketplace, with existing and new projects, unless they have signed long-term contracts.

As with the pricing law, the additional costs of renewable energy under quota systems are paid through a special tax on electricity or by a higher rate charged to all electricity consumers.

Thirteen U.S. states, covering 30 percent of the U.S. load, have mandated quotas through RPS laws (Hamrin, 2003). Quota systems are now in use in several other countries as well, including Japan, the United Kingdom, Italy and Australia.

2.3 Discussion of pricing systems compared with quota systems

Quota systems can be used for a range of technologies and fuels, while the pricing laws and RPS and tendering systems can be used only for electricity. The discussion below covers electricity only. (For heat and fuels, see chapters 3 and 4, and Box 1.) It looks at several issues that have been raised and debated regarding pricing laws and quotas, from their impacts on renewable capacity and generation, to costs and innovation. Note that section 2.4 summarizes much of the analysis below, with lists of the advantages and disadvantages of each system.

2.3.1 Renewable energy capacity and generation

Because quota systems establish specific targets for renewable capacity or generation, there is certainty regarding the future share of the market, and quotas can be tied directly to other government policies, such as emissions reductions. Quotas can provide producers and manufacturers with a predictable, steadily-growing market for renewable energy (Lauber, 2003). With pricing laws it is not possible to know in advance how much generation or capacity will result or, indeed, if the share of renewable energy generation will increase over the long-term. However, tariffs can be adjusted up or down to encourage more or less investment in renewable energy in order to bring installations in line with desired targets. In addition, under a quota system, the speed with which technologies are introduced is based on a political decision that might be largely unrelated to technical progress and the efficiency of using renewable energy (Krohn, 2000). Those countries with pricing laws have regularly surpassed national renewables targets (Menanteau et al, 2003; Lauber, 2003; Meyer, 2003).

There are some concerns that mandated targets or quotas can set the upper limit for development. At least to date, Texas is evidence that this is not necessarily the case as current renewables capacity in Texas is well above the required level. An RPS law is primarily responsible for the rapid growth of wind energy in Texas since 1999, when the state required that 2,000 MW of additional renewable capacity be installed within a decade. Texas was more than halfway there with wind alone by the end of 2002, and the target will likely be met before 2009. In 2001, Texas installed more wind capacity than the entire United States ever had before during the course of one year. At the same time, the combination of excellent winds in Texas and the U.S. federal Production Tax Credit (discussed below) make wind energy cost-competitive or better, so it pays to invest in wind energy. Where circumstances are different, there might be no incentive to install more than the mandated amount of renewable capacity. As this type of system is still relatively new, it is not possible to know whether this will be the case.

One fourth of U.S. states currently have RPS laws, and many of them have had far less success to date than Texas. This is due, at least in part, to the fact that some RPS requirements are not well designed—for example, they apply only to a small segment of the market, they have uncertain purchase obligations and/or end-dates, penalties for non-compliance are too low—or they are not enforced. Any one of these factors can limit the potential for a quota system to advance renewable energies (Wiser et al, 2000). But again, most of these laws have not been in place long enough to determine what their ultimate impact will be.

As with pricing laws, many of these problems associated with quota systems can be overcome with careful system design. Regardless, some analysts believe that the lower purchase prices common under bidding or quota systems, due to competition, result in lower levels of installed capacity (Menanteau et al, 2003). In fact, pricing laws have consistently proved most successful at promoting the growth of renewable electricity capacity and generation. While more than 45 countries installed wind capacity during the 1990s, just three, with pricing laws—Germany, Denmark, and Spain—accounted for more than 59 percent of total additions for the period 1991 through 2001 (Sawin, 2003). When Spain passed a pricing law in 1994, relatively few wind turbines were spinning in the Spanish plains or mountains; by the end of 2002, the country ranked second in the world for wind installations, surpassed only by Germany. These advances in renewable capacity and electricity generation have translated into successes in other areas as well, from job creation and economic development to reductions in greenhouse gas emissions. For example, Denmark's CO_2 emissions dropped 11 percent between 1990 and 2002, despite a 28 percent increase in gross national product, due primarily to increased use of renewable energy and fuel switching from coal to natural gas (DME, 2003).

However, Spain has had less success with solar PV. In 1998, Spain set PV tariffs that were similar to those provided in Germany. Despite having better solar resources, Spain installed little to no PV capacity over the next few years, while Germany's market took off. This is because major barriers remained. For example, no grid connection regulations were established, so utilities could set their own, often exorbitant, charges to cover safety and other factors. Once this issue was resolved in 2001, with national technical standards for grid connection, another barrier remained. PV producers who sold electricity into the grid, even households, had to register as businesses in order to pay income tax on their sales, a cumbersome and costly process which discouraged potential projects. (Bravo, undated; Muñoz, 2003) While there has been significant growth in Spanish PV manufacturing in recent years, most of this is attributable to the neighboring German market (Ristau, 2003). In France, creation of a pricing law was soon followed by a wave of applications for grid-connected wind farms—

about 16,000 MW by early 2003 (Forster, 2003). But just over 180 MW had been installed nationally by then (BTM Consult, 2003). There are still high hurdles that wind (and other renewables) must overcome, including onerous building approval procedures and turbine spacing and capacity limits (Forster, 2003; Choy, 2003). Italy's pricing law had little success for a number of reasons, including a lack of confidence in the continuity of the policy, a lack of standards, difficulty in obtaining financing, and problems in accessing the electric grid (Uh, 2003 and 2004).

Clearly, success with the pricing law is dependent upon the specifics of the law, and other policies enacted in parallel, particularly connections standards and charges. Successful combinations are discussed with regard to Germany's experiences (see Box 2).

2.3.2 Technological innovation, domestic industries and economic benefits

Many analysts have argued that pricing laws do not encourage innovation (Martinot, 2002). It is true that generous tariffs alone provided under pricing systems are no guarantee that a domestic industry will develop. For instance, for most of the 1990s, renewable energy producers in Italy received more generous payments than did those in Germany, yet there was little impact on manufacturing industries in Italy despite significant wind resources, due greatly to the factors discussed above (Lauber, 2003). However, others argue that once producers achieve a certain level of profit, they invest in private R&D to lower costs and increase their profit, a situation that is more favorable to "radical innovations" that require long payback periods than the circumstances created under quota systems (Lauber, 2003; Menanteau et al, 2003). With pricing systems, technological improvements increase profits, thereby encouraging innovation.

Under quota systems, the surplus may go entirely to consumers and, as a result, producers do not receive enough profit (or reliable long term profits) to invest in R&D in order to reduce their costs. At the same time, pressure to minimize costs under quota systems often encourages producers to turn to overseas manufacturers of technology (Lauber, 2003; Menanteau et al, 2003). In the United Kingdom, under the Non-Fossil Fuel Obligation, developers turned to foreign technology to keep costs down, and it became unprofitable for domestic manufacturers to remain in the market (Martinot, 2002). Further, bidding rounds can be time-consuming, costly, and can create cycles of stop-and-go. Because quotas often create on-off cycles, they do not allow for continuous development of the market, they discourage innovation, and they make it difficult to establish a strong domestic industry because investment in production facilities will take place only with a short-term perspective. This in turn limits potential job growth and economic development benefits associated with renewable energy (Wagner, 2000; Martinot and Reiche, 2000). (The impacts of inconsistent, stop-and-go policies are discussed further in chapter 5.) No matter what type of policy is used, companies will try to maximize their profits. But in order to drive down system costs, it is essential to have sustained and growing markets and, to date, payment systems have most consistently provided such markets.

Success of the wind industries in Denmark, Germany and Spain seems to bear this out. Turbine manufacturers in these three countries account for the majority of the world's turbine market, supplying about 90 percent of the market in 2002, and have driven most of the technological development in the wind industry (BTM Consult, 2003). (See Chart 1) About 100,000 people worldwide are employed in the wind industry; of these, three fourths live in the EU and nearly half are in Germany (Millais, 2003; Sawin, 2003; Cox, 2003). Approximately 130,000 people work in the renewable energy industries in Germany (Höhn, 2003). In Spain, about 350 companies are involved in renewables industries and, in Navarre and Castilla-La Mancha alone, a new high-tech industry and more than 3,600 new jobs have been created because of the growth in renewable energy markets (IDAE in Gonzálvez, 2003; Iturriagagoitia, 2002).

2.3.3 Geographic and ownership distribution

Quota type schemes tend to promote the least-cost projects, thus restricting them geographically to the areas with the best resources, and encouraging larger-scale, centralized projects (Lauber, 2003; Meyer, 2003). In Texas, for example, most wind capacity has been installed in the windiest (western) part of the state. In an EU-wide system, this would likely result in significant wind development in the United Kingdom, while solar development would occur (if at all) primarily in sunnier southern countries.

Such was the case with the early pricing laws as well. In the early 1990s, most of the wind development in Germany took place in the northern coastal states, leading regional utilities and consumers to bear the greatest financial burden of renewables development, and creating strong local opposition to wind energy (Twele, 1999; Sawin, 2003). This problem was overcome by adjusting payments to reflect differing costs of production in different regions—for example, wind turbines erected in areas (on-shore) with better wind resources have received lower payments than others. Some consider the pricing system to be a more flexible means for exploiting available resources because it allows for development in areas with varying levels of resource potential, assuming that tariffs vary by location (Meyer, 2003). Such adjustments would be necessary under a regional system—such as an EU-wide system, for example—as well, to ensure that development is more evenly dispersed. This does make pricing systems more complex, however. Similar adjustments are not possible under quota-type systems, although specific targets could be set for each region, state or country.

This situation raises concerns among some analysts that quota systems could have negative impacts on public acceptance of renewables (due to heavy development in particular regions) and on political support. Countries with relatively few resources (and thus experiencing less development, little job creation, etc.) would be less willing to support the more ambitious promotion of renewables in the future (Lauber, 2003). The Netherlands provides an example of this case: the government established a voluntary quota system with tradable credits that resulted in increased use of renewable energy. But about three fourths of the credits and accompanying subsidies went to foreign producers, leading the government to abandon this system (Lauber, 2003).

In addition, in the longer term, there is concern that relying only on the windiest or sunniest regions will be insufficient to meet the growing need for renewable energy. In a system with one common price for green certificates, for example, there will be no incentive to develop in less resource-intensive areas if prices are too low; if prices are too high, developers of good sites will make windfall profits (Meyer, 2003). A system will then be required that promotes the use of a variety of renewable resources in areas with vastly different potential (Meyer, 2003).

Some argue that pricing laws offer no inherent incentive for utilities to reduce institutional barriers to development of renewable energy. In fact, utilities can be driven to raise them, requiring the implementation of grid connection and charging standards (Lauber, 2003). On the other hand, the lack of need for negotiated contracts, combined with the fact that anyone has the right to install renewable technologies on their property and sell it into the grid, tends to ease entry into the marketplace. Pricing laws tend to favor smaller companies (even individuals or cooperatives) and incremental investment, leading to varying sizes of companies and projects. This aspect of pricing laws makes them particularly suited to developing countries, where power markets are often small and dispersed (Flavin, 2003).

Quota systems are more likely to fully integrate renewables into existing electricity supply infrastructure as they put utilities in charge. At the same time, they could also result in serving primarily the interests of major suppliers or utilities (Lauber, 2003). Because they rely on competitive bidding, quotas can limit participation to the large players, concentrating renewable energy development in the hands of a few, often the major power generators. For example, one company in the United States (a subsidiary of the utility Florida Power & Light) owns about half of the nation's wind capacity (Gipe, 2003). Local or smaller projects are often unable to compete with larger ones on the basis of cost alone (Wagner, 2000). Local investors are rarely wealthy, particularly in rural areas, and can seldom assume the risks and uncertainties associated with development under quota systems.

Pricing systems also enable the average citizen to benefit from investments in renewable energy projects, and encourage installation of the most optimal sized project for a location, rather than capacities that meet only individual household or business needs. Also, because development is more geographically dispersed under pricing systems, there is generally less opposition to projects at the local level. As a result, the German pricing law has created a constituency in favor of renewable energy, such that farmers, lawyers, union workers, land owners, construction companies, renewable energy companies, and others lobbied alongside banks in favor of the law. This broad support has helped to overcome powerful political opposition that favors conventional energy technologies over renewables, and subsidies for existing fossil fuel and nuclear power over those for renewable energies.

2.3.4 Technological diversity

Because quota systems tend to encourage the least-cost technologies, they are best at promoting technologies that are closest to market competitiveness (Espey, 2000). For example, in Texas, where wind energy has advanced so rapidly, the RPS has done little to encourage the use of more expensive technologies such as solar PVs, despite vast solar resources in Texas. Higher-cost renewables, such as PV, offshore wind, wave and tidal energy will not be able to compete against the lowest-cost technologies, meaning that quota systems will not create markets for them and thus will not drive them down their "learning curves" (Kleiburg, 2003).

Pricing laws, on the other hand, can encourage a diversity of technologies, assuming that payments vary according to technology type. Because they can create a market for all renewables, they can more easily support technologies from early development to market competitiveness. It is possible that quota systems might be able to overcome this shortcoming with specific standards for different technologies, as with the RPS enacted in the U.S. state of Nevada (which requires that a specific share of generation comes from solar energy). However, this tends to be more complicated, and to date there is not enough experience with this policy to know how effective it will be.

2.3.5 Costs, prices and competition

It had been argued that it is difficult to control the costs of pricing laws over the short term, whereas subsidies can be controlled under bidding or quota systems. For example, if tariffs are set too high, they can encourage significant development and dramatically increase electric rates; if they are not high enough, the policy will bring about little development (Wiser et al, 2000). The pricing law could be more expensive than tendering programs or an RPS per kWh of electricity produced. According to one estimate, in 1998 the Danish government paid out more than 100 million Euros in subsidies to renewable energy, and additional costs in Germany totaled 200 million Euros in 2000 (Menanteau et al, 2003). However, several studies have concluded that the average additional cost per German household has been minimal.[1]

In addition, it is argued there is less competition and cost minimization under pricing laws than with quota systems, in which developers must compete to win bids or gain contracts. Historically, it has been assumed that pricing laws do not inherently encourage cost or price reductions, and do not ensure least-cost development. The pricing law can drive down costs by driving economies of scale and innovation, and manufacturers and developers will compete for the lowest possible costs in order to achieve higher profit margins, which promotes cost reductions. Yet, developers have little incentive to pass these cost savings onto consumers as long as tariffs remain unchanged. Furthermore, under pricing systems, utilities and customers in resource-rich areas can experience the brunt of costs associated with renewable energy development.

However, most of these limitations can be overcome depending on how pricing systems are set up. Pricing policies can address cost and price issues through regular adjustments to tariffs for renewable energy in response to changes in technologies and the marketplace. This is now the case in Germany, where the law was changed in 2000 from a percentage of the retail rate to fixed tariffs; the French and Portuguese pricing laws have also adopted many of these features (Lauber, 2003). In addition, they can be established with help from research institutes (neutral consulting) and the renewables industry (with insight into the costs of production) as in Germany. The introduction of declining tariffs has brought the costs of the pricing and quota systems much closer together (Menanteau et al, 2003). And, at least one analyst believes that pricing laws have delivered renewable electricity more cheaply than have quota or green-certificate policies (Environment Daily, 2003).

There is also some evidence, according to Nitsch et al, that it may be cheaper to provide significant national investment for renewable energy (through the German pricing law, for example) over a period of perhaps 15-20 years to bring renewable energy technologies rapidly down their learning curves, and thus reduce costs very quickly, rather than to introduce renewable energy relatively slowly and over a longer period of time—with an associated slower reduction in costs (Nitsch et al, 2001/2002; Uh, 2004).

Further, as discussed above, pricing systems encourage development of local manufacturing industries, which leads to a large number of companies and in itself creates competition. And even where pricing laws are more expensive per unit of energy produced, they drive technological development and strengthen or establish new businesses, thereby supporting industry and agriculture (biomass), leading to job creation and furthering economic growth (Uh, 2003). The use of well-designed pricing laws can avoid the need for a host of other additional subsidies. They also help to "internalize external costs" of conventional energy and compensate for the benefits of renewable energy (Wagner, 2002). Pricing laws encourage higher growth rates in early years than quota systems generally do, and encourage long-term innovation. Finally, concerns about heavy burdens in resource-rich areas can be addressed, as was the case in Germany, by spreading the costs around the entire country so that each region pays according to its total electricity consumption, rather than according to its resource base.

Quota systems are generally credited with encouraging competition and dramatically driving down the cost and price of renewable energy. This appears to be true in a number of cases. One example often cited is the decline in wind energy prices under the UK's Non-Fossil Fuel Obligation during the 1990s. Wind bids declined dramatically, from US$0.189/kWh in the first round to US$0.043/kWh in the last (Wiser et al, 2000). At the same time, it is unclear whether these reductions came about through the quota system (Espey, 2000). There is evidence that at least part of the reductions were due to the pricing policies of other countries, which drove technological improvements and brought down costs (Moore and Ihle, 1999). In addition, some of the later cost reductions under the NFFO were due to changing terms and conditions, including a longer contract period (Kleiburg, 2003).

There is also speculation that the low costs and prices driven by the RPS in parts of the United States and Australia are due, at least in part, to the availability of wide-open spaces with good resources. This would explain the difference in wind energy costs between those countries and Germany and Spain (Lauber, 2003). Taking into account the relationship between wind speeds and the resultant power output (wind power is proportional to the cube of wind speed), costs under quota systems will come more in line with those of pricing laws once the best resources are no longer available (Uh, 2003).[2]

Particularly early on, when a country has few domestic manufacturers or developers, only a small number of companies might respond to bidding rounds, limiting choice and competition (Martinot and Reiche, 2000). According to some sources, a high degree of concentration of participants can lead to cartels and the abuse of market power (Espey, 2000). And if the price of credits or certificates is high, this can increase the electricity price paid by consumers, as is the case with pricing laws. However, this would likely be a short-term situation as higher certificate prices would encourage more development, thereby reducing certificate prices. Finally, if purchase obligations are large enough, quotas can lead to economies of scale, thereby reducing both costs and prices.

There is some evidence that in quota systems which lack differentiation among technologies, such as the current Renewable Obligation Certificate (ROC) program in the United Kingdom, there is a tendency to over-subsidize lower-cost renewables such as onshore wind and biomass waste-to-power, a factor that will lead to higher costs (Kleiburg, 2003). Under the ROC system, the price paid for renewable electricity (most of which is wind power, in a country with the best winds in Europe) is similar to payments for wind energy in Germany (Mitchell, 2003). As a result, a great deal of development is underway, with a surge in market growth projected for 2004. But this makes it clear that the costs of renewably generated power are at least as dependent on how a particular policy is structured as they are on the system that is chosen. Quota based systems are not inherently cheaper, nor are pricing systems inherently more costly; the costs per unit of electricity produced depend on the details of those systems. (See Table 1 for average prices paid for renewable electricity in several European countries.)

2.3.6 Financial security

Under a pricing system, the long-term certainty that results from guaranteed prices over perhaps 20 years, means that companies are willing to invest in technology, to train staff, and establish other services and resources with a longer-term perspective. This certainty also makes it easier to obtain financing, as banks and other investors are assured a guaranteed rate of return over a specified period of time. In fact, even banks in Germany lobbied the Bundestag for a continuation of pricing laws in 2000.

With quota systems, there are potential uncertainties through many steps in the process from project planning to operation. For example, there can be substantial preparation costs for projects submitted for bids, adding an element of risk and uncertainty that many potential developers cannot afford (Menanteau et al, 2003). Without long-term contracts, under quota systems existing developers could be undersold by future projects, and will always be competing against new developments. While some see this is as a disadvantage, others view this as an incentive to reduce costs (Espey, 2000). This challenge has been resolved in Texas with 10-25 year contract requirements (Lauber, 2003). But unless such contracts are standardized, renewable energy developers must negotiate contracts with utilities or suppliers on an individual basis. While this could be a problem, to date in several U.S. states and elsewhere this does not seem to be a major drawback.

Further, under quota systems potential investors must assess future supply and demand balance during the lifetime of the project (often 20 years or more) by developing a forward price curve. Yet, demand is created by political targets, which could change, thereby resulting in a degree of uncertainty. In addition, estimating supply is a complex process that requires an understanding of a broad range of factors. These include the current competitiveness of all eligible energy technologies; future costs – determined by learning curve effects; cost-resource curves, or the impact on costs when the best resources are no longer available and projects must be sited where wind speeds are lower, or rely on more expensive biomass feedstock, for example. All of these factors add to the level of uncertainty. Finally, if renewable technologies enjoy subsidies or other types of support (e.g., grid connection costs, tax credits, accelerated depreciation), whose continuation over the project lifetime is also uncertain, the risks to investors will be higher, requiring a higher projected rate of return. Under these circumstances, banks will also be less willing to provide financing for renewables projects. (Kleiburg, 2003)

Sources of income are two-fold under a certificate-based quota system: first, is payment for the sale of renewably generated electricity and, second is income from the sale or trade of renewable energy certificates. The price of credits or certificates can fluctuate significantly with changes in the marketplace or meteorological variability, rising when there is a shortage of renewable electricity and falling when there is a surplus. Diversifying sources and location of projects can also reduce fluctuations due to meteorological variability. Establishing minimum and maximum certificate prices can help, but does not eliminate investor uncertainty (Meyer, 2003). Trading in international markets can also work to stabilize prices, and risks can be limited through long-term contracts, or borrowing or banking of credits (Menanteau et al, 2003: Meyer, 2003). Some of these solutions, however, can increase the complexity of the system. Seasonal variations in output lead to variations in income from fixed tariffs as well, and market fixes are not built into the pricing system as they are with certificate models. Over time, however, these variations will also be smoothed out (Meyer, 2003). Further, under quota systems financial security is reduced if there is uncertainty around rules relating to green certificate trading. For instance, as system designs are altered—such as changes in penalties, borrowing or banking provisions, and the status of imports—prices can be affected dramatically (Kleiburg, 2003). In general, many believe that the higher risks and lower profits associated with quota systems make them less attractive for investors than pricing laws (Menanteau et al, 2003).

Some analysts believe that quota systems provide more regulatory and financial stability and security than do pricing systems, which could change with the political winds (Lauber, 2003). For example, long-term purchasing contracts with private entities are enforceable under the law, which might be safer than relying on consistency of government policy (Krohn, 2000). Others believe that pricing systems provide a greater sense of security than quota systems, particularly in developing countries, because there is not the same assurance that a market for renewable energy credits will exist and that they will be of value (Frost, 2003). Targets established under quota systems are also policy dependent and can change over time, affecting the value of certificates and creating uncertainty (Uh, 2003). In addition, payment systems and levels are known at the outset under a pricing system; this is not necessarily the case under a quota system with certificate trading (Krohn, 2000). What is most important is political stability, and long-term, credible, consistent policies.

2.3.7 Ease of implementation

In general, pricing laws are easy to administer and enforce, and they are highly transparent. As with quota systems, policy makers are required to establish targets and timetables, and to determine which technologies are qualified (type and scale). Where applicable, pricing laws also require the setting of tariffs for each technology type (which can be done with the help of research institutes and industries, as in Germany). Once the system is established, the only government follow-up required is regular adjustments of tariffs (assuming this is done).

Under quota systems, many of the requirements are far more challenging. Picking optimal target levels is critical (if they are set too high, they can push prices up dramatically; if they are too low, they will not produce the economies of scale needed to reduce costs), as is the choice of timetables. As mentioned in section 2.3.5, the same can be said for the setting of tariffs under pricing laws. However, they can be established with input from research institutes and industries, and pricing laws can be created to allow for adjustments as necessary. As discussed below, targets set under quota systems are not as flexible. In addition, policy makers must decide which technologies are eligible, and if there should be technology-specific targets—this will depend on the readiness of technologies, their costs, available resources, and other factors. In order to make successful choices, it is also important to understand the cost and learning curves for the relevant renewable technologies (Berry and Jaccard, 2001). Policy makers also need to determine which category of parties must meet the obligation (e.g., retail suppliers, grid companies, or distribution companies), and whether all or just a few of those parties are required to meet the targets. The penalty for non-compliance must be established, and the tradability, life-span and price (floor- or ceiling-prices?) of certificates or credits chosen. These decisions will all determine the impact of the quota system. Once these matters are resolved, government agencies (or other bodies) must certify renewable energy producers, issue and control certificates, monitor compliance, and collect penalties, all of which increases administrative requirements, complexities and costs (Menanteau et al, 2003).

Some argue that quota/certificate systems tend, by their very nature, to be more complex than pricing systems, difficult to administer, and open to utility manipulation, and that such problems could be even more significant in developing countries (Frost, 2003). On the other hand, others have noted that the system for cost-equalization under the German Renewable Energy Law (2000) is neither simple nor transparent (Saghir, 2003). Finally, it has been argued that bidding processes are bureaucratic, have significant transaction costs, and are time-consuming for authorities and renewable energy developers (Wagner, 2000; Goldstein et al, 1999).

2.3.8 Flexibility

Historically, pricing laws have been criticized for being inflexible. For example, once tariffs are established, it could be difficult to reduce them (Wiser et al, 2000). However, it is possible to set up the system such that payments can be adjusted on a regular basis to reflect changes in technologies and market conditions. This flexibility was incorporated into the German system in 2000, and is now featured in other national pricing systems as well. Thus, once a government sets the price to be paid for renewably generated electricity, it is possible in the future to adjust these payments up or down to affect the amount of new capacity coming on line as desired.

On the other hand, with a quota system, once targets and timetables are established, they are difficult to adjust. Even as markets change and technologies advance, experiencing major breakthroughs in efficiency and/or cost, it is highly unlikely that targets or timetables can be altered—or, at least made more ambitious—particularly without lead-times of several years.[3]

2.4 Summary of pricing and quota systems analysis

The following arguments for and against pricing and quota systems are based on the above analysis.

2.4.1 Pricing systems

Arguments in favor:

- To date, they have been most successful at developing renewables markets and domestic industries, and achieving the associated social, economic, environmental, and security benefits
- Flexible – can be designed to account for changes in technology and the marketplace
- Encourage steady growth of small- and medium-scale producers
- Low transaction costs
- Ease of financing

Arguments against:

- If tariffs are not adjusted over time, consumers may pay unnecessarily high prices for renewable power
- Can involve restraints on renewable energy trade due to domestic production requirements.

2.4.2 Quota systems

Arguments in favor:

- Promote least-cost projects - cheapest resources used first, which brings down costs early on
- Provide certainty regarding future market share for renewables (often not true in practice)
- Perceived as being more compatible with open or traditional power markets
- More likely to fully integrate renewables into electricity supply infrastructure.

Arguments against:

- High risks and low rewards for equipment industry and project developers, which slows innovation
- Price fluctuation in "thin" markets, creating instability and gaming
- Tend to favor large, centralized merchant plants and not suited for small investors
- Concentrate development in areas with best resources, causing possible opposition to projects and missing many of the benefits associated with renewable energy (jobs, economic development in rural areas, reductions in local pollution)
- Targets can set upper limits for development – there are no high profits to serve as incentives to install more than the mandated level because profitability exists only within the quota
- Tends to create cycles of stop-and-go development
- Complex in design, administration and enforcement
- High transaction costs
- Lack flexibility—difficult to fine-tune or adjust in short-term if situations change.

It is still too early to know how successful quota systems can be.

2.4.3 Requirements for successful policy

Pricing law:

- Ensure regular adjustments of tariffs – incremental adjustments built into law
- Establish tariffs according to technology (and location) with input from research institutes and renewables industries
- Provide tariffs for all potential developers, including utilities
- Ensure that tariffs are high enough to cover costs and encourage development
- Guarantee tariffs for long enough time period to ensure high enough rate of return
- Costs must be equally shared across country or region
- Eliminate barriers to grid connection.

Quota system:

- Apply to large segment of market
- Include specific purchase obligations and end-dates
- Adequate penalties for non-compliance, and enforcement
- Set different bands by technology type
- Require long-term contracts to reduce uncertainty for project developers
- Establish minimum and maximum certificate prices
- Do not allow time gap between one quota and next.

What is most important for both systems is political stability, and long-term, credible, enforceable and consistent policies.

3. Financial Incentives for Renewable Energy

Financial incentives reduce the costs of renewable energy by lowering the price paid for renewable technologies or energy, increasing the payment received, or reducing the cost of production. They include market compensation in the form of tax credits, rebates, and payments, which subsidize investment in a technology or the production of power. Such incentives have been used extensively in Europe, Japan, the United States, and India—the only developing country that has enacted tax credits to date. (See Box 3) Long-term, low-interest loans and loan guarantees work to reduce the cost of capital. And the reduction or elimination of subsidies for conventional energy, while not technically a subsidy for renewable energy, helps to level the playing field so that renewables are better able to compete on a cost basis.

3.1 Tax relief

3.1.1 Investment and production tax credits

Investment tax credits can cover just the cost of a system—such as a wind turbine or solar hot water or PV panel, or the full costs of installation. They have been used extensively for the promotion of water and space heating systems based on biomass and geothermal energy. They can be helpful early in the diffusion of a technology, when costs are still high, and/or to encourage their installation in off-grid, remote locations. They directly reduce the cost of investing in renewable energy systems and reduce the level of risk. Production tax credits provide tax benefits against the amount of energy actually produced and fed into the electric grid, or the amount of biofuels produced, for example. They increase the rate of return and reduce the payback period, while rewarding producers for actual generation of energy.

To encourage investment in renewables in the early 1980s, the U.S. government and state of California offered investors credit against their income tax. In combination with standard, long-term contracts (discussed above in 2.1), the credits helped to create a wind boom that many people called California's second gold rush. The lessons learned and economies of scale gained through this experience advanced wind technology and reduced its costs. But the combination of enormous tax breaks and a lack of technology standards encouraged fraud and the use of substandard equipment. (In India, too, while investment subsidies for wind energy led to large investments in the 1990s, there was limited concern about maintenance and long-term performance due to a lack of standards.) Inexperienced financial companies and former shopping center developers flocked to the wind business in California, and untested designs were rushed into production—all to take advantage of credits that enabled wealthy investors to recoup anywhere from 66 to 95 percent of their investment over the first few years, in some cases without even generating a kilowatt-hour of power. While these early tax credits helped to jump-start the wind industry, once the credits and fixed prices expired the industry collapsed, with ripple effects felt as far away as Denmark, and numerous wind energy firms went bankrupt. (Sawin, 2001; Lauber, 2003)

One of the largest production tax credit programs is in the United States. Since 1994, the U.S. government has offered a production tax credit (PTC) that reduces the income tax liability for people who supply wind-generated electricity to the grid. The PTC has encouraged wind energy development, and has been credited with driving significant capacity increases in the late 1990s and early 2000s. At the same time, the PTC has encouraged development only in those states with additional incentives. (Sawin, 2001)

In general, production incentives are preferable to investment incentives because they promote the desired outcome—generation of electricity or other forms of energy. Although investment subsidies encourage installation at the optimal level for individuals or businesses, they do not necessarily result in installation at the optimal level for the society or community as a whole. Investment incentives encourage the purchase of renewable energy systems, but on their own they do not necessarily encourage investors to purchase the most reliable systems available, or to maintain them and produce as much energy with them as possible. Another problem associated with investment credits is that investment in the technologies they are designed to support generally declines once the credits expire, unless costs have fallen sufficiently or other support mechanisms are in place. Production incentives, on the other hand, are most likely to encourage optimum performance and a sustained industry.

However, policies must be tailored to particular technologies and stages of maturation. Investment subsidies can be helpful when a technology is still maturing and relatively expensive, as has been the case with PVs in Japan, although rebates are a preferable means for subsidizing investment (discussed below). (Sawin, 2001) Further, investment support is often more appropriate for small-scale renewables such as heat pumps or small-scale PV because their administrative costs are lower—they require a one-time payment rather than annual payments based on metered data (Kleiburg, 2003). Performance problems associated with investment subsidies can be overcome by tying investment incentives to equipment and performance standards, as long as these requirements are enforced. And if investment credits are adjustable and/or gradually decline over time and phase out as technology costs fall, it might be possible to avoid the sudden decline in investment that often occurs when these subsidies expire.

It is also important to note that tax incentives tend to favor one type of entity over another, and they provide greater benefit to people with higher income levels and tax loads. In addition, they are often used as tax loopholes. Investment tax credits, in particular, can affect the timing of installation as people may make investments toward the end of a tax cycle, which can negatively affect renewables industries. As with investment credits, production tax credits should decline over time and eventually be phased out.

3.1.2 Other tax relief

Other tax related incentives can help promote renewable energy development by reducing the costs of investment, or by accounting for the external benefits of renewable energy. The latter include eco- or carbon-tax exemptions. The former include accelerated depreciation, relief from taxes on sales and property, value-added tax (VAT) exemptions, and reduction or elimination of import duties on renewable energy technologies or components. It is important to note that import duties increase the upfront costs of renewable energy projects, and should be significantly reduced if not eliminated, at least until a strong domestic manufacturing industry can be established.

3.2 Rebates and payments

As an alternative to production and investment credits against taxes, some states and countries have subsidized renewable energy through production payments or rebates. Rebates are refunds of a specific share of the cost of a technology, or share of total installation costs (for example, 30 percent of total costs), or refunds of a certain amount of money per unit of capacity installed (for example, $3.00 per peak watt (Wp) of PV capacity). As with investment credits, rebates are most effective when linked to technology and performance standards (discussed below). Japan has provided investment subsidies through rebates for PVs; the rebates in combination with low-interest loans, public education and net metering have led to dramatic success with PVs. (See Box 4; see also Chart 2 for examples of the impacts of sustained rebates and low-interest loans on PV markets.)

Production payments reward energy generation through a certain payment per unit of output. For example, California has enacted a production incentive that awards a per kWh payment for some existing and new renewable energy projects. It is financed through a small per kWh charge on electricity use, meaning that Californians share the cost of the program according to the amount of power they consume. (See Box 5) Provided that such payments are high enough to cover the costs of renewable generation and are guaranteed over a long enough time period, this policy integrates some key elements of a pricing law—similar in effect and perhaps more politically feasible in some countries. (Sawin, 2003)

Experiences to date demonstrate that payments and rebates are preferable to tax credits for a number of reasons. Unlike tax credits, the benefits of payments and rebates are equal for people of all income levels. In addition, investment grants or rebates result in more even growth over time rather than encouraging people to invest at the end of tax periods (as tax credits tend to do). (Sawin, 2001) Finally, at least one analyst believes that there is no evidence that either investment or production tax credits anywhere have led to a substantial increase in market penetration of PV (Haas, 2002). Clearly, the effects of one single instrument are limited.

With regard to rebates, it has been argued that they must cover a fixed amount per unit of capacity rather than a percentage of investment costs, because a fixed rebate encourages investors to seek out the most efficient or cheapest option (Haas, 2002). And all subsidies for investment rather than production should be accompanied by standards or monitoring programs to ensure good performance. It is also important to enact subsidies that are flexible and can be adjusted up or down as necessary.

3.3 Low-interest loans and loan guarantees

Worldwide, one of the major barriers to renewable technologies is the high initial capital costs of renewable energy projects. Thus, the cost of borrowing plays a major role in the viability of renewable energy markets. Financing assistance in the form of low-interest, long-term loans and loan guarantees can play an important role in overcoming this obstacle. Lowering the cost of capital can bring down the average cost of energy per unit and reduce the risk of investment. Germany addressed this through long-term, low-interest loans offered by major banks and refinanced by the federal government. (Twele, 2000) Japan and some U.S. states have also established low-interest loan programs for solar PV and other renewables (Eckhart et al, 2003).

Even in the developing world, all but the very poorest people are able and willing to pay for reliable energy services, and the rate of on-time payment is extremely high. But the poor also need access to low-cost capital and the opportunity to lease systems (Goldemberg, 2000). The very poorest people will likely need targeted subsidies as well (Martinot, 2003). If monthly costs of solar energy systems are comparable to those for candles and kerosene lighting, households should be able to afford to substitute them (Martinot, 2003).[4] According to PV companies in South Africa, Indonesia, India and the Dominican Republic, up to 50 percent of prospective purchasers can afford to buy systems if reasonable third-party financing is available; otherwise, only 2 to 5 percent can buy them (Eckhart et al, 2003). So, the availability of financing could increase the use of PV in some countries by ten-fold or more. The impacts could be similar with other renewable technologies as well. To date, vendor-supplied credit, micro-credit and leasing/rental of renewable systems are still mostly untested systems, and the effectiveness of various consumer loan models are probably country-specific, depending on cultural, financial and legal factors. But a number of developing countries have had successful experiences with lending programs that could be transferable to other countries.

One of the most successful means for disseminating household-scale renewable technologies in rural China has been through local public-private bodies that offer such services as technical support, materials sale, subsidies, and government loans for locally manufactured technology. These bodies frequently provide revolving credit, with repayment linked to the timing of a household's income stream—for example, payments come due after crops have been harvested. As a result of this program, more than 140,000 small wind turbines, producing power for more than a half-million people, have been installed in Inner Mongolia—the greatest number of household-scale wind plants operating anywhere in the world (Martinot et al, 2002; Wu, 1995). In India, the terms of long-term, low-interest loans vary by technology, with the most favorable ones being for PVs. Through small-scale lending programs, even low-income people are able to purchase small systems. In addition, the national government has worked to obtain bilateral and multilateral funding for large-scale projects, particularly wind. (MNES, 2000; CSE, 2002)

3.4 Addressing subsidies and pricing for conventional energy

Perhaps the most important step governments can take to advance renewables and reduce cost disparities is to make a comprehensive change in their perspective and approach to energy policy. Governments must eliminate inappropriate, inconsistent, and inadequate policies that favor conventional fuels and technologies and that fail to recognize the social, environmental, and economic advantages of renewable energy.

In the mid-1990s, governments worldwide were handing out $250–300 billion annually to subsidize fossil fuels and nuclear power (UNDP, 2000). Since then, several transitioning and developing countries have reduced energy subsidies significantly, but global subsidies for conventional energy remain many magnitudes higher than those for renewable energy (Geller, 2003). Most of these subsidies—80–90 percent by some estimates—are found in the developing world, where the price for energy is often set well below the true costs of production and delivery (Martinot email, 2002). The International Energy Agency found that in eight developing countries, that together account for a fourth of the world's energy use, energy subsidies cost $257 billion in lost GDP, or the equivalent of about 11 percent of the nations' combined annual economic output (OECD/IEA, 1999). Even relatively small subsidies in developing countries—for kerosene and diesel, for example—can discourage the use of renewable energy. These subsidies should either be gradually eliminated or shifted to wind, solar PVs, and other renewable technologies and fuels. In industrial and developing countries alike, it is important to ensure that the removal of subsidies for conventional energy does not negatively affect the poor; subsidies must be targeted to enable them to transition to renewable energy alternatives.

In most cases, it is less a matter of finding new money to invest in renewable energy, and more a matter of transferring money flows from conventional energy to renewables. It is estimated that public and private interests invest $250-300 billion annually in new energy infrastructure; $40-60 billion of this is for rural electrification. And more than $1 trillion are spent annually on direct energy purchases (Goldemberg, 2002). According to another estimate, each year hundreds of millions of people in the developing world spend about $20 billion on makeshift solutions such as candles, kerosene lamps, and batteries for lighting and to power small appliances. And transporting diesel fuel to remote regions in the Amazon, for example, can consume two to three times as much fuel for every gallon delivered (Perlin, 1999).

The International Energy Agency projects that $16 trillion will be invested worldwide in energy-supply infrastructure between 2001 and 2030. Nearly 60 percent of this is expected to go to the electricity sector (for both power generation, and transmission and distribution) (IEA, 2003). According to the United Nations, investments for new power sector projects in the developing world alone are expected to be in the range of $50-60 billion annually (UNEP, 2000). Even small shifts in these expenditures and in energy subsidies would have a tremendous impact on renewable energy markets and industries, although more than a small shift is needed.

It is important to recognize that, even if all subsidies for fossil fuels and nuclear power were removed immediately, existing infrastructure in most countries—much of which was funded with public money—would continue to favor conventional energy. In addition, conventional energy benefits from hidden or indirect subsidies, including obligations to purchase a specific form of energy, government investments in grid extensions, exemptions from risk or liability, and government energy purchases.

As the single largest consumers of energy in most, if not all, countries, governments should purchase ever-larger shares of energy from renewables and install renewable technologies on public buildings. This would have a significant impact on renewable energy markets. In the process, governments would set an example, increase public awareness, reduce perceived risks associated with renewable technologies, and reduce costs through economies of scale.

In addition, pricing structures must account for the significant external costs of conventional energy and the advantages of renewable energy, as Germany has begun to do through an eco-tax on fossil fuels and the renewable electricity tariffs under the Renewable Energy Law (feed-in/pricing law) of 2000, and as other countries are doing with energy or carbon taxes.

4. Other essential Policy Mechanisms

4.1 Standards

Another essential ingredient for promoting renewable energy is industry standards. There are several types of standards: technology standards and certification; project siting and permitting standards; grid connection standards; and building codes.

Standards can prevent inferior technologies from entering the marketplace and generate greater confidence in a product, thereby reducing risks, which is important for financing. Technology standards for wind turbines, for example, can include everything from turbine blades, electronics, and safety systems to performance and compatibility with the transmissions system. Denmark adopted wind turbine standards in 1979, largely due to pressure from the wind industry itself. The Danish technology standards program, combined with the sharing of performance and other relevant information among turbine owners and manufacturers, has enabled manufacturers to recognize and address problems with their technologies and to create pride in Danish machines. Standards are credited with playing a major role in Denmark's rise to become the world's leading turbine manufacturer. (Krohn, 2000a; Madsen, 2000) Germany established an investment tax credit for wind energy in 1991, and while it too has been abused as a tax loophole for the wealthy, Germany has avoided the quality control problems experienced in California and India by enacting turbine standards and certification requirements. Eventually, technology standards for all renewable technologies should be established at the international level. (Sawin, 2003)

In addition, siting and planning requirements can reduce opposition to renewables if they address other potential issues of concern, such as noise and visual or environmental impacts. Such laws can be used to set aside specific locations for development or to restrict areas at higher risk of environmental damage or injury to birds, for example. Both Germany and Denmark have required municipalities to reserve specific areas for wind turbines and have set restrictions on proximity to buildings and lakes, among other things. These policies have been extremely successful, reducing uncertainty about if and where turbines can be sited and expediting the planning process. The United Kingdom offers the best example of how the lack of planning regulations can paralyze an industry. Despite having the best wind resources in Europe, the nation added little wind capacity under its renewables obligation regulations (NFFO, discussed above), in part because a lack of planning regulations virtually halted the process for obtaining planning and environmental permits. (Sawin, 2001; Madsen, 2002).

Renewables face two challenges when it comes to interconnection with the grid. First, unlike conventional plants that have flexibility in siting, renewable plants must be sited where the resources are located. Second, some renewables, such as solar and wind, are intermittent. Both challenges necessitate the creation of fair connection standards and charges, and guaranteed access to the grid. Interconnection requirements are often overly burdensome and inconsistent, which can lead to high transaction costs for renewable energy project developers, particularly if they must hire technical and legal experts. Safety requirements are essential, but many utilities go beyond that to discourage interconnection with relatively small residential or commercial systems. For example, utilities can block transmission access or charge high prices for access to the grid and use of transmission lines (Beck and Martinot, 2004). In addition, transmission charges on a per capacity basis put intermittent renewables at a disadvantage, as they must pay for access even when they are not using it, increasing average transmission costs per kWh. Thus, it is important that governments establish interconnection standards under which renewable energy developers pay only for the direct costs of connection with the grid, not for necessary upgrades to carry the additional capacity, and only for the transmission service that they actually use. Further, because most renewable electricity (with the exception of biomass) has zero marginal costs (the fuel is free), it should always have priority access to the transmission system. This makes economic sense, and all other sources (that are dispatchable) can easily be ramped down as necessary.

Building codes and standards can also be designed to promote energy efficiency and renewables such as passive solar (transparent and opaque insulation), solar thermal energy, modern biomass, geothermal and PV by requiring that these be incorporated into designs and planning processes for residential and commercial buildings. In November 2003, the London borough of Merton adopted a requirement that new non-residential buildings larger than 1,000 meters square meet at least 10 percent of their energy needs with on-site renewables such as solar thermal and PV (SolarAccess.com, 2003c). Barcelona, Spain has adopted an ordinance requiring that new or renovated buildings meet 60 percent of their energy needs for hot water with solar thermal systems, and several other Spanish cities have followed suit. Alternatively, a portion of new buildings could be required to include wiring and other hardware that make them PV- or thermal systems-ready, an addition that would add little to construction costs in many instances, while making it easier and far less costly to install PV/solar thermal systems later. Depending on climate conditions where buildings are sited, the existence of such standards can have a significant impact on energy requirements, particularly for heating and cooling needs.

Furthermore, improving energy efficiency facilitates the use of renewable energy for two reasons. First, because the scale becomes more manageable, renewables can more easily satisfy energy needs; second, as the load is reduced, it is easier to bear higher costs per unit of output. The combination of new materials and technologies, natural cooling techniques, and passive solar heating and lighting, can significantly increase the efficiency of buildings.

4.2 Education and information dissemination

Information dissemination is another key policy component. Education and information dissemination related to renewable energy must include everything from resource studies and education about various renewable technologies, to training and information about available government incentives and support systems.

Even if a government offers generous incentives and low-cost capital, people will not invest in renewable energy if they lack information regarding resource availability, technology development, the numerous advantages and potential applications of renewables, the fuel mix of the energy they use, and the incentives themselves. During the 1980s, several U.S. states offered substantial subsidies for wind energy—including a 100 percent tax credit in Arkansas, a state with enough wind resources to generate half of its electricity (Righter, 1996; Battelle/PNL, 1991). But these subsidies evoked little interest due to a lack of knowledge about wind resources. By contrast, it was wind resource studies in California, Hawaii, and Minnesota that led to interest in wind energy in these states. And cloudy Germany has more solar water heaters than the sunnier countries of Spain and France, greatly because public awareness of the technology is so much higher in Germany (Hua, 2002).

Lack of experience or past experiences—from failed Californian wind projects in the 1980s to early development projects in Africa—have left people in much of the world with a perception that renewables do not work, are inadequate to meet their needs, are too expensive, or are too risky as investments. Above all, it is essential that government leaders recognize the inherent value of renewable energy. Then governments, non-governmental organizations, and industry must work together to educate labor organizations about employment benefits, architects and city planners about ways to incorporate renewables into building projects and their value to local communities, agricultural communities about their potential to increase farming incomes, and so on. In India, the government's Solar Finance Capacity Building Initiative educates Indian bank officials about solar technologies and encourages them to invest in projects. The Indian government has also used print media, radio, songs, and theater to educate the public about the benefits of renewable energy and government incentives, and has established training programs. (MNES, 2000) In Austria, students learn about renewable energy in schools and universities, and in Germany many vocational training programs cover renewable energy issues (Goldstein et al, 1999; BMU, 1994).

It is often assumed that barriers and solutions to renewables are unique to particular countries or settings, but this is not necessarily the case (Kammen, 1999). At the local, national, and international levels, it is essential to share information regarding technology performance and cost, capacity and generation statistics, and policy successes and failures in order to increase awareness and to avoid reinventing the wheel each time. While several countries now do this on a national level, a centralized global clearinghouse for such information is clearly needed.

4.3 Public ownership and stakeholder involvement

Public ownership and/or participation are also essential for the success of specific projects, as well as the development of effective renewable energy policies. Germany's renewable energy law of 2000 was designed in cooperation with research institutes and the renewables industries, and the U.S. state of California has designed recent renewable energy programs with stakeholder input provided at public workshops.

In Germany and Denmark, where individuals singly or as members of cooperatives still own most of the turbines installed, there is strong and broad public support for wind energy. Farmers, doctors, and many others own turbines or shares of wind farms, and stand beside labor and environmental groups in backing policies that support wind power. As of 2002, about 85 percent of the installed wind capacity in Denmark was established through local initiatives and owned by farmers or cooperatives, and at least 340,000 Germans had invested about €12 billion in renewable energy projects (PREDAC, 2002/03). The 40 MW Middelgrunden project off the coast of Copenhagen is co-owned by a utility and several thousand Danes who have purchased shares in the project (EWEA/Greenpeace, 2002). Construction costs of the world's largest roof-mounted PV plant, which opened in Munich, Germany in November 2002, were financed by interested citizens eager to invest in renewable energy (Maycock, 2003).[5]

Through cooperatives, people share in the risks and benefits of renewable projects; often avoid the problems associated with obtaining financing and paying interest; play a direct role in the siting, planning, and operation of machines; and gain a sense of pride and community (Sawin, 2001). Several surveys have demonstrated that those who own shares of projects and those living closest to wind turbines view wind power more positively than those who have no economic interest or experience with it (Damborg and Krohn, 1998). Local investment also provides an opportunity to strengthen and diversify local economies, particularly in rural areas, and can lead to new projects through the sharing of information and relevant experiences (PREDAC, 2002/03).

Public participation and a sense of ownership are as important in the South as in the North. When technologies are "forced" on people without consultation regarding their needs or desires or are donated as part of an aid package, people often place little value on them and do not feel they have a stake in maintaining them. On the flip side, when individuals and communities play a role in decision making and ownership, they are literally empowered and become invested in the success of the technologies. The key to success of some projects in developing countries has been a sense of ownership among local people. For example, local participation and ownership of solar mini-grid projects in Nepal and the Indian islands of Sundarbans, have played a crucial role in the success of projects and have eliminated electricity theft (BBC News, 2003).

5. Importance of consistent, long-term Policies

It is important to note that policies enacted to advance renewable energy can slow the transition if they are not well formulated or are inconsistent, piecemeal, or unsustained. For example, because early investment credits in the U.S. state of California were short-lived and extensions were often uncertain, many equipment manufacturers could not begin mass production for fear that credits would end too soon (CEC, 1982). When incentives expired, interest waned and the industries and markets died with them. In the case of wind power, the impact was felt as far away as Denmark, which relied on the California market for sales of Danish turbines. The U.S. Production Tax Credit for wind energy has been allowed to expire several times, only to be extended months later. As a result, the credit has stimulated wind capacity growth but has created cycles of boom and bust in the market. Such cycles lead to suspension of projects, worker lay-offs, and loss of momentum in the industry.

This on-and-off approach to renewables has caused significant uncertainties, bankruptcies, and other problems and has made the development of a strong industry in the United States a challenge, at best. Indeed, the United States is the only country to have seen a decline in total wind generating capacity over the last decade (Gipe, 1998). In India, uncoordinated, inconsistent state policies and bottlenecks imposed by state electricity boards have acted as barriers to renewables development (CSE, 2002). Even in Denmark, years of successful wind energy growth ended in 1999 when the government changed course, and uncertainty overtook years of investor confidence. The future of some planned offshore wind farms is now uncertain, as is Denmark's target to produce half its electricity with wind by 2030 (Møller, 2002), and the number of jobs in the domestic industry is now in decline (BWE, 2003a). (See Chart 3 for impacts of inconsistency, and policy types, on annual wind installations in Germany, the United States and Spain.)

Consistent policy environments are necessary for the health of all industries. Consistency is critical for ensuring continuous growth and stability in the market, enabling the development of a domestic manufacturing industry, reducing the risk of investing in a technology, and making it easier to obtain financing. It is also cheaper. (Sawin, 2001) With stop-and-go policies, each time around the funds must be appropriated, a new program must be administered, information must be distributed to stakeholders, and so on. As a result, costs of administering the program could approach those of the incentives themselves (Uh, 2003).

Clearly, government commitment to develop renewable energy markets and industries must be strong, and long-term, with a clear intent to advance these technologies, just as it has been with fossil fuels and nuclear power.

6. Conclusions and Recommendations

For renewable energy to reach its full potential—to make as large as possible a contribution to economic development and job creation, improving domestic energy security and reducing oil dependence, and reducing the health and environmental impacts of energy production and consumption—it is essential to create the conditions that allow for development of sustained markets and industries which, in turn, will result in increased renewable capacity and generation, and will drive down costs.

To date, feed-in—or pricing systems have been responsible for most of the additions in renewable energy capacity and generation, while also driving down costs through technology advancement and economies of scale, and developing domestic industries and jobs. Pricing systems, where well-implemented, have provided increased predictability and consistency in markets, which in turn has encouraged banks and other financial institutions to provide the capital required for investment, and has attracted private investment for R&D. The record of quota systems is more uneven thus far. Quota systems, if designed well, have the potential to work effectively. But they are harder to get right and have a tendency to lead to stop and go, and boom and bust markets. Once renewable electricity markets and industries are well-established, and renewables can compete favorably with conventional energy, quota systems will likely be the most appropriate means for furthering the development and use of renewable energy technologies.

A combination of policies is required, whether for grid-connected electricity or other uses, including production-based incentives and financing support to lower initial investment costs and reduce risk, whether real or perceived. Ultimately, the effectiveness of policies in promoting renewable energy will depend on their design, enforcement, how well they address needs and national circumstances, and the extent to which they are reliable and sustained. Long-term, consistent and clear government commitment to renewable energy is imperative.

Following are recommendations for policies to advance a range of renewable energy technologies. Additional recommendations that are specific to developing countries are discussed in Box 6.

- **Establish regulatory frameworks** needed to provide access to relevant markets and favorable climates for investment, such as well-designed quota or pricing systems for grid-connected renewable electricity. Recommendations specific to pricing and quota systems are listed in section 2.4.3.

- **Provide net metering** for small-scale renewable systems (California provides net metering for systems up to 1 MW) where pricing laws are not in use. Time-of-use metering should be implemented for PVs.

- **Provide financing assistance** to reduce costs through production payments (rather than tax credits) for more-advanced technologies, and long-term, low-interest loans with investment rebates (rather than tax credits) for more-expensive technologies and/or those that are off-grid such as solar PV. Investment incentives should always be tied to technology and/or production standards. It can also be useful to require reporting of operational data for subsidized projects on a regular basis. Regarding rebates, a fixed amount per unit of capacity might be preferable to a percentage of investment costs for encouraging the most efficient and least-cost options, and thus for reducing costs. All subsidies must be "smart subsidies" that gradually phase out over time—subsidies are not likely to lead to sustainable markets unless they help create the conditions in which they eventually are not needed.

- **Be careful if setting capacity limits** on large-scale projects in the context of financing assistance and quota or pricing laws. At a minimum, capacity restrictions should allow for project sizes that can achieve cost reductions through scale economies; otherwise, they can discourage development of some renewable resources. When capacity restrictions are necessary, they might be addressed better under siting regulations, with variations by region and technology where appropriate.

- **Research, educate and disseminate information** regarding resource availability, the benefits and potential of renewable energy, capacity and generation statistics, government incentives (for renewable and conventional energy), and policy successes and failures on local, national, and international levels. Establish a centralized global clearinghouse for such information. And establish national training programs in vocational schools, universities and other appropriate institutions. Provide information at all levels of education (from primary schools to universities) about the potential and benefits of renewable energy, state of the technologies, and other relevant issues.

- **Encourage stakeholder/public ownership and participation** in renewables policy formulation and in project planning and decision making. Citizen involvement can be critical to project development and viability, while introducing the concepts of democracy and self-determination to the process of energy procurement.

- **Establish standards** for technology performance, safety, and siting, and create or strengthen building codes to improve efficiencies and encourage the integration of renewable technologies into structures. Standards must also be set for grid connection to eliminate burdensome utility interconnection requirements and charges.

- **Incorporate external costs and benefits** of energy technologies and fuels in pricing structures and consider them when developing policy objectives. In addition to environmental, health and employment benefits, considerations should include factors such as reliability and security benefits associated with modular, distributed, and smaller-scale renewable technologies, the reduced risk of fuel price volatility, and benefits of a more diversified (and domestic) portfolio of energy options.

- **Shift government subsidies** from conventional to renewable energies, in line with previous point.

- **Increase government procurement** of renewable energy. Governments should purchase ever-larger shares of energy from renewables and install renewable technologies on public buildings and in public spaces (where appropriate) to set an example, increase public awareness, reduce perceived risks associated with renewable technologies, and reduce costs through learning and economies of scale.

The devil is in the details, and certain types of policies can be successful or not depending on how they are implemented. For any of the above policies to be effective, they must be:

- **Predictable, long-term and consistent, with clear government intent**. These characteristics are critical to provide certainty in the market to draw investors into the industry, and to provide enough lead-time to allow industries and markets to adjust to change.

- **Appropriate**. The right types of support are needed—policies must match objectives and might vary by resource potentials, location, technology type, and timing. It is also important that the level of support not be too high or too low.

- **Flexible**. It is essential to design policies such that adjustments (fine-tuning, but not wholesale changes or elimination of policies) can be made on a regular, pre-determined time schedule if circumstances change. Governments must be able to address existing barriers as they become apparent, and new barriers as they arise. Policies also must be designed to allow developers/generators flexibility for meeting government mandates.

- **Credible and enforceable**. If policies are not credible, or are not enforceable (or enforced), there will be little incentive to abide by them.

- **Clear and Simple**. Policies must be easy to implement, understand, and comply with. Procedures of permission and administration, where necessary, must be as clear and simple as possible.

- **Transparent**. Transparency is important for suppliers and consumers of energy and is necessary to avoid abuse. It facilitates enforcement, maximizes confidence in policies, and helps ensure that mechanisms are open and fair.

7. Boxes

Box 1: Ethanol in Brazil

About 180 million people live in countries that mandate the mixing of ethanol with petrol, and more than two thirds of the world's ethanol is consumed in Brazil (Martinot, 2003). In fact, modern biomass provides about 20 percent of Brazil's primary energy supply, and much of this is due to the use of alcohol fuels (Martinot et al, 2002).

In 1975, the Brazilian National Alcohol Program (PROÁLCOOL) was established in response to the first oil crisis, to reduce oil imports and avoid an economic downturn. The program required that all oil be blended with alcohol (ethanol), with the exact share regulated through government decree, generally between 20 and 24 percent.[6] The government also promoted the manufacture and sale of cars that run on 100 percent ethanol, and provided subsidies to increase sugar cane production and the construction of distilleries. Infrastructure was developed to distribute ethanol to thousands of pumping stations around the country (de Hollanda and Poole, undated). Alcohol vehicle sales soared and reached a high of 96 percent of total sales in the mid-1980s (de Andrade et al, 1998).

A decline in oil prices and the 1989 ethanol shortage combined to reduce purchases of all-alcohol cars; they came crashing down to 0.03 percent of total vehicle sales by 1997 (de Andrade et al, 1998). But sales are again on the rise in response to new tax breaks in alcohol producing regions and required government "green fleets" (Khalip and Blackburn, 2002). Energy security concerns are revitalizing PROÁLCOOL—Brazil must now import 40 to 50 percent of the oil it consumes, despite its significant petroleum reserves (US DOE, 2002; Coelho, 2002). Brazil is now testing other combinations of fuels for blending, including methane, vegetable oils, and hydrogen. In addition, the country is now developing a national biodiesel program—starting with 5 percent quotas, with a long-term goal of 20 percent by 2020—to reduce dependence on imported diesel and to lower pollution levels (Pekic, 2003).

Since the introduction of Brazil's ethanol program in 1975, the cost of producing ethanol has declined by 4-5 percent annually (Woods and Hall, undated). Even without subsidies, which were eliminated in the late 1990s, ethanol is now cheaper per unit of energy than gasoline (Goldemberg, 2002; Khalip and Blackburn, 2002). The ethanol program has opened up much of Brazil, creating more than a million jobs—for 40 percent of the rural labor force, and reducing the nation's CO_2 emissions to 20 percent below what they would be otherwise (Panik, need date; CO2e.com, 2002).[7] About 4 million cars continue to run solely on alcohol, and the sales of all-alcohol cars doubled in early 2002 (Coelho et al, 1999; Khalip and Blackburn, 2002). It has been estimated that Brazil's savings from avoided fuel imports over the past 27 years exceed $52 billion, many times the total investments in the agricultural and industry sectors for ethanol production for vehicle use (Goldemberg et al, 2003). Brazil is now an exporter of ethanol fuel, soon to be exporting its technologies as well (Khalip and Blackburn, 2002).

Box 2: Germany and the Feed-in/Pricing Law

When the 1990s began, Germany had virtually no renewable energy industry and, in the view of most Germans, the country was unlikely ever to be in the forefront of these alternative energy sources. Yet, by the end of the decade, Germany had transformed into a renewable energy leader, with a new, multibillion-dollar industry and tens of thousands of new jobs.

Driven by growing public concerns about the safety of nuclear power, the security of energy supply, and environmental impacts including global climate change, the German government passed a new energy law in 1990 that required utilities to purchase the electricity generated from all renewable technologies in their supply area, and to pay a minimum price for it—at least 90 percent in the case of wind and solar power. The "Electricity Feed-in Law" was inspired in part by similar policies that had proved effective in neighboring Denmark.

The law has been adjusted numerous times since it entered into force in 1991. Most significantly, in 2000, the German Bundestag required that renewable electricity be distributed among all suppliers based on their total electricity sales, ensuring that no one region would be overly burdened. And, with help from scientific input and the various renewable industries, the Bundestag established specific per kilowatt-hour payments for each renewable technology based on the real costs of generation. Electric utilities also qualify for these tariffs, a change that the government correctly expected would reduce utility opposition while further stimulating the renewable energy market. (Gerdes, 2000)

Soon after the first pricing law was established, wind energy (but wind only) development in Germany began a steady and dramatic surge, and farmers, small investors, and start-up manufacturers began to create a new industry from scratch. Some barriers to renewables remained; as each new hurdle arose, the government enacted laws or established programs to address them. Obstacles to wind included lengthy, inconsistent and complex siting procedures. The government responded by encouraging communities to zone specific areas for wind. As of 2000, grid operators must connect plants at the most suitable location and pay for necessary upgrading, eliminating barriers that arose when utilities discouraged wind development through inflated connection-related charges (Lackmann, 2002).

Germany addressed the challenge of high initial capital costs of renewable energy through low-interest loans offered by major banks and refinanced by the federal government, and through the introduction of PV-specific tariffs in the 2000 pricing law (Twele, 2000). The "100,000 Roofs" program, which expired in 2003, provided 10-year low-interest loans for PV installation. Income tax credits granted only to projects and equipment that meet specified standards have enabled people to take tax deductions against their investments in renewable energy projects. In addition, the federal and state governments have funded renewable resource studies on- and off-shore, have established institutes to collect and publish data, and have advanced awareness about renewable technologies through publications of subsidies and through architectural, engineering and other relevant vocational training programs. (Mayer, 2001; DEWI, 1998; BMU, 1994)

All of these policies have played an important role, but the pricing law has had the greatest impact on Germany's renewable energy industries. It ended uncertainties regarding whether producers could sell their electricity into the grid and at what price, and provided investor confidence, making it easier for even small producers to obtain bank loans, and drawing money into the industries. Increased investment drove improvements in technology, advanced learning and experience, and produced economies of scale that have led to dramatic cost reductions. The average cost of manufacturing wind turbines in Germany fell by 43 percent between 1990 and 2000, and the cost of total PV systems has declined 39 percent over the past decade (Wagner, 2002; Weiss and Sprau, 2002).

German wind capacity mushroomed from 56 MW in early 1991 to 12,001 MW at the end of 2002, and Germany became the world's leading wind energy producer in 1997. By the end of 2002, wind energy met 4.7 percent of Germany's total electricity demand, up from 3 percent the previous year (Reuters, 2003). Cumulative PV installations climbed from just under 6 MW in 1992 to nearly 280 MW at the end of 2002 (PVPS, 2003); by late 2003, they were approaching 400 MW (SolarAccess.com, 2003). In 2001, Germany's PV capacity surpassed that of the United States, and is now second only to Japan. Germany accounts for most of Europe's PV production and installed capacity, 35.5 percent (as of 2001) of its biogas capacity, and has the largest solar thermal water heating market in the EU (French, 2003; SolarAccess.com, 2003b). Some 45,000 people worked in Germany's wind industry by early 2003; one fifth of them were hired the previous year (BWE, 2003). And it is estimated that the 100,000 Roofs program created 10,000 new jobs, at a cost of €24,000 per position (Platts, 2003). So many Germans are employed in renewables industries, or own shares in wind turbines, solar or other projects that there is now broad public support for renewable energy. Germany has pledged to reduce its CO_2 emissions 21 percent below 1990 levels by 2010, and the nation will accomplish much of this through increased use of renewable energy.

Box 3: Renewable Energy in India

The Indian state of Tamil-Nadu began assessing its wind resource potential in the mid-1980s. The state utility soon built demonstration projects, the necessary grid infrastructure, and provided information about good wind sites to potential investors (TERI, 2003). In 1991, the Indian government opened the electric grid to private producers, allowing them to build and operate power plants, and to enter into long-term contracts with state electricity boards (Osafo and Martinot, 2003). For the first time, private companies could produce wind power in remote regions with good resources, and "wheel" it over transmission lines for their own needs or for sale to third parties. This access to the transmission system, combined with investment tax credits, financing assistance and accelerated depreciation, led to a wind energy boom in India, and in Tamil-Nadu in particular.

Today India has the world's largest wind resource assessment program. Long-term low-interest loans, provided through the Indian Renewable Energy Development Agency (IREDA), have attracted private funding and encouraged banks to fund renewable energy projects. In fact, the private sector has contributed 96 percent of the investment in wind energy to date. (TERI, 2003) The government has also made it easy to establish joint ventures with foreign companies, and the subsidies and demand for power have drawn major wind companies to India from Germany and Denmark (Watts, 2003).

As in California during the 1980s, investment-based subsidies and a lack of turbine standards or production requirements led wealthy investors to use wind farms as tax shelters, and several early projects experienced poor performance. This occurred despite significant technology advancements that had taken place since the early 1980s. And wind energy growth slowed considerably when investment credits declined. Despite some bumps in the road, India now ranks fifth in the world for wind energy capacity, with 1,870 MW as of early 2003 (MNES, 2003). India's turbine manufacturing capability is now about 500 MW a year, and 15 companies are involved in the industry, building turbines for domestic use and export, and creating local jobs (TERI, 2003a; Chaurey, 2003; Martinot, 2002). In 2003, certification of design and performance became mandatory, reducing if not eliminating concerns about substandard technologies (TERI, 2003a).

There are still challenges to overcome. Policies are inconsistent from state to state, and many states do not follow MNES guidelines for grid interfacing, wheeling charges, length of power purchase contracts, and tariffs (TERI, 2003a). Commercial demand for renewables remains relatively low, and most manufacturers and suppliers are small players with limited resources. In addition, tariffs discourage the installation of off-grid, remote projects, and most Indians, particularly those living in peri-urban and rural areas, do not have access to financing (Shekhar et al, 2001; Babu and Michaelowa, 2003). Import duties, as well, have made it more costly to develop renewable energy projects—in the mid-1990s, India was the world's largest market for PVs, but had some of the highest PV prices in the world because of high import duties (McPhee, 1996; World Bank/IEA, 1997).

At the same time, India has made some remarkable achievements. In addition to its success with wind energy, India has the world's largest decentralized solar energy program, and the world's second largest biogas and improved-cookstoves program (MNES, 2002). The Indian government established a number of financial incentives for PVs in the 1980s, and set up local service centers and shops as market volumes increased. While government subsidies are still essential for most PV installations in India, the nation ranks fifth worldwide for grid-connected PV capacity (Martinot et al, 2002; MNES, 2003). Annual turnover of the renewable energy industry now exceeds 30,000 million Rupees (about US$660 million) (Chaurey, 2003). (See Table 2)

Box 4: PVs in Japan

Japan established net metering for PV in 1992, requiring utilities to purchase excess power at the retail rate. Between April 2001 and March 2002 alone, Japanese electric power companies bought more than 124 GWh of surplus PV power (PVPS, 2003a).

In 1994, Japan launched the "Solar Roofs" program to promote PVs through low-interest loans, a comprehensive education and awareness program, and rebates for grid-connected residential systems that were provided in return for data about systems operations. Government promotion of PV has included publicity on television and in print media (PVPS, 2003a). The rebates declined gradually over time, from 50 percent of installed costs in 1994 to 12 percent in 2002, the year the program ended. In 1997, the rebates were opened to owners and developers of housing complexes as well, and Japan became the world's largest supporter of PVs with a seven-fold increase in funding for the expanded "70,000 Roofs Program." (Haas, 2002; Moore and Ihle, 1999)

The goal of Japan's PV program was to create market awareness and stimulate PV production in order to reduce costs through economies of scale and technology improvements, and thereby enable large-scale power generation and the export of PVs to the rest of the world. And the policy has succeeded.

Japan is now the world's leader in the manufacture and use of solar PV, having surpassed the United States at both in the late 1990s. When "Solar Roofs" ended, the program had exceeded its objectives; more than 420 MW of PV were installed between 1994 and 2002 (Maycock, 2003a). Total installed capacity has increased an average of more than 42 percent annually since 1992 (PVPS, 2003). To keep up with demand, Japanese PV manufacturers have dramatically increased their production capacity, by nearly 47 percent in 2002 alone (Maycock, 2003a). Japan was responsible for more than 43 percent of global PV production in 2002, and Sharp is now the world's leading producer of solar cells (Maycock, 2003a; Moore and Ihle, 1999). (See Chart 4) By some accounts, PV system costs in Japan have dropped at least 75 percent since the mid-1990s, far more rapidly than the decrease in average global module costs; according to Maycock, the cost of residential grid-connected systems in Japan declined by more than 40 percent between 1995 and 2003 (EPVA/Greenpeace, 2001; Flavin, 2003; Maycock, 2003a).

Box 5: Public Benefit Funds and Bond Initiatives

Fifteen U.S. states now have public benefit funds (PBFs)—accounts created to finance electricity-related programs to benefit the public, including renewable energy projects, energy efficiency, R&D, and low-income assistance. PBFs are funded through a small per kWh surcharge on electricity consumption (averaging 0.2-0.3 percent of the retail electric rate (Kittler, 2003)).

The state of California has the largest fund by far, created in 1996 as part of the state's electricity restructuring legislation with a promise of $540 million for renewable energy. More money has been added since then, and the program extended to 2012. Existing and new renewable energy projects can receive production payments of up to 1.5¢/kWh, with funds allocated through an auction (bids are ranked in order of lowest incentive request to highest). The California Energy Commission projects that an additional 750 MW of new capacity will be on line by the end of 2003, as a result of this New Renewable Resources Account.

California also provides rebates (up to 1.5¢/kWh) for consumers who buy certified green electricity, and for investors in "emerging renewables" (PVs, small-scale wind, solar thermal electric, and fuel cells powered with renewable hydrogen). People who purchase small wind or PV systems, for example, have been able to choose between a rebate of $4.50/W or a 15 percent investment tax credit, whichever is less (CEC, 2003).[8]

The state's PV program has led to significant growth in PV markets, and in the number of manufacturing, distribution and installation companies in California (Lamb, 2003). Since 1998, the Emerging Renewables Program has helped to reduce PV system costs by 50 percent. More than 80 percent of California's 50 MW of grid-connected PV capacity has been installed since 2000, with at least another 5-10 MW expected in 2003. (SolarAccess.com, 2003a) California is the third largest PV market in the world, with ten times more installed PV capacity than any other U.S. state (CEC, 2003).

Another program driving PV in California is the San Francisco Solar Bond Initiative. In 2001, the city's voters overwhelming approved a $100 million bond program to purchase renewable energy for public facilities. A combination of bulk purchasing and bundling of PV with wind energy and energy efficiency measures means that energy savings will pay for the additional costs associated with PV. The initiative grew out of concerns about climate change, air pollution and dependence on foreign energy sources. The program aims to increase public awareness, create jobs, drive down the costs of PV through economies of scale, and to make the city a world leader in the use of clean energy. Several other U.S. cities and states are considering following San Francisco's lead (Vote Solar, 2003; Mayfield, 2003).

Box 6: Policies for Developing Countries

In developing countries it is essential to bring down the costs of renewable energy, increase confidence and awareness, attract investment, build local capacity, and develop supporting infrastructure (i.e., legal and regulatory systems, transport and communications) (Wilkins, 2002). At least for the short run, sustainable and replicable business models, and consistent and growing markets for renewable energy, are more important than quantity. Perhaps the most critical factors for achieving these goals are consistent, long-term policies and a clear government commitment to renewable energy.

For grid-connected electricity, developing countries face many obstacles and policy options similar to those in industrial countries. The keys to development include creation of a favorable investment climate that provides long-term stable tariffs, and a regulatory framework for independent power producers that provides open grid access with fair transmission charges, and permits wheeling. Such factors have helped to catalyze the wind industry in India, and small hydropower in Brazil (Martinot, 2002; Martinot et al, 2002). While experience with them is very limited in the developing world, a few countries have begun to implement quota (China and India) and pricing systems (Brazil) to provide the necessary regulatory frameworks. Financing is also crucial, as are production-based incentives to encourage optimal performance and sustainability (Martinot et al, 2002). Ultimately, large and expanding domestic industries are necessary to overcome regulatory, technical, contractual and operational challenges (Martinot, 2002).

Success stories for off-grid electricity programs are still limited, but there are examples of programs that have succeeded in providing electricity for rural areas through mini-grids. For instance, Argentina's government offers concessions through which the winning company gains a monopoly in a given region, and provides grants to cover lifecycle costs. Benefits of this system include creation of a large market to provide critical mass for commercially sustainable business and to reduce unit costs through scale economies (for equipment, transactions, operation and maintenance), as well as its appeal to large companies that have their own sources of funding (Reiche et al, 2000). This system has been duplicated in several other countries, including Cape Verde, Togo, Benin, and South Africa (Osafo and Martinot, 2003; Reiche et al, 2000). The Philippines and Bangladesh have networks of consumer-owned and -managed cooperatives that receive financial incentives in exchange for meeting annual performance targets and providing electricity to members and the local community. Results have been mixed in both countries (Osafo and Martinot, 2003).

The Chinese government has undertaken an ambitious program to electrify—with mini-grids—more than 1,000 townships within 20 months, beginning with township "seats," followed by an additional 20,000 administrative villages. Nearly 30 percent of the total funds ($340 million) are earmarked for institutional development and training, which will focus on certifying Master Trainers who will then instruct others on a local basis. (Ku et al, 2003)

For rural markets, whether for electrification or other needs, there are four key dimensions to entrepreneurship (Martinot et al, 2002). Marketing can be challenging and expensive, particularly in rural areas, and is discussed further below. Business financing is necessary to overcome the barrier of up-front costs for small dealers. Financing can be more difficult to obtain in remote areas, particularly if bankers lack knowledge of renewable energy, and interest rates are often extremely high.

Possible solutions include partnering with larger dealers, micro-finance lending, and partial credit guarantees (Reiche et al, 2000). Bundling of renewables with existing products can reduce costs. And a policy framework for rural electrification is essential—for example, the primary barriers to renewable energy are often unrealistic promises of grid access and subsidies for kerosene (Martinot et al, 2002).

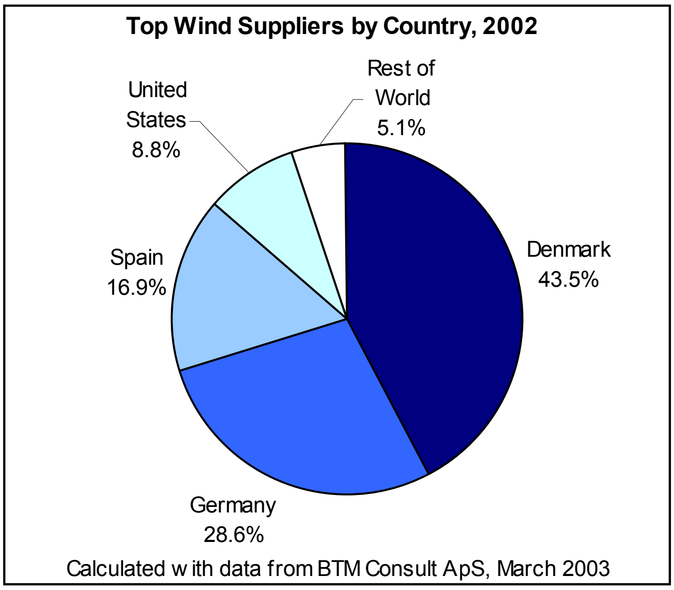
A relatively high density of projects is also required to support the establishment of local businesses with trained technicians, which also necessitates that renewable technologies be affordable for consumers. Microcredit, leasing and prepaid meters are the most promising options to date (Reiche et al, 2000). China offers revolving credit, with repayment linked to timing of a household's income stream. India provides low-interest loans that vary by technology, with the most favorable terms available for PV. For the poorest populations, additional subsidies may be needed as well (Reiche et al, 2000).

Some key recommendations from the literature about renewable energy in developing countries include the following (note that there are several additional and relevant recommendations in Chapter 6 that are not incorporated below):

- Support should focus on institutions rather than individual projects, as project-specific funding tends to create cycles of boom and bust and does not generally build institutional capacity (Kammen, 1999).
- Distorting subsidies should be reduced or eliminated. Subsidies that remain must be carefully targeted to those who truly need them. For example, the Argentinian government subsidizes minimum rural household electricity consumption of 10 kWh/month; beyond that there is no support (Reiche et al, 2000).
- Marketing assistance is essential in the early phases. Local governments played a significant role in Argentina by preparing detailed market studies, disseminating information, and preparing studies regarding reliability of DC appliances to help overcome barriers created by a lack of awareness and high marketing costs (Reiche et al, 2000).
- Develop the capacity for local regulation and certification. Poor production quality can result from a lack of standards.
- Ease import procedures and eliminate or reduce import duties for renewable technologies and components to reduce project costs and time delays.
- Remove barriers to joint-ventures with foreign companies, as India has done.
- Encourage local production, which provides jobs, local investment, and significantly reduces costs of renewable energy technologies. One option for promoting local production is to provide purchase subsidies for locally manufactured technologies (Martinot, 2003).
- Bundling can be used to attract bi- and multilateral financing assistance, as India has done. China's "Brightness program" is funded jointly by China's Finance Ministry and the German state-owned development bank (Kreditanstalt für Wiederaufbau).
- Government procurement of renewable energies can help achieve a sustainable market and industry, while increasing public awareness and reducing perceived risk. Government and national utilities can also incorporate solar home systems, for example, into rural electrification planning (Reiche et al, 2000).

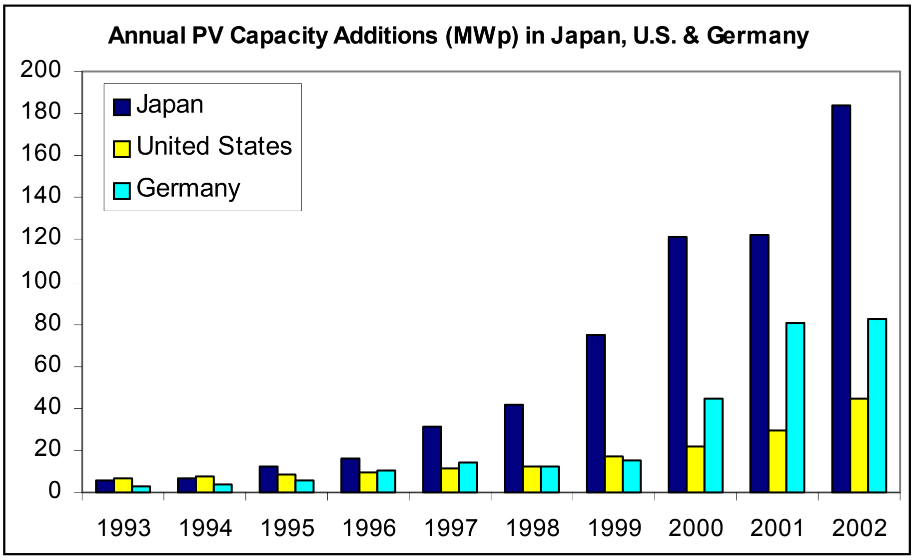
8. Charts and Tables

Chart 1: World's Top Wind Turbine Suppliers, 2002



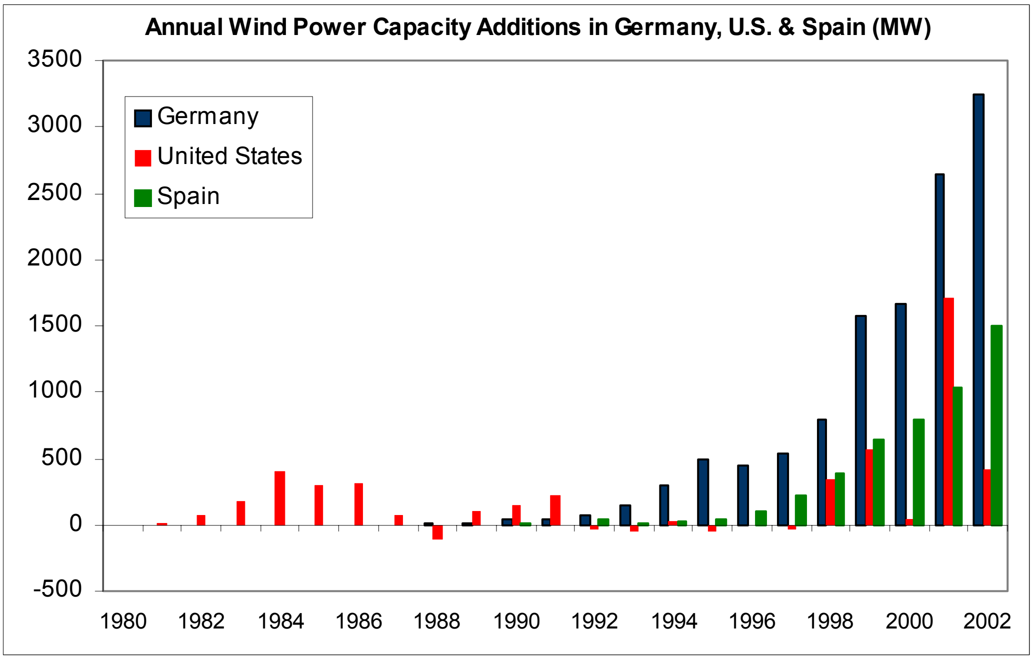
(Based on MW sales in 2002)

Chart 2: Annual PV Capacity Additions in Japan, the United States and Germany



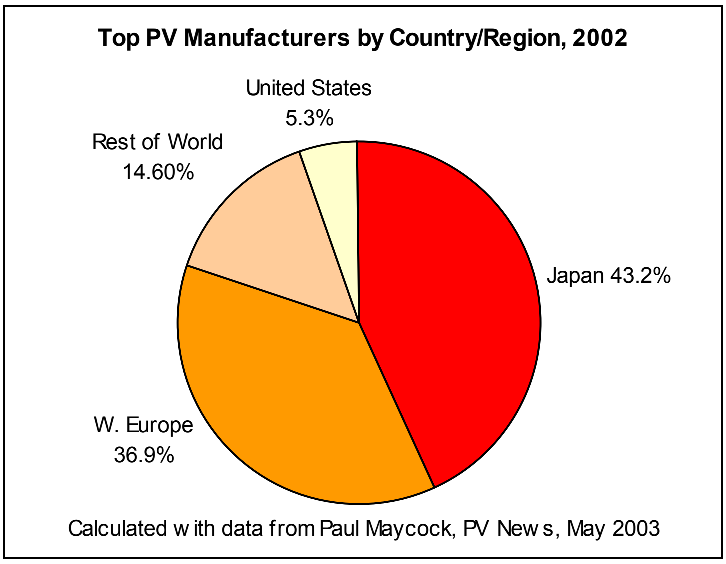
(Source: IEA – PVPS)
Note that much of the US growth in recent years has been in California.

Chart 3: Annual Wind Capacity Additions (net) in Germany, the United States and Spain: The Importance of Consistent Policy



(Sources: BWE, EWEA, AWEA, Paul Gipe, BTM Consult, IDAE)

Chart 4: World's Top PV Cell/Module Producers, 2002



(Based on MW manufactured in 2002)

Table 1: Average Prices (€/MWh) Paid for Renewable Electricity in 11 European Countries, 2002; and in Germany 2003 and 2004

Country	Small Hydro	Wind	Biomass	PV	Other
Austria	25 (pool price + green certificate) or 32 (R)	73.5-109 (R; and investment costs)	47.7-174.5 (S)	358-726 (R)	
Denmark		57.6 (rate under old pricing system)	Farm biogas: 80 (for 10 years)		
France	Pre-2001: 28.81 (summer - su); 71.65 (winter - w); Post-2001: 44.5/84.2 (su/w; <500kVA); 40.1/75.8 (su/w; >500kVA)[1]	83.8 (first 5 years); 30.5-83.8 (depending on output; for next 10 years)[2]	Landfill gas only: 57.2 (< 2MW); 45 (>6 MW)	87 (<10 kWp); 152.5 (to start soon, if not already in effect); 305 (Corsica & overseas)	
Great Britain		39 (pool) + 49 (green certificate)[3]			
Ireland[4]	64.1 (weighted average price)	47.23-52.97 (<3 MW); 45.47-48.12 (>3 MW)	37.65-59.16		
Italy		46 (pool price) + 67 (green certificate)[5]			
Netherlands		77.1 (Pool + green certificates)			
Portugal[6]	69.1 (up to 10 MVA)	75.56-83.1 (depending on hours in operation; up to 2800 h)	61.984	393.84 (<5kW); 229.56 (>5kW)	Wave: 223.391
Spain[7] (up to 50 MW)	63.827 (up to 10 MW)	62.806; or market price + 2.89 (premium)	Primary biomass: 61.724; Other: 3.5% less	397[8] (<5kW); 217 (>5kW)	

[1] Additional bonus of 7-7.5 €/MWh in winter for regularity.
[2] For plants up to 1,500 MW; 10% decrease for larger plants.
[3] Maximum value for Green Certificates, calculated according to expected penalty.
[4] Contract prices under the Alternative Energy Requirement tendering competitions.
[5] Maximum price for 2002. Green certificates work for the first 8 years; from then on producers receive only pool price.
[6] Fixed prices are updated monthly, according to inflation. Fixed prices for PV are in place until total capacity reaches 50 MW; wave prices in place up to 20 MW of national capacity.
[7] These are fixed prices, except for the market price plus premium listed included here for wind. Spain's support system also offers hourly pool electricity price plus a fixed premium.
[8] Available until Spain reaches total PV capacity of 50 MW.

Sweden	24 (market price) + 10 (for plants <1,500 kW) + 10% of investment cost	24 (market price) + 29 (for plants <1,500 kW) + 10% of investment cost	24 (market price) + 10 (for plants <1,500 kW) + 25% of investment cost	24 (market price) + 10 (for plants <1,500 kW)	
Germany (2002) (tariff duration 20 years)	76.7 (<500 kW); 66.5-76.7 (500kW-5 MW)[9]	89 (first 5 years); 61 (yrs 6-20)	General biomass: 84-101 (S); Landfill & sewage: 66-77 (S)	481	Geothermal 89 (< 20 MW); 72 (>20 MW)
Germany (2003) (tariff duration 20 years)	76.5 (<500 kW); 66.3 (< 5 MW)	89 (first 5 years onshore; first 9 years offshore); 60 (final tariffs)	100 (<500 kW); 90 (500-5,000 kW); 85 (5-20 MW). Landfill/ sewage gas: 76.5 (<500 kW); 66.3 (< 5 MW)	457	Geothermal 89.3 (<20 MW); 71.4 (> 20 MW)
Germany (2004) (tariff duration 20 years)	76.5 (<500 kW); 66.3 (< 5 MW)	88 (first 5 years onshore; first 9 years offshore); 59 (final tariffs) (tariff duration 20 years)	99 (<500 kW); 89 (500-5,000 kW); 84 (5-20 MW). Landfill/ sewage gas: 76.5 (<500 kW); 66.3 (< 5 MW)	457 + 117 (roof installations <30kW); 93 (roof; >30 kW); 50 (facades)[10]	Geothermal 89.3 (<20 MW); 71.4 (> 20 MW)

S = depending on size of plant; R = depending on region of plant.
(Sources: EREF, 2002; Lackmann, 2002; APPA, 2002; WCRE, 2003)

Table 2: Renewable energy installations in India, 31 March 2003

Technology	Capacity Installed (MW)	World Ranking
Wind	1,870	5th
Small hydro (up to 25 MW)	1,509.24	10th
Biomass power	483.9	4th
Biomass gasifiers	53.4	1st
Photovoltaics	121	5th

(Source: MNES, 2003)

[9] Fixed prices apply for plants commissioned during 2002, for a period of 20 years, except for hydropower, which receives prices permanently.
[10] Additional payment is to take the place of 100,000 roof program, which ended summer 2003. A total capacity limit of 1,000 MW (to receive tariffs) has been eliminated.

9. References

Books, Reports and Papers

Babu, Y.D. and A. Michaelowa, "Removing barriers for renewable energy CDM projects in India and building capacity at the state level," a joint report by The Energy and Resources Institute (TERI) and Hamburgischen Welt-Wirtschaft-Archiv (HWWA), Hamburg, September 2003.

Battelle/Pacific Northwest Laboratory, *Assessment of available windy land area and wind energy potential in the contiguous United States* (Battelle/PNL, August 1991).

Beck, Fred and Eric Martinot, "Renewable energy policies and barriers," forthcoming in *Encyclopedia of Energy*, Cutler J. Cleveland, ed. (Academic Press/Elsevier Science, 2004).

Berry, T. and M. Jaccard, "The renewable portfolio standard: design considerations and an implementation survey," *Energy Policy*, Vol. 29 (2001), pp. 263-277.

Bolinger, Mark and Ryan Wiser, "Customer-sited PV: a survey of clean energy fund support," Lawrence Berkeley National Laboratory, LBNL-49668, Berkeley, CA., May 2002.

Bravo, Isidoro Lillo, "Procedimiento de conexion para inyectar energia a la red electrica convencional desde una instalacion fotovoltaica," Grupo de Termodinámica y Energías Renovables, Escuela Superior de Ingenieros, University of Seville, Spain, undated.

BTM Consult ApS, *World market update 2002: forecast 2003-2007*, Ringkøbing, Denmark, March 2003.

Bundesverband Windenergie e.V. (BWE, 2003), "German wind power still flying high," press release (Osnabrück: 22 February 2003).

Bundesverband Windenergie e.V. (BWE, 2003a), "Down and out in Denmark," *New Energy*, April 2003.

California Energy Commission (CEC), *Wind energy program progress report* (Sacramento, CA: 1982).

Choy, Marguerita, "French law to slow wind power growth—government official," *Reuters*, 28 March 2003.

CO2e.com, "Environment: Brazil to take renewable energy plan to Johannesburg," Inter Press Service, 17 May 2002. http://www.co2e.com/News/story.asp?StoryID=576.

Coelho, Suani T., Marly F. Bolognini, Orlando Cristiano Silva, Carlos E.M. Paletta, "Biofuels in Brazil: the current situation," Centro Nacional de Refência em Biomassa (Brazilian Reference Center on Biomass), October 1999.

Damborg, Steffen and Søren Krohn, "Public attitudes towards wind power," Danish Wind Turbine Manufacturers Association, 1998.
Danish Ministry of the Environment (Miljøministeriet), (DME, 2003), "GNP, CO2—emissions and energy," *Nature and Environment: Total Set of Indicators,* 2003.

de Hollanda, Jayme Buarque and Alan Dougals Poole, "Sugarcane as an energy source in Brazil," Instituto Nacional de Eficiencia Energetica (undated), at http://www.inee.org.br/down_loads%5Cabout/SUGARCANE&ENERGY.pdf.

de Vries, HJ, CJ Roos, LWM Beurskens, AL Kooijman-van Dijk, and MA Uyterlinde, *Renewable electricity policies in Europe: country fact sheets* (Amsterdam: Energy Research Centre of the Netherlands, October 2003).

Deutches Windenergie Institut/German Wind Energy Institute (DEWI, 1998), *Wind energy information brochure* (Wilhelmshaven, Germany: 1998).

Eckhart, Michael, Jack Stone, and Keith Rutledge, "Financing PV growth: why finance may be the key to real expansion," *Renewable Energy World*, vol. 6, no. 3, May-June 2003, pp. 112-127.

Espey, S., "Renewables portfolio standard: a means for trade with electricity from renewable energy sources?" *Energy Policy*, Vol. 29 (2000), pp. 557-566.

European Actions for Renewable Energy (PREDAC), "4 good reasons to favour local investment," 2002 or 2003, at <www.cler.org/predac/wp1>.

European Commission, 2001/77/EC Directive on the Promotion of Electricity from Renewable Energy Sources in the Internal Electricity Market.

European Photovoltaic Industry Association and Greenpeace (EPVA/Greenpeace, 2001), *Solar generation: solar electricity for over 1 billion people and 2 billion jobs by 2020*, October 2001.

European Renewable Energies Federation (EREF, 2002), "2002 average prices (€/MWh) for RES-E, Second Edition," Paris, 2002.

European Wind Energy Association and Greenpeace (EWEA/Greenpeace, 2002), *Wind force 12*, May 2002.

Forster, Siegfried, "6,000 MW of wind power by the end of 2006," *New Energy*, no. 3, June 2003, p. 22-24.

French, Ian, "Biogas in Europe: huge potential in a growing market," *Renewable Energy World*, vol. 6, no. 4, July-August 2003, pp. 120-131.

Frost, Thomas, "Novel funding for renewable energy developments," *Commodities Now*, Asian Energy Supplement, September 2003, p. 25.

Geller, Howard, *Energy revolution: policies for a sustainable future* (Washington, DC: Island Press, 2003).

Germany Embassy, United Kingdom (EoG, 2003), "Renewable energy law to be retargeted," Environment Information Note 6.03, 3 February 2003, at http://www.britischebotschaft.de/en/embassy/environment/pdf/env-note_03-06.pdf.

German Ministry for the Environment, Nature Conservation and Nuclear Safety/Deutsche Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU, 1994), *Environmental policy: the federal government's decision of 29 September 1994 on reducing emissions of CO2, and emissions of other greenhouse gases, in the Federal Republic of Germany* (Bonn: November 1994).

Gipe, Paul, "Electricity feed laws power European renewables," *Solar Today*, 20 August 2003.

Goldemberg, José, "Rural energy in developing countries," in U.N. Development Programme, U.N. Department of Social and Economic Affairs, and World Energy Council, World Energy Assessment: Energy and the Challenge of Sustainability (New York: UNDP, 2000).

Goldemberg, José, Suani Teixeira Coelho, Plinio Mário Nastari, and Oswaldo Lucon, "Ethanol learning curve—the Brazilian experience," *Biomass and Bioenergy* (issue number not available; accepted 14 May 2003), 2003.

Goldstein, Larry, John Mortensen, and David Trickett, "Grid-connected renewable-electric policies in the European Union," National Renewable Energy Laboratory, NREL/TP.620.26247, May 1999.

Group of Eight (G8) Renewable Energy Task Force, *G8 renewable energy task force final report 2001* (London: 2001).

Haas, Reinhard, "Building PV markets: the impact of financial incentives," *Renewable Energy World*, vol. 5, no. 4, July/August 2002, p. 195.

Hamrin, Jan, "The amazing growth of the US green electricity market," *Renewable Energy World*, vol. 6, no. 4, July-August 2003, pp. 144-153.

Hua, Li, "China's solar thermal industry: threat or opportunity for European companies?" *Renewable Energy World,* vol. 5, no. 4, July/August 2002, p. 107.

Indian Ministry of Non-Conventional Energy Sources (MNES, 2002), *Annual report 2001-2002* (New Delhi: MNES, 2002).

Indian MNES, *Annual report 1999-2000* (New Delhi: MNES, 2000).

International Energy Agency (IEA, 2003), *World energy investment outlook* (Paris: 2003).

Iturriagagoitia, Nuria, "EHN—a new energy model in action," *Renewable Energy World*, Vol. 5, No. 3, May/June 2002, p. 46.

Kammen, Daniel M., "Bringing power to the people: promoting appropriate energy technologies in the developing world," *Environment*, June 1999.

Khalip, Andrei and Peter Blackburn, "Feature – pioneer Brazil seeks to crank up alcohol motor again," *Reuters*, 3 June 2002.

Kittler, Ronny, "Renewable energy in the USA: federal and state activities to promote alternative electricity generation," Policy paper no. 21, Heinrich Böll Foundation, Washington, DC, April 2003.

Krohn, Søren (2000a), "Danish wind turbines: an industrial success story," Danish Wind Industry Association, 21 January 2000, http://www.windpower.org/en/articles/success.htm.

Ku, Jean, Debra Lew and Shenghong Ma, "Sending electricity to townships: China's large-scale renewables programme brings power to a million people," *Renewable Energy World*, vol. 6, no. 5, September/October 2003, pp. 56-67.

Lamb, Celia, "New laws reshape, fuel solar power growth," *Sacramento Business Journal*, 20 October 2003.

Lauber, Volkmar, "REFIT and RPS: options for a harmonized community framework," *Energy Policy* (article in press), 2003.

Martinot, Eric, "Renewable energy in developing countries: lessons for the market," *Renewable Energy World*, vol. 6, no. 4, July/August 2003, pp. 50-65.

Martinot, Eric, Akanksha Chaurey, Debra Lew, José Roberto Moreira, and Njeri Wamukonya, "Renewable energy markets in developing countries," *Annual Review of Energy and the Environment* 27(2002), pp. 309-348.

Martinot, Eric and Kilian Reiche, "Regulatory approaches to rural electrification and renewable energy: case studies from six developing countries," World Bank, Washington, DC, Working Paper, June 2000.

Maycock, Paul (Maycock, 2003), *PV News*, vol. 22, no. 9, September 2003.

Maycock, Paul (Maycock, 2003a), "PV market update," *Renewable Energy World*, vol. 6, no. 4, July/August 2003, pp. 84-101.

Mayfield, Kendra, "'Fog city' catches a few rays," PowerLight Corporation, news release (San Francisco: 7 January 2003).

McPhee, Marnie, "Bringing (solar) light to the world," *The Energizer*, Solar Energy Association of Oregon, vol. XVI, no. 3, Autumn 1996

Menanteau, Philippe, Dominique Finon, Marie-Laure Lamy, "Prices versus quantities: choosing policies for promoting the development of renewable energy," *Energy Policy* 31 (2003), pp. 799-812.

Meyer, Niels I., "European schemes for promoting renewables in liberalised markets," *Energy Policy* 31 (2003), pp. 665-676.

Meyer, Niels I, and Anne Louise Koefoed, "Danish energy reform: policy implications for renewables," *Energy Policy* 31 (2003), pp. 597-607.

Møller, Torgny, "Government closes door in Denmark," *Windpower Monthly*, July 2002. Moore, Curtis and Jack Ihle, "Renewable energy policy outside the United States," Issue Brief no. 14, Renewable Energy Policy Project, Washington, DC, 1999.

Nitsch, J., M. Fischedick, et al., "Analysis and elaboration of long-term scenarios for a sustainable energy use in Germany," research study for the German Federal Environment Ministry, Wuppertal Institut, DLR Stuttgart, 2001/2002.

Organization for Economic Cooperation and Development and International Energy Agency (OECD/IEA, 1999), *Enhancing the market deployment of energy technology: a survey of eight technologies* (Paris: OECD, 1999).

Osafo, Yaw, and Eric Martinot, "An inventory of renewable energy policies in developing countries," Global Environment Facility, Washington, DC, 2003 (working draft).

Panik, Monica Saraiva, "Greenhouse gases are global," *Sustainable Development International*, Edition 4, p. 112.

Pekic, Vladimir, "Lula's resolve spurs Brazil's biofuels market," *Platts Renewable Energy Report*, Issue 53, July 2003, p. 33.

Perlin, John, "Electrifying the unelectrified," *Solar Today*, November/December 1999.

Reiche, Kilian, Alvaro Covarrubias, and Eric Martinot, "Expanding electricity access to remote areas: off-grid rural electrification in developing countries," *WorldPower 2000* (London: Isherwood Production Ltd.), pp. 52-60. http://www.martinot.info/Reiche_et_al_WP2000.pdf.

Ristau, Oliver, "Sunny prospects on the Costa del Sol," *New Energy*, no. 3, June 2003, pp. 48-50.

Righter, Robert, *Wind energy in America: A history* (Norman: University of Oklahoma Press, 1996).

Sanner, Burkhard and Werner Bussmann, "Current status, prospects and economic framework of geothermal power production in Germany," *Geothermics* 32 (2003), pp. 429-438.

Sawin, Janet L., *The role of government in the development and diffusion of renewable energy technologies: wind power in the United States, California, Denmark, and Germany, 1970-2000*, Ph.D. thesis, Tufts University, Fletcher School of Law and Diplomacy (Ann Arbor, MI: UMI, 2001).

Sawin, Janet L., "Charting a new energy future," in *State of the World 2003*, Linda Starke ed. (New York: W.W. Norton & Company, 2003), pp. 85-109.

Sprau, Peter and Ingrid Weiss, *National survey report of PV power applications in Germany 2001*, prepared for the German Federal Ministry of Economics and the Research Centre Jülich, WIP-Renewable Energies Division, Munich, Germany, June 2002.

The Energy and Resources Institute (TERI, 2003), "Public sector financing for wind power development," Asia-Pacific Environmental Innovation Strategies, Research on Innovative and Strategic Policy Options, Good Practices Inventory, March 2003.

The Energy and Resources Institute (TERI, 2003a), "Survey of energy and environmental situations in India," TERI report 2003IE42.

United Nations Development Programme (UNDP), *World energy assessment* (New York: 2000).

UN Environment Programme (UNEP, 2000), *Natural selection: evolving choices for renewable energy technology and policy* (Paris: UNEP, 2000).

United States Department of Energy (US DOE, 2002), "An energy overview of Brazil," 16 May 2002.

Watts, Himangshu, "Clean energy brings windfall the village," *Reuters*, 5 November 2003.
Weiss, Ingrid and Peter Sprau, "100,000 roofs and 99 pfennig—Germany's PV financing schemes and the market," *Renewable Energy World*, January-February 2002.

Wilkins, Gill, "Renewables and development: overcoming barriers to technology transfer," *Renewable Energy World*, vol. 5, no. 4, July-August 2002, pp. 203-215.

Wiser, Ryan, Jan Hamrin and Seth Baruch, "Renewable energy policy options for China: feed-in laws and renewable portfolio standards compared," prepared for Center for Renewable Energy Development, Energy Research Institute, State Development Planning Commission, China (San Francisco: Center for Resource Solutions, 2000).

Woods, Jeremy and David O. Hall, "Bioenergy for development: technical and environmental dimensions," at http://www.eurosolar.org/download/Woods.pdf.

World Bank/International Energy Association (World Bank/IEA, 1997), "Solar photovoltaic power: an overview," Renewable Energy Briefing, *Energy Note* 10, 1997.

Presentations and Speeches

Cox, Patrick, President, European Union Parliament, speaking at opening session of the European Wind Energy Conference, Madrid, Spain, 16-19 June 2003.

de Andrade, Adnei Melges, Carlos Américo Morato de Andrade and Jean Albert Bodinaud, "Biomass energy use in Latin America: focus on Brazil," for workshop on Biomass Energy: Data, Analysis and Trends, International Energy Agency, Paris, 23-24 March 1998, p. 3, at http://www.iee.usp.br/biblioteca/producao/1998/trabelho/biomass/pdf, viewed 9 August 2002.

Goldemberg, José, Secretary for the Environment, State of São Paulo, Brazil, "The Brazilian energy initiative," 25 June 2002.

Gonzálvez, Cayetano Hernández, "Wind energy development in Spain," presentation at European Wind Energy Conference, Madrid, Spain, 16-19 June 2003.

Höhn, Bärbel, Secretary for the Environment, Conservation, Agriculture and Consumer Protection, North Rhine Westphalia, "Renewable energy in North Rhine-Westphalia and the transformation of the energy market in Germany," presentation at "Approaches—Challenges—Potentials: A German-American Roundtable on State Initiatives for Renewable Energy," Heinrich Böll Foundation, 23 October 2003.

Krohn, Søren, "Renewables in the EU single market—an economic and a policy analysis," paper presented at the European Small Hydro Conference, Lisbon, May 2000.

Lackmann, Johannes, "The German market promotion initiatives for renewable energies," Bundesverband Erneuerbare Energie e.V. (German Renewable Energy Association), presentation at conference of the World Council for Renewable Energy, 2002, at http://www.world-council-for-renewable-energy.org/downloads/WCRE_Lackmann.pdf.

Martinot, Eric, (Martinot, 2002) "Grid-based renewable energy in developing countries: policies, strategies, and lessons from the GEF," Washington, DC: Global Environment Facility. Presentation at World Renewable Energy Policy and Strategy Forum, Berlin, Germany, 13-15 June 2002.

Millais, Corin, *European Wind Energy Conference Special Newsletter*, Madrid, 18 June 2003.

Mitchell, Catherine, "The England and Wales renewables obligation," Warwick Business School, University of Warwick, UK. Presentation at "Renewable Energy in America" conference of the American Council on Renewable Energy, Washington, DC., 8-9 July 2003.

Shekhar, S., A. Kumar, and C. Shah, "Promotion and financing of clean energy options in India," presented at the 9th Greening Industry Network Conference, Bangkok, 24 January 2001.

Wagner, Andreas, speaker at presentation at US-European Wind Energy Briefing, sponsored by the Environment and Energy Study Institute, Washington, DC, 22 May 2000. (Videotape)

Wu, L., "Inner Mongolia: one of the pioneers of Chinese wind power development," in Proceeding of the Beijing International Conference on Wind Energy (Beijing: Organizing Committee of the Beijing International Conference on Wind Energy, 1995).

Emails and Interviews

Chaurey, Akanksha, The Energy and Resources Institute (TERI), emails to author, 16 October 2003, 3 and 5 November 2003.

Coelho, Suani T., Executive Assistant for the Secretary of State for the Environment, São Paulo, Brazil, interview with author, Washington, D.C., 25 July 2002.

Eurosolar, "WCRE update November 27, 2003," release to group email list, 28 November 2003.

Flavin, Christopher, President, Worldwatch Institute and member, International Steering Committee for Renewables 2004, multiple conversations in November and December 2003.

Gerdes, Gerhard, Deutches Windenergie Institut (DEWI, German Wind Energy Institute), discussion with author, 7 December 2000.

Gipe, Paul, discussion with author and fax, 1 October 1998.

Kleiburg, Robert, Vice President Strategy and Planning, Shell International Renewables BV, comments on draft text, provided 28 November 2003.

Madsen, Birger, BTM Consult ApS, discussion with author, 8 December 2000; email to author 14 September 2002.

Martinot, Eric, email to author, 9 October 2002. (Martinot email, 2002)

Mayer, Roland, Bundesministerium für Wirtschaft (BMWi, German Federal Ministry of Economics), email to author, 30 March 2001.

Muñoz, Miquel, affiliated with Institut de Ciència i Tecnologia Ambientals, Universitat Autònoma de Barcelona, numerous emails and conversations, November and December 2003.

Saghir, Jamal, Director, Energy and Water, The World Bank, comments on draft text, provided 2 December 2003.

Twele, Jochen, Bundesverband WindEnergie e.V. (BWE), Berlin, Germany, discussions with author, April 1999, 5 December 2000.

Uh, Dieter, Thematic Advisor, Secretariat, International Conference for Renewable Energies, comments on draft text, provided 2 December 2003, and email to author dated 8 January 2004.

Wagner, Andreas, GE Wind and European Wind Energy Association, emails to author, 10 September and 18 September 2002; discussion with author 10 September 2002.

Newspaper Articles (no authors noted)

"Europe urged to give renewables more backing," *Environment Daily*, Issue 1468, 23 June 2003, quoting Joan Fages, European Renewable Energy Foundation. (Environment Daily, 2003)

"German 2002 wind power market up 22 pct," Reuters, 24 January 2003. (Reuters, 2003)

"Germany passes laws to push renewable energy," SolarAccess.com, 2 December 2003. (SolarAccess.com, 2003)

"Germany reaches 100,000 roof milestone—but faces meltdown," Platts Renewable Energy Report, Issue 53, July 2003. (Platts, 2003)

"'Minigrids' solve South Asia power crisis," *BBC News*, 27 October 2003. (BBC News, 2003)

"Japan—National status report 2002: framework for deployment—non-technical factors," International Energy Agency, Photovoltaic Power Systems Programme, August 2003. (PVPS, 2003a)

"Solar electric systems boost California power grid," *SolarAccess.com*, 5 November 2003. (SolarAccess.com, 2003a)

"Trends in European solar thermal market," SolarAccess.com, 11 July 2003. (SolarAccess.com, 2003b)

"UK boosts outlook for solar energy," SolarAccess.com, 6 November 2003. (SolarAccess.com, 2003c)

"Why renewables cannot penetrate the market," *Down to Earth*, 30 April 2002. (CSE, 2002)

Websites

Asociación de Productores de Energías Renovables (APPA, 2002; Renewable Energy Producers Association), http://www.appa.es.

California Energy Commission (CEC, 2003), Sacramento, CA., 2003, http://www.energy.ca.gov/renewables/.

Indian Ministry of Non-Conventional Energy Sources (MNES, 2003), http://mnes.nic.in.

International Energy Agency, Photovoltaic Power Systems Programme (PVPS, 2003), http://www.iea-pvps.org.

Vote Solar Initiative, San Francisco, California, http://www.votesolar.org.

Endnotes:

[1] A BET-Study estimates that the price increase for electricity consumers caused by the pricing law was only 0.11 €cent/kWh in 2000, and will be 0.19 €cent/kWh in 10 years assuming a doubling of renewables' share of total generation (Lackmann, 2002). A German government article estimates the extra cost at an average of € 8 per German household each year (EoG, 2003). A third estimate puts additional costs at 0.25 €cents/kWh in 2001, a number that has been accepted by authorities of the German federal states (Uh, 2003 and 2004).

[2] At least one expert notes that, once the best resources are no longer available, there will be no difference in costs, but countries with pricing systems will have domestic industries while those with quota systems will not (Uh, 2003).

[3] Note, however, that both California and New Jersey are now considering increasing the targets under their quota (RPS) systems.

[4] Rural households that are off-grid pay US$ 3-15 per month for energy in the form of kerosene, candles, battery charging and disposable batteries (Reiche et al, 2000).

[5] The total project is 2.1 MW, including an existing plant erected in 1997. Construction costs of the new project, of 1.058 MW, are about € 5.5 million.

[6] Note that cars manufactured to run on gasoline can operate, without any modification, on a blend of up to 24-26 percent alcohol.

[7] The manufacture of fertilizers, and extraction and purification can be very energy intensive, but not in Brazil b/c much of work is done by hand.

[8] The $ 4.50/W rebate is as of mid- to late-2003; the investment tax credits drops to 7.5 percent for 2004 and 2005.

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