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RENEWABLE ENERGY SOURCES FOR DEVELOPMENT

BY
RICHARD L. OTTINGER* AND REBECCA WILLIAMS**

Renewable energy resources hold great promise for meeting the energy and development needs of countries throughout the world. This promise is particularly strong for developing countries where many regions have not yet committed to fossil fuel dominance. Solar photovoltaic and solar thermal technologies are particularly advantageous for serving the two billion people in rural areas without grid electricity. Modern biomass energy is attractive because it uses locally available agricultural wastes. Wind energy and small hydroelectric resources also are mature technologies well suited to developing countries. Such renewable resources are far more economical than traditional energy resources, especially where the costs of acquiring, maintaining, and operating centralized power stations and remediating their pollution can be avoided. However, a host of economic, social, and legal barriers prevent these renewable resources from reaching their full potential. This Article explores the legal mechanisms for overcoming these barriers and provides examples of how they have been overcome in industrial, as well as developing countries.

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I. INTRODUCTION

Virtually every expert who has addressed the energy aspects of sustainable development has concluded that renewable resources should play a major role. Yet, while the use of these resources is growing rapidly in both developed and developing countries, use has not reached anywhere

near the technical and economic potential that worldwide studies have attributed to them.[1]

A host of economic, social, and legal barriers account for the failure of renewable resources to reach their potential. Those barriers can be overcome, as in a number of jurisdictions, including India and other developing countries. Legislation can remove these barriers, get the price signals right, and encourage successful use of renewable resources. This Article explores mechanisms that can be used and that have been used successfully in developing countries in various parts of the world to remove those barriers and to promote greater use of renewable resources.

II. RESOURCES COVERED

Renewable resources vary widely in technical and economic characteristics. Some renewable resources, such as wind, geothermal, modern biomass, and small hydroelectric energy, are in fairly wide use throughout the world, are often economical, and offer significant environmental advantages. Those renewable resources are applicable for either grid use or for stand-alone energy in rural communities. Other renewable resources, such as photovoltaics, remain too expensive for many electric grid applications, but are well suited for grid niche applications, such as for switching equipment upgrades. For poor and remote communities not yet served by electricity, the above-mentioned renewable resources are highly economical, particularly to provide power for lighting, refrigeration, irrigation, and communications.[2] In addition, modern biomass applications are particularly advantageous for developing countries because they use local feedstocks and labor.[3] Other renewable resources with tremendous technical and economic potential such as hydrogen fuel cells, wave and tidal energy, and deep hot rock geothermal energy, require additional research and development to be economically or technically feasible.[4]

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[1] UNITED NATIONS DEVELOPMENT PROGRAM, WORLD ENERGY ASSESSMENT 31 (2000); UNITED NATIONS DEVELOPMENT PROGRAM, ENERGY AFTER RIO: PROSPECTS AND CHALLENGES 1.1 (1997); Interlaboratory Working Group, *Scenarios of US Carbon Reductions: Potential Impacts of Energy-Efficient and Low-Carbon Technologies by 2010 and Beyond* (1997), *at* http://eetd.lbl.gov/5lab; MARK BERNSTEIN ET AL., DEVELOPING COUNTRIES AND GLOBAL CLIMATE CHANGE ELECTRIC POWER OPTIONS FOR GROWTH 2 (1999); *see also* Howard A Learner, *Cleaning, Greening, and Modernizing the Electric Power Sector in the Twenty-First Century*, 14 TUL. ENVTL. L.J. 277, 279 (2001) (discussing the need for clean energy development in the United States); Energy Info. Admin., *International Energy Outlook 2001: Hydroelectricity and Other Renewable Resources*, *at* http://www.eia.doe.gov/oiaf/ieo/hydro.html (last visited Mar. 11, 2002) (discussing the use of renewable energy worldwide).

[2] WORLD ENERGY ASSESSMENT, *supra* note 1, at 376; AMORY B. LOVINS & L. HUNTER LOVINS, ROCKY MTN. INST., CLIMATE: MAKING SENSE & MAKING MONEY 25 (1997).

[3] WORLD ENERGY ASSESSMENT, *supra* note 1, at 373; *see also* Nat'l Renewable Energy Lab., *Profiles in Renewable Energy: Case Studies of Successful Utility-Sector Projects*, *at* http://www.nrel.gov/documents/profiles.html (last visited Mar. 11, 2002) [hereinafter *Profiles*] (discussing the advantages of biomass energy).

[4] WORLD ENERGY ASSESSMENT, *supra* note 1, at 394.

Nuclear energy is excluded from this analysis as a development option because of its high capital and operating costs, complex technical requirements for operation and maintenance, and unresolved problems of proliferation and waste disposal. After the attacks on the World Trade Center in New York on September 11, 2001, an overriding concern with nuclear plants is their great vulnerability to terrorist attack (particularly on the control rooms and spent fuel pools that are located outside the containment vessels). At any rate, nuclear energy is not renewable unless reprocessing of spent fuel is used; and this process is even more prohibitively expensive and technologically challenging for developing countries. Further, reprocessing poses difficulties for all countries because its plutonium production is particularly vulnerable to proliferation.

In addition, nuclear energy is derived from plutonium or uranium processed with high energy into forms capable of utilization in reactors. If fossil fuels are used as the energy source to refine the uranium (currently the usual process) then nuclear energy has much of the same carbon dioxide and pollution problems as direct fossil fuel combustion.[5] Nuclear power waste disposal and plant decommissioning also involve substantial unsolved environmental problems and costs. Finally, there are safety problems with nuclear power plant operations, and risks of diversion of nuclear fuel to weapons production. Because nuclear power requires safety and high capital costs for construction, waste disposal and decommissioning, nuclear power is not an economical energy option today in the United States; no new U.S. plants have been constructed for more than twenty-three years.[6] Indeed, nuclear power is the world's slowest growing energy source. Worldwide some ninety nuclear plants have been retired after serving fewer than seventeen years. Though nuclear power is widely used in Japan and Europe, there is now considerable public resistance to construction of new nuclear plants. This is particularly true in Japan following a recent major accident. Germany is phasing out its existing nuclear plants, while France (which gets more than seventy-five percent of its electricity from nuclear power), has put a moratorium on nuclear plant construction.[7]

Waste to energy power from trash incineration also is excluded from this analysis because it is highly polluting, and because recycling options for wastes are much cleaner and more economical.

Additionally, large hydroelectric dams have been excluded because of

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[5] ENVIRONMENTAL COSTS OF ELECTRICITY 25 n.39 (Richard Ottinger et al. eds., Oceana Pub, Inc. 1991); Meridian Corp., *Energy System Emissions and Material Requirements*, prepared for the Deputy Assistant Secretary for Renewable Energy, U.S. Dep't. of Energy (1989) (showing nuclear CO_2 emissions at 8.590 tons/GWh). One recent report, however, asserts that nuclear fuel cycle CO_2 emissions could become comparable to CO_2 emissions from fossil fuel plants if nuclear plant construction were greatly accelerated. LOVINS & LOVINS, *supra* note 2, at 8.

[6] Christopher Flavin & Nicholas Lenssen, *Nuclear Power Nears Peak*, WORLDWATCH NEWS BRIEF, Mar. 5, 1999, *at* http://www.worldwatch.org/alerts/990304.html; Energy Info. Admin., *International Energy Outlook 2001: Nuclear Power* 90, *at* http://www.eia.doe.gov/oiaf/ieo/nuclear.html (last visited Mar. 11, 2002) [hereinafter EIA, *Nuclear Power*].

[7] EIA, *Nuclear Power*, *supra* note 6, at 86.

their expense, their unreliability (the vulnerability of dams to droughts has recently been demonstrated in Brazil and the west coast of the United States), and the environmental damage that results from flooding large areas of productive and often populated lands and from the carbon dioxide released from decaying vegetation in the dam reservoirs.

III. RENEWABLE ENERGY RESOURCES

Renewable energy resources hold great promise for meeting the energy and development needs of countries throughout the world. This promise is particularly strong for developing countries where many areas have not yet committed to fossil fuel dominance.

Renewables include a considerable number of proven and emerging technologies. For instance, electricity can be produced from sunlight via photovoltaic cells for individual buildings or communities of buildings, for the production of central station power, and for localized tasks such as providing homes with hot water or space heating. Other renewable sources of power include fields of parabolic collectors that focus on a fixed hot water source[8] or solar ponds, crop waste cellulose that can be gasified for heat, electric and transportation applications, and power generated from wind, geothermal applications, ocean tides and waves, temperature variations between ocean surfaces and depths, hydropower installations, biomethanation (power from agricultural wastes), and biomass crops grown for energy use.[9]

Use of renewable resources has grown markedly in the past decade. Many countries have significant renewable installations and programs. For example, India is a world leader in the use of renewable energy. India is perhaps the only country in the world to have created a cabinet-level department for promotion of renewable energy technology—the Ministry of Non-Conventional Energy Sources (MNES).[10] India has pioneered research

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[8] A large solar thermal project was constructed by Luz International, Ltd., which began construction of nine (I–IX) Solar Electric Generating System (SEGS) plants in the Mojave Desert in 1984. *Profiles, supra* note 3. Generation costs have decreased by more than half since Luz built the first plant. The cost of the SEGS I plant was $62 million ($4500/kW), and generation costs were 24 ¢/kWh (in 1988 real levelized dollars). *Id.* Investing $3400/kW in improving technology reduced the generation costs of SEGS III–VI to 12 ¢/kWh; and investing $2875/kW reduced costs further to between 8 and 10 ¢/kWh for SEGS VIII and IX. Luz was able to finance the SEGS plants by raising over $1 billion and taking advantage of the available federal and state tax credits. *Id.* However, ultimately, Luz International was forced to file for bankruptcy and turn over the SEGS plants to its investors. *Id.* The following factors contributed to Luz's financial difficulties: the piecemeal fashion of extending energy tax credits for solar energy property, building SEGS IX in seven months to obtain the tax credit, the fact that Luz could not apply the credit against the alternative minimum tax established in the 1986 Tax Reform Act, and the size limitation of Public Utility Regulatory Policies Act's (PURPA) Qualifying Facility specifications for mandatory utility renewable purchases. *Id.*

[9] *See Profiles, supra* note 3 (discussing the use of various renewable fuel sources).

[10] TATA Energy Research Inst., *Overview: Renewables in India, at* http://www.teriin.org/enew/overview.htm (last visited Mar. 11, 2002); *see also* Gov't of India, *Ministry of Non-Conventional Energy Sources, at* http://www.mnes.nic.in (last visited Mar. 11, 2002) (providing information on the Ministry, its administrations, and achievements).

in renewable energy applications through its internationally renown TATA Energy Research Institute. Technology support centers have been created in India's universities to promote renewable technology support to manufacturers and to certify the quality of technology procured by the government.[11] India has also embarked on manufacturing a number of renewable technologies, and in 1987, created a Renewable Energy Development Agency (IREDA) to fund renewable energy projects.[12]

The results of these efforts have been remarkable. India now has cumulative installations of 3.02 million family-size biogas plants, 32 million modern cook stoves (including 485,000 solar cookers), 500,000 solar hot water systems, 57 megawatts of photovoltaic installations (including 3371 water pumps, 1920 kilowatts of electric power systems, 40,000 community and street lighting units, 100,000 home electric systems, and 250,000 home and community lighting systems), 34.36 megawatts of biomass gasifier electric systems, 222 megawatts of bagasse cogeneration units, 1167 megawatts of wind farms, and 217 megawatts of mini- and micro-hydroelectric generating units.[13]

Since India created MNES in 1993, major increases in these installations have been achieved. This increased penetration of renewables is largely attributable to the conversion from a technology-oriented subsidy program to one that focuses on fostering markets through indirect subsidies[14] to meet communities' end-use needs such as lighting, communications, pumping, and industrial uses.[15] In addition, MNES is now organized into sectoral groups of rural energy, urban/industrial energy, and power generation, rather than by technology.[16] Quality control, systems maintenance, and personnel training also have contributed to India's successes.[17] It should be noted, however, that India, like most countries, still gets the preponderance of its energy from coal and large hydroelectric projects.[18]

Other countries also have extensive renewable energy programs. Indonesia has a goal of providing one million solar homes and already has delivered 200,000 systems towards this goal through installment purchases and the assistance of World Bank and Global Environmental Facility (GEF) loans.[19] In Europe, Finland extracts about thirty percent of its electricity

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[11] TATA Energy Research Inst., *supra* note 10.

[12] *Id.*

[13] TATA Energy Research Inst., *Estimated Potential and Installed Capacity of Major Renewable Energy Technologies in India*, *at* http://www.terrin.org/renew/estpot.htm (last visited Mar. 11, 2002).

[14] These indirect subsidies include financial incentives such as low interest loans, financing packages, 100% depreciation allowance for equipment during the first year, waiver of excise duties for renewable technologies and their components, and exemption from central and state sales taxes. TATA Energy Research Inst., *supra* note 10.

[15] *Id.*

[16] *Id.*

[17] *Id.*

[18] TATA Energy Research Inst., *Thermal Power Generation. Key Issues in India*, *at* http://www.teriin.org/features/artl45.htm (last visited Mar. 11, 2002).

[19] Int'l Energy Agency (IEA), *Survey of National and International Standards, Guidelines, and QA Procedures for Stand-Alone PV Systems* (1999), *at*

from renewable resources, the majority of which comes from biomass.[20] The other Scandinavian countries and Germany also have significant renewable energy programs.

Renewable resources are attractive for developing countries where some two billion people have no access to electricity. In 1990, fifty-six percent of the world's rural population had no access to electricity,[21] and today ninety percent of the entire African population is without electricity.[22]

In rural areas, renewable resources often are far cheaper than traditional resources that have heavy capital costs for generating equipment as well as demanding transmission and distribution requirements. Wind, photovoltaic, biomass, and hydroelectric resources are the most advantageous and widely used renewable resources for energy in developing countries today.[23]

Wind energy for electricity production is a mature, competitive, and virtually pollution-free technology widely used in many areas of the world. It is also still used to some extent for pumping water; however, wind electric systems have some siting problems such as aesthetics and the real, but decreasing, danger to birds that fly into the blades.[24]

Denmark pioneered the use of wind energy for electricity. The country currently generates fourteen percent of its electricity via wind.[25] A partial redemption of the Danish carbon dioxide tax levied on all electricity, regardless of origin, provides the basic support mechanism for Denmark's wind energy. 4800 wind turbines are in operation in Denmark, more than eighty percent of which are owned by wind energy cooperatives or by individual farmers. Approximately 100,000 families either own shares in wind cooperatives or own their own wind turbines.[26] Wind power has become a big business for Denmark. It exports windmills to thirty-five countries and produces more than fifty percent of all the devices

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http://141.51.158.34/iea/DevelopingCountries/developingCountries.htm [hereinafter *Survey of PV System Standards*].

20 Kurtis Parker & Harri Makinen, *Finland Renewable Energy Technologies, at* http://www.tradeport.org/ts/countries/finland/isa/isar0005.html (last visited Mar. 14, 2002).

21 Food & Agric. Org. of the United Nations, *Solar Energy, Power for Rural Development, at* http://www.fao.org/NEWS/2000/001003-e.htm (last visited Mar. 11, 2002).

22 K. Jechoutek, *Empowering the Future: The Dawn of a New Energy Service Worldwide*, in WORLD BANK, SIXTH ANNUAL SYMPOSIUM ON GLOBAL RESPONSIBILITY (April 2000).

23 WORLD ENERGY ASSESSMENT, *supra* note 1, at 369.

24 Modern machines have generally minimized the danger to raptors.

25 Danish Wind Indus. Assoc., *Danish Wind Turbines. An Industrial Success Story, at* http://www.windpower.dklarticles/success.html (last visited Mar. 11, 2002) [hereinafter *Danish Wind Turbines*]; SolarAccess.com, *Eco-Economy Offers Alternative to Oil, says Author, at* http://www.solaraccess.com/news/story.jsp?storyidl213 (last visited Mar. 11, 2002).

26 *Danish Wind Turbines, supra* note 25. U.S. windpower, Inc. (USW) currently operates 23 wind plants, ranging in size from 25 MW to 85 MW, which provide power to the Pacific Gas and Electric Company. The cost of a Model 56-100 turbine is approximately $1200/kW with generation costs of 7 to 9 ¢/kWh, as opposed to 12 ¢/kWh in 1981. Utilities have provided financial support so that USW could develop a larger, 360 kW horizontal-axis turbine, the 33M-VS. Nat'l Renewable Energy Lab., *Performance Improvements Make Wind Power Economical, at* http://www.nrel.gov/documents/profiles.html#us/ (last visited Mar. 11, 2002).

manufactured in the world.[27] Germany also has extensive wind applications and is a large wind machine manufacturer and exporter. Based on these successful models, the potential exists for developing countries to manufacture and market their own wind machines as well.

Solar energy presents great development opportunities in developing countries, particularly because most of them receive substantial sunlight throughout the year. In rural areas unserved by electric grids, solar photovoltaic energy can provide basic services such as refrigeration, irrigation, communications, and lighting. For example, China currently is promoting widespread use of photovoltaic energy and is manufacturing photovoltaic cells for export. Solar thermal energy is particularly suited to respond to the domestic, agricultural, industrial, and commercial sectors' large demands for heat. In addition, it is applied successfully to water heating, industrial-process heating, drying, refrigeration and air conditioning, cooking, water desalination and purification (through use of solar ponds), pumping, and power generation.[28]

Solar energy often is far more efficient than existing energy uses. Used in the rural areas of many developing countries to provide night lighting, a photovoltaic compact fluorescent light system is 100 times more efficient than kerosene and 500,000 times more efficient than candles.[29] Photovoltaic systems also avoid the high costs and pollution problems of standard fossil-fueled power plants.[30]

Particularly for developing countries, biomass is an attractive energy resource because it uses local feedstocks and labor. Crop wastes, cellulosic biomass, and crops raised to provide energy feedstocks on otherwise barren lands are effective energy sources for industry, electricity production, and home heating and cooking if used in efficient modern stoves or gasified. Brazil has pioneered the growth of energy crops of sugar to produce ethanol for use in vehicles, thus halving its oil imports.[31]

As the largest renewable resource in use today, hydroelectricity is primarily generated through large dams that flood extensive tracts of land, creating environmental problems, and displacing people and agriculture. The dammed water also creates some carbon dioxide and methane (another greenhouse gas) emissions from decaying vegetation. However, adding power to existing dams does not create these problems, so placing generating equipment at existing dams has great worldwide potential with

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27 Warren Hoge, *In This Energy Project, No Tilting at Windmills*, N.Y. TIMES, Oct. 9, 1999, at A4.

28 TATA Energy Research Inst., *Solar Thermal Technology*, *at* http://www.teriin.org/renew/tech/solth/about.htm (last visited Mar. 11, 2002).

29 Fredrik Lundberg, *PV Lighting*, INTERNATIONAL ASSOCIATION FOR ENERGY-EFFICIENT LIGHTING (IAEEL) NEWSLETTER, *at* http://www.iaeel.org/IAEEL/NEWSL/1996/tva1996/LiRen_a_2_96.html (last visited Mar. 11, 2002).

30 UNITED NATIONS DEVELOPMENT PROGRAM, THE CLEAN DEVELOPMENT MECHANISM: ISSUES AND OPTIONS (Jose Goldemberg ed., 1998), *available at* http://www.undp.org/seed/eap/Publications/1998/1998a.html.

31 Convention on Climate Change, *The Alcohol Program*, *at* http://www.mct.gov.br/clima/ingles/comunic_old/alcohol2.htm (last visited Mar. 11, 2002).

no environmental consequences. Run-of-the-river hydroelectric systems are technologically more complex, but also result in minimal environmental consequences. Lastly, small dams can reduce the environmental harms of hydroelectric power production.

Hydrogen is the most promising alternative fuel for the future. It currently is produced from natural gas in a process less polluting than oil- or coal-fired power plants; but with improved and more economic technology, hydrogen also can be produced from photovoltaic or wind-powered electrolysis, separating hydrogen from water, and from some seawater algae.[32] In the near-term, hydrogen will most likely be used in fuel cells that can power vehicles or stationary electric generators. Hydrogen combustion is virtually pollution free (recombining hydrogen and oxygen to release water), and the gas is economically transportable in pipelines. The principal challenge to widespread hydrogen use is reducing the cost of both hydrogen production and fuel cells. Also, an infrastructure must be constructed to transport the hydrogen (although existing natural gas pipelines can be used if treated), and a distribution network must also be established for vehicle use. Developing this infrastructure will involve large initial capital expenses; however, hydrogen is sufficiently developed today that it is beginning to be used as an electric power source, and a number of major vehicle manufacturers plan to market fuel cell vehicles in the next few years.[33]

IV. RENEWABLE ENERGY BARRIERS

The more widespread use of renewable resources is constrained by the following factors:

1) The public lacks information about the availability, costs, and benefits of renewable energy technologies.[34]

2) Project initiators and managers often fail to understand the energy and related social needs of rural communities, fail to adapt projects to meet these needs, and fail to involve the communities in project design. This failure at the community level may be the most significant barrier. If projects fail to meet their intended local needs, renewable energy applications can be impeded for decades. Rural community residents can ill-afford unsuccessful experiments.

3) Governments and agencies frequently fail to assess costs and benefits correctly when comparing renewable to traditional energy options—particularly given the heavy subsidization of traditional energy resources—and fail to value resources on a life-cycle basis, accounting for externality costs to society.

4) Many government, commercial, and industrial officers prefer known

32 Anastasios Melis et al., *Sustained Photobiological Hydrogen Gas Production upon Reversible Inactivation of Oxygen Evolution in the Green Alga* Chlamydomonas reinhardtii, 122 PLANT PHYSIOLOGY 127 (2000).

33 WORLD ENERGY ASSESSMENT, *supra* note 1, at 299–302.

34 Government, commercial, and industrial energy officials often share this lack of knowledge.

fossil resources to newer renewable resources.[35]

5) Pool power dispatchers, utilities, and government procurement agencies discriminate against intermittent energy sources such as solar and wind power, even though these resources often are available at peak times of power needs. Dispatchers often require commitments of availability and impose penalties for failure to comply that are unreasonable for intermittent resources. Utilities impose unreasonable interconnection requirements, such as excessive standby rates and cost recovery through fixed unavoidable charges (which lengthen the payback period to intermittent resource providers), as well as intermittent-generator exit fees to compensate for stranded costs that are usually fictitious. Moreover, government agencies develop excessively burdensome approval requirements for interconnection of intermittent resources. Lastly, dispatchers, utilities, and government procurement regulations fail to credit intermittent resources with the benefits provided, such as peak-load reduction, value added reseller (VAR) support to prevent power surges, emissions reductions, and fuel diversity.[36]

6) Large, well-financed sales teams encourage traditional energy sources, and decision makers have a common financial stake in these sources.

7) There is a paucity of sales forces and financial and political clout to promote renewable resources effectively.

8) Few personnel are trained in renewable energy equipment installation, operation, and maintenance.

9) There is a lack of knowledge and personnel trained in financing mechanisms to support renewable energy projects.

10) General and energy-specific barriers discourage foreign investment, such as import duties on renewable equipment.

11) Research and development is needed to improve renewable technologies and lower initial costs.

Renewable energy resources require substantial up-front capital costs; however, solar, wind, geothermal, and small hydroelectric technologies achieve considerable savings from costless fuels and low maintenance requirements. In developing countries, financing is required to raise the necessary initial capital for technologies that are not yet commercially competitive.

Despite this formidable list of constraints, renewable energy is the world's fastest growing energy supply resource.[37] The barriers listed can be and have been overcome. For example, small hydro, geothermal generation, biomass, wind farms, and photovoltaics have been established technologically in niche applications and are sufficiently inexpensive to supply electricity to power grids.

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[35] Banking and other financing officials may also share this preference.

[36] *See generally* ENERGY AFTER RIO: PROSPECTS AND CHALLENGES, *supra* note 1, § 4.1.5 (exploring how widespread use of renewable energy technologies could provide energy to meet the challenges of sustainable development).

[37] LOVINS & LOVINS, *supra* note 2, at 8.

V. MECHANISMS FOR RENEWABLE ENERGY IMPLEMENTATION

Public and private sectors worldwide (in industrial as well as developing countries) have successfully realized renewable energy solutions through such mechanisms as economic and market incentives, government procurement programs, utility regulatory requirements and programs, standards, government-encouraged voluntary programs, and citizen-suit enforcement measures. These measures are by no means mutually exclusive, and in many cases more than one mechanism has been applied. They are categorized here according to their predominant characteristic.

A. Information

1. Education and Training

Education is vital for informing the public, energy decision makers, non-government organizations (NGOs), and the private sector about available renewable energy options, application, and costs and benefits. This knowledge is also essential to build the political support necessary to enact appropriate legislative measures that will promote renewable resource use. Educating the public should start at the primary and secondary school levels and continue as a part of professional and technical training for those whose jobs will involve energy-related decisions.

Architects, engineers, builders, commercial enterprise managers, trades people, and government officials at all levels should be educated about available, economical renewable energy technologies and applications, about legal requirements that have been adopted to promote energy efficiency and renewable resources, and about the costs and benefits of measures they can take voluntarily or pursuant to legal requirements.[38] Retail sales staff, contractor installers, and maintenance/service personnel must also understand the benefits of renewable technologies and realize that they can personally benefit from promoting these products to end-users.

It is also essential that technical staff be trained and available to maintain and operate all renewable systems installed. Failure to perform this function can discourage rather than promote renewable energy projects. Often the staff of equipment providers can deliver some or all of this requisite training, but governments must rigorously supervise private-sector systems maintenance as well as operation training and performance.

Governments must conduct or contract for much of the necessary renewable energy education. They must create a legislative framework for this educational effort and appropriate or seek grants for the necessary funding. Governments also should provide staff to do mailings, conduct

[38] The usual means of compensating architects and engineers worldwide, based on a percentage of building and equipment costs, has the perverse incentive of discouraging least cost solutions. LOVINS & LOVINS, *supra* note 2, at 18. It has been estimated that this incentive design has led the United States to misallocate about $1 trillion in air conditioning equipment and energy needed to operate the buildings had they been optimally designed. *Id.*

workshops and conferences, and educate the media

As commercial enterprises learn that renewable energy measures can be profitable, they also will participate in the educational efforts. NGOs advocating renewable energy measures can perform an important part of the educational effort by creating internet sites and listing services to disseminate information about renewable and efficiency resource opportunities, advantages, and costs. Political leaders can play an important educational role as well.

2. Ratings

Rating companies on their products' greenness also can be an effective educational tool. For example, major environmental organizations from the United States, together with consumer and industry participants, and the NGO Center for Resource Solutions, have established a "Green-e" clean electricity certification program. This program permits power providers to display the Green-e logo if they meet rigorous green conditions: fifty percent plus renewables, and for the remaining fifty percent, non-renewables with low emissions; full disclosure of electricity sources; no nuclear power generation; and one year after deregulation, at least five percent new renewables, increasing five percent per year until twenty-five percent is reached. Power companies must also commit to biannual reviews of truth in advertising as well as annual independent audits of renewable offerings. The rating is designed to inform electricity consumers of assured superior green power offerings.[39] With the advent of deregulation in the United States, a Power Scorecard also has been developed to rate the greenness of power plants, enhancing informed consumer choice. Pennsylvania has adopted the Power Scorecard and regulatory authorities in several states are also considering adopting the Power Scorecard.[40]

3. Awards

Lastly, many governments and private organizations have established award programs to recognize companies, private organizations, and products that accomplish outstanding energy efficiency and renewable achievements. A number of government agencies have also created information programs; for example, the United States Federal Trade Commission has issued Energy Guide labels, and the United States Environmental Protection Agency developed the ENERGY STAR program, which provides awards for using green power.[41]

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[39] Center for Res. Solutions, *Green-e Renewable Electricity Certification Program, Overview of Standard, at* http://www.green-e.org/what_is/standard/standard.html (last visited Mar. 11, 2002); *see also* Center for Res. Solutions, *Green-e Renewable Electricity Certification Program, Summary, at* http://www.green-e.org/what_is/program_sum/program summary.html (last visited Mar. 11, 2002) (explaining the program's benefits for consumers).

[40] Pace Energy Project, *Power Scorecard, at* http://www.powerscorecard.org (last visited Mar. 11, 2002).

[41] HOWARD GELLER ET AL., AM. COUNCIL FOR AN ENERGY-EFFICIENT ECON., APPROACHING THE

B. Assessment and Adaptation to Local Needs

Renewable energy promotion cannot succeed without assessing local needs, adapting projects to meet those needs, and including local communities in project design. While these requisites seem obvious, they are too often overlooked—and not only in the context of renewable projects. Often, well-meaning international and national agencies, equipment suppliers, and project funders and promoters are ignorant of community needs, customs, and cultures. They ignore local input to the peril of their projects, and promotion of renewable resources throughout the country or region is affected.

Renewable energy can facilitate economic and social development in communities, but only if the projects are intelligently designed and carefully planned with local input and cooperation. Particularly in poor rural areas, the costs of renewable energy projects will absorb a significant part of participants' small incomes. Communities cannot afford unsuccessful projects that may fail to meet development objectives and leave participants destitute.

Governments promoting renewable energy projects should require local-needs assessment and community participation in project designs. All project designers, architects, engineers, suppliers, technical operation and maintenance personnel, educators, trainers, project funders, government officials, NGOs, and others with an interest in design and execution of renewable energy projects must participate in local assessment efforts and be trained to meet these needs adequately.

C. Environmental Impact Statements

Governments can also promote renewable resources by requiring an environmental assessment (EA) or impact statement (EIS) for all major energy-related projects. The National Environmental Policy Act of 1969[42] requires an EIS for all major "federal actions significantly affecting the quality of the human environment."[43] The EIS must detail the environmental impacts of any proposed action, any unavoidable adverse environmental effects, alternatives to the proposed action, short versus long-term effects, and any irreversible commitments of resources. EIS assessments that do not conform to NEPA can be challenged in court, a tool that effectively assures that the consequences of proposed actions be considered before they are implemented. More than 175 countries have enacted their own environmental impact legislation and a number of international environmental treaties also require assessments.[44] The World Bank and

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KYOTO TARGETS: FIVE KEY STRATEGIES FOR THE UNITED STATES 7 (1998).

[42] 42 U.S.C. §§ 4321–4730e (2000).

[43] *Id.* § 4332(c).

[44] For example, the United Nations Convention on the Law of the Sea requires an impact statement. U.N. Doc. A/CONF. 62/122, *reprinted in* 21 I.L.M. 1261 (1982), *available at* http://www.un.org/Depts/los/index.htm.

other multilateral banks require similar assessments under their administrative procedures.[45]

In the same vein, a number of states require utilities to disclose emissions and power generation sources.[46] States typically require information such as generation sources, fuel mix, fuel emissions, kilowatt per hour, price volatility, and contract terms.

Market studies and polls consistently show that consumers want clean energy resources. In competitive retail markets, this disclosure requirement enables consumers to make informed decisions about the environmental consequences of their choice among suppliers, advantaging pollution-free renewable resources.

D. Economic and Market Mechanisms

1. Removal of Fossil-Fuel Subsidies

Legislation to repeal and remove subsidies for production and use of fossil fuels is the most direct measure to promote renewable energy. Subsidy removal not only is a costless measure, but, by definition, it is a certain revenue-enhancing one. In many countries fossil-fuel subsidies amount to tens of billions of dollars or more.[47] Global annual fossil-fuel subsidies were estimated at about $250 to $300 billion in the mid-1990s, and that figure did not include the huge U.S. subsidies required to secure the supply of oil imports that have been estimated to produce a true oil cost of more than $100 per barrel.[48] Revenues saved from subsidy removal can be used to promote renewable energy alternatives internally.

The problem in achieving subsidy removal is political—recipients of subsidies get addicted to them and feel they cannot survive without them. But these subsidies both encourage increased use of fossil fuels and discourage the use of clean alternatives by making them less economically competitive.

Subsidies are usually granted by governments under the pretext of protecting domestic jobs, promoting use of domestic resources, and protecting the poor from high energy prices. In fact, subsidies are enacted under pressure from the wealthiest elements of society to reduce their costs and, in the case of companies, to increase their profits. In most developing countries, the poor do not even have electricity or automobiles and thus receive virtually no benefit from the subsidies. It would be more efficient

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45 Nicholas Robinson, *Environmental Law Systems for Sustainable Energy*, Proceedings of the CleanEnergy2000 Conference, Geneva, Switzerland (January 24–28, 2000).

46 MARTIN KUSHLER, AM. COUNCIL FOR AN ENERGY-EFFICIENT ECON., AN UPDATED STATUS REPORT OF BENEFIT PROGRAMS IN AN EVOLVING ELECTRIC UTILITY INDUSTRY 12 (1998). States with disclosure requirements by law or commission order include California, Connecticut, Illinois, Maine, Massachusetts, Michigan, Montana, Nevada, New Hampshire, New Jersey, Pennsylvania, Rhode Island, and Vermont. *Id.*

47 NORMAN MEYERS & JENNIFER KENT, PERVERSE SUBSIDIES: HOW TAR DOLLARS CAN UNDERCUT THE ENVIRONMENT AND THE ECONOMY 76 (2001).

48 LOVINS & LOVINS, *supra* note 2, at 19.

and far less costly to subsidize the energy needs of the poor directly than to subsidize fuels for all users. In many countries, fossil fuels are imported at great cost, displacing investment in basic needs such as education, health care, and the environment. In those countries that have domestic fossil resources, more beneficial use can be made of the subsidy funds to retrain and place workers and acquire clean energy resources that also can be domestically produced.

Developing countries such as China are eliminating coal subsidies, downsizing coal production, and creating major renewable energy industries that can be exported worldwide. China's actions are particularly remarkable. Between 1990 and 1997, annual fossil-fuel subsidies in China fell from $24.5 billion to $10 billion.[49] Coal subsidy rates fell from sixty-one percent in 1984 to thirty-seven percent in 1990 to twenty-nine percent in 1995, and further since then.[50] Petroleum subsidies fell from fifty-five percent in 1990 to two percent in 1995.[51] Over 40,000 coal mines were closed between 1999 and 2000, with more expected to be shut down within the next couple of years.[52]

Poland has decreased its fossil-fuel subsidies by $3 billion per year. These reductions led to an overall thirty percent decrease in the amount of coal used between 1987 and 1994.[53] Since 1990, Russia has lowered fossil-fuel subsidies by more than fifty percent.[54] The United Kingdom decreased coal subsidies from $7 billion in 1989 to zero in 1995.[55]

On the other hand, some countries are not making comparable strides in reducing incentives and subsidies for unsustainable resources. For instance, the United States provides as much as $14 billion a year in direct fossil-fuel support,[56] and the current administration is proposing still higher fossil-fuel subsidies. Germany still requires its electric utilities to purchase domestic coal and has increased the amount of money funding subsidies by more than fifty percent. Canada's tax incentives amount to $6 billion per year. France and Japan, while reducing the amount of money available for fossil-fuel support, still provide substantial incentives for the use of coal—$722 million and $149 million per ton respectively.[57]

The political difficulties of eliminating subsidies and the transition problems for local economies in fossil-producing countries cannot be minimized. Nevertheless, countries as diverse as Brazil, China, the Czech Republic, India, the Netherlands, Poland, the United Kingdom, and Russia have reduced or eliminated fossil-fuel subsidies successfully.[58] Eliminating

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49 CHRISTOPHER FLAVIN & SETH DUNN, RISING SUN, GATHERING WINDS: POLICIES TO STABILIZE THE CLIMATE AND STRENGTHEN ECONOMIES 28 (1997).

50 Energy Info. Admin., *China: Environmental Issues*, *at* http://www.users.qwest.net/~kyopak/chinaenv.html (last visited Mar. 11, 2002).

51 *Id.*

52 Coal Portal, *China*, *at* http://www.coalportal.com/members/documents/Exporters-f/China-f.html (last visited Mar. 11, 2002).

53 FLAVIN & DUNN, *supra* note 49, at 26.

54 *Id.*

55 *Id.*

56 MEYERS & KENT, *supra* note 47, at 85.

57 FLAVIN & DUNN, *supra* note 49, at 27.

58 *Id.* at 25–33.

fossil-fuel subsidies is a *sine qua non* of promoting renewable resources.

2. Inclusion of Externality Costs

A legislative or regulatory requirement for consideration of externality costs can promote clean energy use. When the costs of fossil-fuel use are compared to the costs of clean energy resources, the costs to society from fossil-fuel emissions are generally ignored, thus effectively placing a zero value on these costs.[59] Numerous studies have now shown that these external costs are substantial, especially with respect to the increased incidence of human health problems and early mortality.[60] Some of these studies calculate that, in developed countries, the externality costs of burning coal for electricity can be greater than the generation costs.[61] In many developing countries, fossil fuels are used not only for vehicles, electric power, and commercial and industrial energy, but also for the heating of homes and commercial buildings and for home cooking, thus posing horrific health threats because the pollution is in a confined area. No accurate assessment can be made of the comparative costs of clean energy without inclusion of externality costs.

3. Use of Life-Cycle Costs

The costs of introducing clean energy resources often entail substantial up front investments, but the savings over the life of these resources make them cheaper than fossil-fuel alternatives. This phenomenon is particularly evident for efficiency measures and for solar, hydroelectric, and wind energy resources, where the initial cost of equipment acquisition can be considerable, but the total absence of fuel costs and low maintenance costs make them more economical than fossil fuels over their anticipated life time use. The costs of fossil fuels should always be compared to efficiency and renewable resource costs on a life-cycle basis. Legislative or regulatory requirements for life-cycle pricing are feasible and costless.

4. Removing Investment and Import Restrictions

Many developing countries impose high duties on equipment imports, including equipment required for renewable energy. If renewable energy use is to be promoted, these duties must be eliminated, as must many restrictions on investment of foreign capital in order to create a climate encouraging investment.

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59 ENVIRONMENTAL COSTS OF ELECTRICITY, *supra* note 5, at 25 n.39 (1991).

60 For example, it has been estimated that just the health care cost of air emissions in Cairo may exceed $1 billion a year. *See generally* BERNSTEIN ET AL., *supra* note 1, at 5 (1999) (discussing the impacts of electricity on socioeconomic development).

61 ENVIRONMENTAL COSTS OF ELECTRICITY, *supra* note 55, at 137.

5. Pollution Taxes

Taxing pollutants or polluting fuels can help effectively promote emission reductions in the marketplace because such taxes make the polluters pay the externality costs of the damages to society from their pollution. They raise the price of emissions-intensive goods and lower profits for fossil-fuel use, thus allowing market forces to encourage adoption of renewable resources.

Taxation of polluting fuels directly promotes renewable resources.[62] Pollution taxes (including carbon emission taxes) have been imposed in Brazil, Denmark, Finland, Italy, Latvia/Lithuania, Sweden, and the United Kingdom (which funds its Renewable Purchase Obligation subsidies with electricity taxes). Sweden instituted environmental taxes in 1991 and included NO_x emissions in 1992.[63]

Pollution taxes are politically difficult because inevitably they affect some energy-intensive industries and jobs. However, if pollution taxes are offset by reductions in other business taxes, the taxes can produce a net economic benefit.[64] The political difficulty is illustrated by the fact that in a number of countries that have legislated such taxes, major industries have been exempted to avoid competitively disadvantaging domestic production. Ideally, pollution taxes should be imposed internationally to eliminate adverse competitive effects. However, the competitive effects of pollution taxes can be ameliorated with border tariffs and rebates. An international tax on fossil fuels or on carbon dioxide emissions could effectively fund technology transfer and acquisition of sustainable energy resources by developing countries.

6. Technology Incentives

While long-term subsidization of any fuel, technology, or product distorts the market and is therefore undesirable in the long term, temporary subsidies to bring new technologies into the marketplace has proven effective, useful, and often essential to accelerate market acceptance. Also, where fossil-fuel subsidies persist, non-fossil-fuel subsidies are justifiable to

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62 The potential of carbon taxes as a funding mechanism is enormous. A carbon tax of just $1 per ton on fossil-fuel use in Organization for Economic Cooperation and Development (OECD) countries at 1990 emission levels would yield annual revenues of $4.3 billion. Two years of such a tax would support the solar technology research and development needs of the world over the next twenty years. Such a tax in the United States would increase energy prices less than 0.3% or less than $6 per capita per year. Michael Jefferson, *Carbon Dioxide Emissions 1990–1996*, WORLD ENERGY COUNCIL J., July 1997, *at* http://www.worldenergy.org/wec-geis/publications/open.plx?file=archives/techpapers/other_tech_papers/WECco2rpt97.html (last visited Mar. 11, 2002).

63 *Database of Environmental Taxes and Charges for Sweden*, *at* http://europa.eu.intlcomm/environmentlenveco/env_database/sweden2000.htm (last visited Mar. 11, 2002).

64 S. BERNOW ET AL., TELLUS INST., ECOLOGICAL TAX REFORM: CARBON TAXES WITH TAX REDUCTION IN NEW YORK (1997), *available at* http://www.tellus.org/energy/publications/nyexecsm.html.

level the playing field.

Denmark's introduction of wind power provides a good example of effective use of such temporary incentives. From the start of its wind power program in 1976 through 1996, the Danish government spent $75 million on wind turbine research and development. The government provided subsidies for up to thirty percent of the investment costs of a turbine in 1980, reduced the subsidy to fifteen percent in 1984 and repealed it in 1989 as the market accepted the new technology. The government now requires Danish power companies to pay eighty-five percent of the retail electricity price of wind energy, paid for with rebates from carbon taxes on fossil fuels. Consumers now pay less for wind power than for coal power. As a result of this program, Denmark accounts for more than half of the world sales of wind turbines. Its turbine production provides about sixty percent of new wind turbines installed throughout the world, "produces revenues of nearly $1 billion a year and has provided over 16,000 jobs. Today, 100,000 Danish families own wind turbines or shares in wind cooperatives."[65]

The Poland Efficient Lighting Project, financed by the Global Environment Fund (GEF) of the World Bank and administrated by the International Finance Corporation, established a two-year program to subsidize compact fluorescent lamp sales.[66] In 1997, at the end of the program, some 1.6 million lamps had been installed and ninety-seven percent of buyers indicated intent to buy these efficient lights again.[67]

Germany has had great success with its Electricity Feed Law (EFL), which subsidizes the purchase of renewable resources. EFL requires utilities to pay ninety percent of the retail residential price for electricity produced by wind, solar, hydropower and biomass resources.[68] For wind resources, the law also provides subsidies based on electricity output or capital costs. By the end of 1997, Germany had an installed wind capacity of 2081 MW, the highest in the world. EFL also stimulated a four hundred fifty percent increase in photovoltaic (PV) installations from 1991 to 1997, with a thirty-seven percent drop in prices. German companies such as Siemens now lead the world in PV sales. Germany has begun a 100,000 Roofs PV program—with private banks issuing low interest loans—that promises to be the largest single PV subsidy program in the world.[69]

Sweden used a competition among suppliers to encourage manufacturers to improve the efficiency of a variety of home appliances. The improved performance of the winning refrigerator-freezer model was remarkable, using more than thirty percent less electricity than the most efficient model currently on the market. The U.S. Department of Energy has implemented similarly successful competitions under its "Golden Carrot"

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[65] CURTIS MOORE & JACK IHLE, RENEWABLE ENERGY POLICY OUTSIDE THE UNITED STATES, RENEWABLE ENERGY POLICY PROJECT ISSUE, BRIEF NO. 14, at 8 (Washington, D.C., Oct. 1999).

[66] Int'l Fin. Corp., *Poland Efficiency Lighting Project (PELP)*, *at* http://ifc.org/enviro/How/Structure/EPU/Efficiency/PELP/pelp.htm (last visited Mar. 11, 2002).

[67] *Id.*

[68] MOORE & IHLE, *supra* note 65, at 3.

[69] *Id.*

program discussed below.[70] Such competitions also effectively promote renewable energy applications.

E. Standards

Standards are a particularly effective means of assuring emission reductions because they result in higher costs for polluting fossil fuels, thus promoting renewable energy applications. Standards for minimum efficiency performance of products such as appliances, light fixtures, ballasts, motors, and the like effectively remove the least efficient products from the marketplace.

Politically, standards are set only where technological and economic feasibility has been demonstrated and where the affected businesses can be persuaded to agree on the level of control. Therefore, standards generally represent minimum rather than maximum feasible achievements. Other incentives, such as temporary subsidies, tax incentives, government procurements, information programs, labels, and other measures are required to reach maximum penetrations. Also, because many products involve rapid technological change, standards must be updated regularly or risk obsolescence.

Consideration must also be given to the applicability of standards. For example, it makes sense to require compact fluorescent lamps only where usage is reasonably high; the lamps may be uneconomical where they are used only a few hours a day. Also, information, incentives, and research and development programs may be more appropriate where standards may not be compatible with new technologies that are still relatively unproven and costly. Lastly, standards are ineffective if not enforced, so regular reporting, inspections, and enforcement mechanisms must be included, as well as training of the personnel involved in their application.

1. Renewable Portfolio Standards

In the United States and other countries, renewable portfolio standards have been adopted or are under consideration. These standards require electric utilities to purchase a certain percentage of their power from renewable resources. As of mid-1999, nine U.S. states (Arizona, Connecticut, California, Maine, Massachusetts, Nevada, New Jersey, Texas, and Wisconsin) had adopted some form of renewable portfolio standard utility requirement.[71] Massachusetts and Connecticut regulatory commissions implemented a Generation Portfolio Standard that requires each distribution company to offer a mix of generation sources meeting federal and state air

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70 LOVINS & LOVINS, *supra* note 2, at 17; M.R. LEDHETTER ET AL., PACIFIC NORTHWEST NAT'L LAB., U.S. ENERGY-EFFICIENT TECHNOLOGY PROCUREMENT PROJECTS EVALUATION AND LESSONS LEARNED (1999), *available at* www.pnl.gov/buildings/lessons_learned_ab.pdf.

71 HOWARD GELLAR ET AL., AM. COUNCIL FOR AN ENERGY-EFFICIENT ECON., MEETING AMERICA'S KYOTO PROTOCOL TARGET: POLICIES AND IMPACTS 8 (1999).

pollution standards.[72] If such standards were widely adopted, they would encourage mass production of renewable energy generation equipment, substantially reducing equipment costs, thus making renewable energy more competitive against fossil fuels.

The United Kingdom (UK) has enacted a similar Non-Fossil Fuel Obligation (NFFO).[73] After the deregulation of its electric utility industry, the UK created Regional Electricity Companies (RECs), which in 1992 were required to purchase 1500 MW of non-fossil generated power by the year 2000 in a series of auctions, five of which have taken place.[74] 3271 MW of non-fossil power were purchased at the auctions, far in excess of the 1500 MW requirement. The program's fifteen-year contracts with five-year repayment grace periods permit reasonable project financing. The auction device has driven renewable prices down to about 4.3 ¢/kWh (very close to the electricity pool price of 4.2¢). On the other hand, the intense competition arising from the auction process has favored large, deep-pocket companies and has discouraged small investors, independent developers, and the domestic renewable energy manufacturing industry. Subsidies to pay the RECs for excess costs of non-fossil resources are paid from a tax on all electricity.[75]

Denmark and Germany also have adopted utility renewable requirements.[76] The Netherlands mandates renewable purchases where utilities purchase excess power to cover avoided fuel and capacity costs. Denmark, in addition to pollution taxes and incentives for renewables purchases, has adopted a renewable portfolio standard under which a target for renewables is set legislatively and utilities are required to meet these targets. The utilities may either develop renewable resources themselves or purchase credits from other renewable generators. The extra costs of renewable purchases are passed down to all of the utility's customers.[77]

Under Japan's "Project Sunshine," the government subsidizes utilities' photovoltaic purchases to meet a Ten Thousand Roofs goal. In 1997, the government enacted a New Energy Law establishing a goal to provide 3.1% of primary energy from renewable resources by 2010 (versus 2.1% in 1996).[78] While there is no purchase requirement under the Japanese system, the government's requests to suppliers are the effective equivalent of a required standard.[79]

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[72] R. Wiser & K. Porter, *Renewable Energy Markets in State Electric Industry Restructuring*, *at* http://www.spratley.com/leap/stuff/1999.07.08.guest_perspective.php3 (last visited Mar. 11, 2002).

[73] MOORE & IHLE, *supra* note 65, at 4. The NFFO legislation has been carried forward in the U.K. Utilities Act 2000.

[74] *Id.* at 12.

[75] *Id.* at 12–15.

[76] *Id.* at 3.

[77] *Id.* at 4.

[78] *Id.* at 19.

[79] *Id.*

2. Pollution Standards

Promoting renewable energy resources can also be achieved through standards for air polluting emissions from power plants and vehicle tailpipes. The United States, most European countries, and many developing countries have adopted such standards. Power plant standards are usually adopted for emissions of sulfur dioxide, nitrogen oxides, particulates, and sometimes mercury. By making it more expensive to use fossil fuels, these standards encourage the use of cleaner alternatives such as renewables. They also reduce the health, mortality, and environmental effects of air pollutants, creating a double dividend. The costs in terms of more expensive electricity have been slight.

3. Building Codes and Standards

Most countries have adopted standards for construction of new buildings and some also have included energy requirements for the use of economic renewable resources in these building standards. The standards also have been applied to the retrofitting of existing buildings.[80] All of the IEA countries provide energy requirements in their building codes and many are strengthening them. For example, France is adopting more stringent thermal regulations for new residential and commercial buildings with the goal of improving energy efficiency by twenty-five percent.[81] Experience in the United States has shown that building codes can reduce space conditioning energy use in new buildings by twenty-five percent or more.[82]

Building efficiency standards usually require all new residential, commercial, and industrial construction to be built to a minimum energy efficiency level that is cost-effective and technically feasible. "Good practice" residential energy codes, as defined by the 1992 Model Energy Code (now known as the International Conservation Code),[83] have been adopted in the U.S. by thirty-two states, and "good practice" commercial energy codes, as defined by the ASHRAE[84] 90.1-1989 model standard, have been adopted by twenty-nine states.[85] The Energy Policy Act of 1992[86] requires all states to adopt this commercial building code standard and to consider upgrading their residential codes to meet or exceed the 1992 Model Code, but this legislative requirement has not been well enforced. Legislation to give tax credits for highly efficient new housing was

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80 Int'l Energy Agency, *Energy Efficient Updates*, *at* http://www.iea.org/pubs/newslett/eneeff/intro.htm (last visited Mar. 11, 2002).

81 *Id.*

82 GELLER ET AL., *supra* note 41, at 5.

83 Building Codes Assistance Project, *Status of State Energy Codes*, (Washington, D.C., 1999).

84 American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE).

85 GELLER ET AL., *supra* note 41, at 5.

86 Pub. L. No. 102-486, Title VII, 106 Stat. 2776.

introduced but not passed by the U.S. Congress in 1999.[87]

4. Enforcement of Standards

Every standards program depends on effective enforcement, which requires resources for framing, inspection, and enforcement processes. Theoretically, the governments adopting the standards should enforce them, but in practice governments and their regulatory agencies often come to identify with the industries or companies they regulate. Political pressures also often prevent effective government enforcement. Citizen enforcement provisions of the Clean Air Act[88] and other United States environmental statutes have provided an effective enforcement mechanism. NGOs in the United States are able to hold regulators' feet to the fire by filing suit to enforce standards. With the award of attorney's fees for such litigation, the very presence of citizen-suit provisions enables the NGOs to influence government enforcement policies.

F. Government Procurement

All governments are major energy users. Legislation or regulation that requires national, state, and municipal governments to purchase clean energy products and processes can do much to promote the use of renewable resources. Government procurements of green products also create markets that reduce prices and set an example for the private sector to follow.

The United States government is the world's largest single buyer of energy-using products, purchasing more than $10 billion worth of energy-using products each year.[89] Through legislation and executive orders, the government has required that all federal agencies must use thirty percent less energy per square foot in their buildings than they consumed in 1985, followed by thirty-five percent less in 2010, and required the agencies to acquire economic renewable resources.[90] In implementing these

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87 GELLER ET AL., *supra* note 41, at 4.

88 42 U.S.C. §§ 7401–7671(q) (2000).

89 A.K. McCane & J. Harris, *Changing Government Purchasing Practices: Promoting Energy Efficiency on a Budget*, in PROCEEDINGS OF THE AM. COUNCIL FOR AN ENERGY EFFICIENT ENV'T SUMMER STUDY (1996).

90 Energy Efficiency and Renewable Energy Network, *FEMP Helps Government Agencies to Buy Energy-Efficient Products*, *at* http://www.eren.doe.gov/success stories/femp_procurement.html. (last visited Mar. 11, 2002) [hereinafter *FEMP Helps*]; *See also AC Photovoltaic Array Demonstrated at Pentagon*, FEMP FOCUS NEWSLETTER (U.S. Dep't of Energy) Sept./Oct. 1999, *at* http://www.eren.doe.gov/femp/newsevents/femp-focus/oct99ac-priv.html (last visited Mar. 11, 2002) [hereinafter *AC Photovoltaic Array*] (citing Exec. Order No. 13123); *EPA Becomes the First Federal Agency to Buy 100 Percent Green Power*, FEMP Focus Newsletter (U.S. Dep't. of Energy) Sept/Oct. 1999, *at* http://www.eren.doe.gov/femp/femp_focus/oct99_epa_green_power.html (last visited Mar. 11, 2002) (citing Exec. Order No. 13123); *Programmatic Guidance on Energy and Energy-Related Cost Savings and Payments Under Super ESPC*, FEMP FOCUS NEWSLETTER (U.S. Dep't of Energy) Sept./Oct. 1999, *at*

requirements, the Federal Energy Management Program (FEMP) requires that renewable resources must be acquired wherever cost effective. The program has saved the government agencies, and thus taxpayers, hundreds of millions of dollars in energy and pollution quantities and costs.[91]

The United States government also includes renewable energy specifications in its contracting guide specifications used for government-financed construction and renovation projects. For example, by adopting efficiency criteria, the U.S. Navy in just one year (1998) saved an estimated $1.2 million in reduced electricity use by 500,000 efficient (T-8) fluorescent lamps, 200,000 electronic ballasts, and 20,000 renewable light-emitting diode (LED) exit signs.[92] As a part of a massive renovation program, the Departments of Defense and Energy have recently installed photovoltaic panels on the Pentagon.[93] Government procurement programs involve payment of a premium up front, but result in a substantial long-term savings.

Government procurement actions can also include conducting competitions to produce renewable energy technologies and equipment with superior energy savings. Sweden created an ingenious program under which purchasing offices issue requests for proposals guaranteeing to buy a large number of devices at specified prices if the products meet technical standards for energy efficiency and customer savings.[94]

Governments also can aggregate procurements to make production of renewable energy technologies and other energy superior equipment economical for manufacturers. The International Energy Agency has sponsored a number of technology procurement projects including renewable LED traffic signals.

1. Technology Transfer and Research, Development, and Demonstration

Government-sponsored research,, development, and demonstration projects have dramatically reduced the cost and increased the performance of renewable resources. The U.S. Department of Energy technology laboratories have pioneered in studies and effective research on renewable technologies. For example, research and development has fostered the development of compact fluorescent light bulbs that last four times longer and use less than half the electricity of incandescent bulbs.[95]

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http://www.eren.doe.gov/femp/newsevents/femp_focus/oct99_prog_guide.html (last visited Mar. 11, 2002) [hereinafter *Programmatic Guidance*] (citing Exec. Order No. 12902; 42 U.S.C. 8287(a) (2000); 10 C.F.R. § 436.36) (2001).

91 *FEMP Helps*, *supra* note 90.

92 *AC Photovoltaic Array*, *supra* note 90.

93 *Id.*

94 LOVINS & LOVINS, *supra* note 2, at 17.

95 U.S. Dep't of Energy, *Compact Fluorescent Lamps, Consumer Energy Information*, *at* http://eren.doe.gov/consumerinfo/refbriefs/ef2.html; *see also* U.S. Dep't of Energy, *Technologies for Distributed Energy Resources* (July 2002) (discussing wind energy systems) [hereinafter *Technologies*], *available at* http://www.eren.doe.gov/femp/techassistIpdt729657.pdf; Dep't of Energy, *CFL Efficiency Recommendation*, *at* http://www.eren.doe.nov/femp/procurement/cfl.html (last visited Mar. 11, 2002) (listing comparative efficiency standards for compact fluorescent light bulbs compared with alternative

Technology transfer is critical if developing countries are to take advantage of renewable technologies. Because technical assistance and education of key energy players is essential to success, governments and international agencies currently sponsor many such efforts around the world.[96]

Improved technology could enable developing countries to leapfrog to use of modern renewable technologies by adopting cleaner technologies from the start, avoiding the economic and pollution costs of more expensive traditional polluting fuels and then replacing or retrofitting them to meet pollution standards, as industrialized countries have done.

In the formerly planned economies of Eastern Europe and China, a particularly successful effort is the Energy Outreach Centers—a project overseen by the U.S. Department of Energy's Pacific Northwest National Laboratory.[97] Start-up funding was provided by the U.S. Environmental Protection Agency, the U.S. Department of Energy, the World Wildlife Fund, the U.S. Agency for International Development, the Charles Steward Mott Foundation, and the John D. and Catherine T. MacArthur Foundation.[98] Uniquely, each of the centers has been successful in becoming self-funded after the initial project funding ended. Some 250 local and international companies now participate in center projects. The centers partner with suppliers of modern renewable and energy efficient equipment and services, and in-country collaborators. Six centers were established as not-for-profit, non-governmental independent entities in Poland, the Czech Republic, Russia, Bulgaria, China, and the Ukraine. In the nine years since the first center was established, the centers have achieved remarkable results in reforming local laws to promote energy efficiency and renewables, and effectuating technology transfers.[99]

The centers have been successful in numerous areas. For example, the Russian center helped develop the first regional level code for energy building construction incorporating energy efficiency and renewables; the Czech center helped draft a national energy policy and legislation for energy labeling and standards provisions; the Polish center developed a program for utility energy efficiency and renewable investments; and the Beijing center provided expertise in instituting Integrated Resource Planning for a major utility. The centers have focused on policy reform, private sector assistance for joint energy technology and service ventures, demonstration and training, public education, and information dissemination.[100]

Development of hydrogen fuel cells for use in power plants and vehicles, refinement and reduction of the costs of photovoltaic cell manufacture, and reduction of costs of various kinds of central station solar

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options).

96 BERNSTEIN ET AL., *supra* note 1, at 1–8.

97 *See* WILLIAM CHARNDLER ET AL., PACIFIC NORTHWEST NAT'L LAB, ENERGY EFFICIENCY CENTERS IN SIX COUNTRIES: A REVIEW iii–4 (1999) (summarizing recent review of activity and progress by the project).

98 *Id.* at 4.

99 *See id.* at 3 (discussing the project's past success).

100 *Id.*

power stations are a few examples of renewable technology ongoing research and development that could drastically reduce emissions.

Unfortunately, with the advent of increased global commercial competition and increasing privatization around the world, corporations have significantly decreased their long-term research and development expenditures. Utility spending in the United States on energy research and development also drastically declined—from 1993 to 1996 expenditures dropped from $708 million to $476 million, a reduction of thirty-three percent.[101] Consequently, if the benefits of new technology are to be achieved, governments must conduct the requisite research and development themselves or legislate the funding of private research and development efforts. They could also mandate that private companies devote a percent of sales to research and development. Several countries are exploring private/government partnerships by entering into agreements with private companies to develop new clean energy technologies.

2. Recycling Programs

Recycling has become a common effort, with many countries today providing for the recycling of waste paper, glass, and metal products. For example, in Denmark, half of all waste is recycled, and eighty percent of new paper is made from used paper.[102] Almost every U.S. city has established a recycling program for paper, glass, plastic, and metal wastes, with either curbside pickup or a central recycling municipal facility.[103] Many businesses and institutions not required by law to do so also recycle their waste products on a voluntary basis.

In the industrial and commercial sectors, the recycling of wastes is also economically and environmentally advantageous. For example, the United States throws away enough aluminum to rebuild the country's commercial aircraft fleet every three months, even though recycling aluminum takes ninety-five percent less energy than manufacturing it.[104] Interface, the world's largest carpet-tile maker, estimates it cuts its materials flow by about tenfold by leasing floor-covering services instead of selling carpet and by remanufacturing old carpet.[105] Land and coal mine gas recovery turns heat trapping and hazardous methane emissions into the valuble fuel that also displaces fossil-fueled power plants.[106]

G. Industry-Government Partnerships

In recent years, a number of industries have undertaken major

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101 JOSEPH ETON ET AL., AM. COUNCIL FOR AN ENERGY-EFFICIENT ECON., RATEPAYER-FUNDED ENERGY-EFFICIENCY PROGRAMS IN A RESTRUCTURED ELECTRICITY INDUSTRY: ISSUES AND OPTIONS FOR REGULATORS AND LEGISLATORS (1998).

102 Hoge, *supra* note 27, at A4.

103 LOVINS & LOVINS, *supra* note 2, at 7.

104 *Id.*

105 *Id.*

106 *Id.*

programs to promote efficiency measures and renewable energy use, often in partnership with sponsoring governments on a shared funding basis.[107] Some of these efforts are in anticipation of Kyoto Protocol requirements and credits. Large international companies such as Dupont, Shell Oil, British Petroleum (BP), and others have instituted such programs.[108] Major U.S. and Japanese automobile manufacturers have instituted aggressive programs to develop hydrogen fuel cell-powered automobiles in collaboration with their governments.

The United States government has relied heavily on partnerships with industrial companies to achieve energy efficiency and use renewable technologies. For example, the federal government initiated the ENERGY STAR program, which provides technical assistance and recognition to companies that market efficient equipment and renewables. As of 1997, the program was saving $500 million per year and was estimated to save nearly double that by 2000.[109]

In 1995, Canada started a Voluntary Challenge and Registry (VCR) program as a part of its National Action Program on Climate Change that became an independent private/public partnership in 1997. Its purpose is to spur voluntary actions to promote use of efficiency and renewable resources, to address climate change, and publicize those actions. Two-thirds of its funding is from the private sector, and the federal and provincial governments provide the remaining funding. In its first three years, Canada's VCR program registered about seven hundred companies and organizations.[110]

A major problem for industrial energy managers in promoting renewable energy is that suppliers often do not stock renewable energy and energy-efficient equipment because there is insufficient demand for them due to lack of information. This stock problem was solved ingeniously for energy efficiency equipment by B.C. Hydro of Canada, which paid a small, temporary subsidy to suppliers to stock only efficient models. In three years, the market share of premium-efficiency motors soared from three percent to sixty percent, and the subsidy was phased out.[111] Similarly, California's Pacific Gas and Electric paid refrigerator distributors a small bonus for each efficiency model stocked, but nothing for inefficient models, which quickly vanished from the shops. Pacific Gas and Electric found that the vendor subsidy improved refrigerator efficiencies faster, at less than one-third the cost of providing rebates to end-users.[112] The same incentives could be adopted for renewable resources.

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107 WORLD ENERGY ASSESSMENT, *supra* note 1, at 294.

108 Int'l Petroleum Indus. Envtl. Conservation Ass'n (IPIECA), *Practical Applications of the Kyoto Mechanisms: Opportunities and Issues*, *at* http://www.ipieca.org (last visited Mar. 11, 2002).

109 LOVINS & LOVINS, *supra* note 2, at 16.

110 Int'l Energy Agency, *supra* note 80.

111 LOVINS & LOVINS, *supra* note 2, at 17.

112 HOWARD GELLER ET AL., AM. COUNCIL FOR AN ENERGY-EFFICIENT ECON., UPDATE ON BRAZIL'S NATIONAL ELECTRICITY CONSERVATION PROGRAM (PROCEL) 1 (1999).

H. Utility Programs and Regulatory Requirements

1. Utility Incentives

Regulatory commissions in many U.S. states have required local utilities to undertake integrated resource planning (IRP), including detailed assessments of the costs and benefits of renewable resource use.[113] The utilities must provide their customers with incentives to purchase energy efficiency and renewable resources where economically justifiable.[114]

Application of utility incentives to rental apartment buildings can be problematic because tenants have no incentive to install measures benefiting the landlord, and the landlord has little incentive to invest in measures that primarily benefit the tenants. Some state utility regulators have addressed this problem by giving landlords larger incentives.[115] To induce tenant cooperation, apartments must be individually metered for electricity and gas consumption. This monitoring has already been established in Brazil, which developed an extensive metering program run by the country's national utility in conjunction with PROCEL, a national electricity conservation program.[116]

Where U.S. states have deregulated their utility generation, environmental advocates have often successfully lobbied utility regulators and legislators to impose a systems-benefit charge on the distribution utility, which remains a regulated monopoly, to fund efficiency, renewable, and other public benefit investments.[117] The revenues from these charges often are placed in independently administered public benefit funds. As of July 1999, fifteen states had adopted utility system benefit charges and benefit funds.[118]

A national public benefits trust fund of $.02/kWh (which would cost the typical residential customer only about $1 per month) has been introduced in the U.S. Congress.[119]

In 1996, the Rhode Island legislature and regulatory commission authorized electric distribution companies to levy a charge of at least 2.3 mills[120] per kWh for energy efficiency and renewables; about $17 million per

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113 REGULATORY ASSISTANCE PROJECT, INTEGRATED RESOURCE PLANNING FOR STATE UTILITY REGULATORS 5–8 (June 1994).

114 *Id.* at 8–14.

115 M. SUOZZO ET AL., AM. COUNCIL FOR AN ENERGY EFFICIENT ECON., POLICY OPTIONS FOR IMPROVING EXISTING HOUSING EFFICIENCY (1997).

116 GELLER ET AL., *supra* note 71, at 1.

117 *See* MARTIN KUSHLER, AM. COUNCIL FOR AN ENERGY-EFFICIENT ECON., AN UPDATED STATUS REPORT OF PUBLIC BENEFIT PROGRAMS IN AN EVOLVING ELECTRICITY UTILITY INDUSTRY (1998) (exploring current policies that support energy efficiency and renewable resources, including public-purpose programs supported by system benefit charges).

118 State restructuring funds are being used to finance energy research and development, energy efficiency programs, renewable energy programs, and low-income programs. For a good discussion of these state programs, see KUSHLER, *supra* note 117. For a good discussion of the policy considerations involved in establishing such funds, see ETON ET AL., *supra* note 101.

119 GELLER ET AL., *supra* note 71, at 7.

120 Mills are a monetary unit equivalent to 1/1000 of a U.S. dollar, or 1/10 of a cent.

year of the funds raised were to be spent by utilities on efficiency and renewable projects to be selected by collaboratives of all utility stakeholders.[121] In the Pacific Northwest, the governors of Idaho, Montana, Oregon, and Washington recommended that each state spend about three percent of revenues on a variety of public benefit programs; a nonprofit corporation with a board of directors representing the stakeholders was created to determine allocations.[122] The California legislature adopted a charge on the distribution utilities of about $1.8 billion between 1998 and 2001 for funding energy efficiency, renewable resources, and related research and development, with the regulatory commission to select program administrators competitively.[123]

Similarly, other countries have established a variety of public benefit arrangements to fill the gap for energy efficiency funding after deregulation. The United Kingdom established an Energy Savings Trust as a private limited company, funded by a small charge on distribution services, to promote energy efficiency for small customers. New Zealand set up an Energy Saver Fund as a part of its restructuring legislation to support residential programs funded by an $18 million appropriation for an initial three year period.[124]

A new entrepreneurship of Energy Service Companies (ESCOs) has emerged to perform energy retrofits, including the installation of renewables, for homes and businesses as a profitable enterprise, but to date they have penetrated only niche markets for large customers in the United States.[125] Also, under deregulation, performance-based regulation (PBR) is replacing rate-of-return regulation for the monopoly distribution company. PBR can encourage distribution companies to provide electricity efficiently and encourage use of renewables, rewarding performance measured against specific benchmarks.[126] Some commissions have placed a price cap on utility charges, giving the utilities an incentive to keep costs low. However, a revenue cap is far superior because a price cap provides strong incentives for utilities to increase sales, thus discouraging efficiency and renewable investments.

2. Utility Purchases

A number of U.S. utilities have acquired renewable resources for their own use. For example, Pacific Gas and Electric uses 1100 photovoltaic (PV) systems to produce a combined total of 44 kilowatts of energy, the majority of which provides power for gas-flow computers, automated gas meters, and water-level sensors. "Technology improvements have reduced PV generation

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121 MARTIN KUSHLER & P. WHITE, AM. COUNCIL FOR AN ENERGY-EFFICIENT ECON., A REVIEW AND EARLY ASSESSMENT OF THE PUBLIC BENEFIT POLICIES UNDER ELECTRIC RESTRUCTURING 1 (2000).

122 ETON ET AL., *supra* note 101, at 47.

123 *Id.*

124 *Id.* at 17.

125 *Id.* at 14.

126 REGULATORY ASSISTANCE PROJECT, PERFORMANCE-BASED REGULATION FOR DISTRIBUTION UTILITIES 2 (2000), *available at* http://www.rapmaine.org/PBRfinal.pdf.

costs from \$1.50/kWh in 1980 to a range of \$.30-\$.40/kWh today."[127]

PV systems are often the most cost-effective solution for specialized applications that pays off for utilities in reliability, modularity, low maintenance, and independence from transmission and distribution systems. The systems have successfully powered small off-grid loads, and have been installed on transmission towers and switching stations in place of transformers to handle small loads.[128]

3. Green Marketing

A number of U.S. utilities offer customers the option to purchase a package of green-generation products at a slightly higher cost, but it is too early to assess the programs effectiveness in reducing pollutants. Similarly, countries such as the Netherlands have created a green pricing program that permits consumers to purchase renewables at a small premium.[129]

The Los Angeles municipal utility announced a particularly ingenious and promising "Green Power for a Green LA" program in June 1999. The program encourages customers to invest in renewable generation sources by choosing to pay a six percent rate increase (about \$3 per month on average). In return, the utility also installs free energy efficiency measures for subscribers, guaranteeing to lower subscriber bills, then providing an incentive to participate. Several thousand subscribers have selected this option. Utility president, David Freeman, one of the world's clean energy pioneers, has thus found a way to finance new renewable resources without increasing customer costs, thereby creating a unique win-win financing arrangement.[130]

I. Financing Mechanisms

The success of renewable energy measures depends on financing. Many measures, while cost-effective in the long run, require substantial initial investments of capital.

1. Internal Resources

a. Subsidy Removal, Pollution Taxes, Government, and Utility Financing

As indicated previously, governments can generate a number of financial resources internally. The largest of these in most countries is removal of fossil-fuel subsidies. Many energy efficiency measures achieve such large savings over time as to provide very substantial revenue resources. Countries have used taxes on pollutants and fossil fuels to help

127 *Profiles, supra* note 3.
128 *Id.*
129 MOORE & IHLE, *supra* note 65, at 4.
130 *L.A. Leads Way in Developing True "Green Power,"* L.A. DAILY NEWS, June 2, 1999.

finance renewable energy measures. Others have lowered the costs of pollution-reduction measures through emissions trading rights. Using general tax revenues, some governments have also funded efficiency, renewable programs, and research and development for new technologies. While purchasing renewables for their own use, some governments also have required their electric utilities to assist customers in acquiring renewable resources through integrated resource planning.

b. Utility Programs Funded from Electricity Charges

As mentioned earlier, many state regulatory commissions require U.S. utilities to assist their customers in financing energy efficiency and renewable resources. These programs usually consisted of rebates for renewables and efficient equipment, as well as energy audits of customers' homes or places of business.[131] Some utilities provided loan programs repayable by a charge on customer utility bills. Other countries have enacted similar programs. In a few cases, the utility may act as retailer of renewable and energy efficiency equipment.

Electricity charges often fund renewable energy measures internally. Thus, electricity surcharges funded Japan's successful 10,000 Roofs solar PV program, which covered one-third of the installation costs of household PV systems.[132]

Often utilities maintain programs of rebates, customer loans, and grants to encourage the purchase of energy-efficient equipment and renewable resources. Sometimes utilities give incentives more effectively to the manufacturer than the end-user. Consumer incentives have the advantage of educating the end-user, putting the sponsor in direct contact with consumers, and giving the sponsor recognition for promotion of efficient products. Manufacturer incentives reduce paperwork and administrative costs, lower the price of renewables and efficient projects, and make them more widely accepted.

With the advent of deregulation in the United States, direct utility financing has been replaced in many jurisdictions with non-bypassable systems benefit charges placed on the distribution utility to fund public benefit programs including efficiency and renewable energy measures.[133] Utilities place the funds collected in an independently administered trust fund that makes grants and loans for energy efficiency and renewable projects, low income programs, and other energy-related projects. Increasingly, these funds make standard offers of a dollar amount per unit of energy saved, and standard contracts are proffered to reduce transaction costs.[134]

131 ETON ET AL., *supra* note 101, at 3.
132 MOORE & IHLE, *supra* note 65, at 18.
133 ETON ET AL., *supra* note 101, at 19.
134 *Id.*

c. Government Financial Assistance

The Netherlands has accelerated depreciation of renewable energy, provided tax deductions for renewable investments of between forty and fifty-two percent of the costs, subsidized loans for green projects at one to two percent below prevailing rates, and developed a program that authorizes the use of a green label for renewable generation. Additionally, it provides green mortgages that loan up to $35,000 to borrowers who install renewable equipment in homes costing $188,000 or less.[135]

National and local agencies in a number of countries support renewable projects. For example, India's Federal Ministry for Non-Conventional Energy Sources and state Renewable Energy Development agencies support renewable energy projects.[136]

Brazil supplies sixty percent of its primary energy requirements from renewable energy sources, thirty-seven percent from hydro, and twenty-three percent from biomass under programs sponsored by the government.[137] The biomass figure largely results from an ethanol fuel production program started in 1975 from sugar cane crops grown specifically for fuel use, presently occupying 2.7 million hectares of land and employing about 350 distilleries. Ethanol currently provides more than forty percent of the fuel consumed by cars and light trucks in Brazil.[138] It is estimated to have saved Brazil over $40 billion in oil imports, excluding the costs of the program. The government subsidized ethanol heavily until 1998, when it deregulated ethanol and substituted gasoline taxes for its costs. To start the program, the state-owned oil company guaranteed ethanol purchases on a cost plus basis and provided tax incentives for the purchase of neat ethanol-using vehicles. Nine metric tons of carbon emissions are now being avoided annually, and local emissions of lead, sulfur, and carbon monoxide have been greatly reduced in Brazil. In addition, the ethanol production supports about 700,000 rural jobs throughout the country.[139]

In 1985, Brazil established a national electricity conservation and renewable energy program, known as PROCEL, housed at the national electricity utility. PROCEL funds energy efficiency and renewable projects carried out by state and local utilities, state agencies, private companies, universities, and research institutes. The program's measures are estimated to have saved about 5.3 terawatt-hours (TWh) per year in 1998, equivalent to 1.8% of Brazil's electricity use, and another 1.4 TWh due to power plant improvements. The program avoided about 1560 MW of new capacity, saving

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135 MOORE & IHLE, *supra* note 65, at 17.

136 Mathew M. Mendis, *Financing Renewable Energy Projects B Constraints and Opportunities* (Alternative Energy Dev., Inc. 1998).

137 *Brazil Has Water Power and Ethanol But Can They Meet Rising Needs*, CLIMATE ALERT, Feb. 1997, *at* http://www.climate.org/Climate_Alert/articles/10.1/Brazil.html (last visited Mar. 11, 2002).

138 ADNEI MELGES DE ANDRADE ET AL., INT'L ENERGY AGENCY, BIOMASS ENERGY USE IN LATIN AMERICA: FOCUS ON BRAZIL 4 (1998), *available at* http://www.iea.org/pubs/proc/files/bioends/s2p5-adn.pdf.

139 GELLER ET AL., *supra* note 112, at 9.

about $3.1 billion of avoided investments in new power plants and transmission and distribution facilities, with investments of only $260 million. In addition, a number of new technologies are now manufactured in Brazil, including solar hot water heaters.[140]

The U.S. Department of Energy has joined with top finance firms to create the International Performance Measurement and Verification Protocol.[141] Like Federal Housing Authority (FHA) mortgage rules, the Protocol standardizes streams of energy savings in buildings so that they can be aggregated and securitized. More than twenty countries including Brazil, China, India, Mexico, Russia, the Ukraine, and the United States had adopted the Protocol as of November 1997. The Protocol has stimulated a market in which loans to finance energy savings and use of renewables can be originated and affordably financed without using internal capital or creating competition with other internal investment needs.[142]

d. Commercial Loans

Renewable projects such as biomass combustion/cogeneration, geothermal, hydropower, and wind farms are considered mature, low-risk, and commercially ready technologies having a reasonably established cost basis; thus, these projects often have access to commercial lenders. However, renewable projects tend to have higher initial capital costs per person than conventional systems, and require longer-term debt financing, making them more difficult to finance. Establishing project cash flow is also challenging because project revenues are not secured by enforceable fuel supply or power purchase contracts. Also, non-recourse financing is difficult to procure because many suppliers are new and do not have extensive financial performance records.[143]

Nevertheless, commercial banks often do make loans to finance energy efficiency and renewable installations where the projects produce sufficient net revenues to justify commercial financing. Securing commercial loans for disbursed efficiency and renewable energy installations may be problematic, however, because the projects tend to be small with numerous points of sale; some technologies are relatively new and unproven; and the revenue streams for renewable resources may be uncertain because of the risks of unavailability of sufficient sunlight or wind.

e. Aggregated Loans

The problems with small loans for distributed resources may be overcome by aggregating the loans in various ways.

140 *Id.* at 9–10.
141 LOVINS & LOVINS, *supra* note 2, at 11–12.
142 *Id.*
143 *Id.*

i. Installment Loans

Several countries have adopted an innovative credit arrangement, in which loans are made to credit-worthy institutions like local utilities, which in turn set up revolving funds to manage installment loans to individual and small businesses on relatively attractive terms. Such arrangements have been adopted in Bangladesh, the Dominican Republic, and Honduras. More specifically, Indonesia uses a loan program for its Solar Home Systems Project; India for a solar photovoltaic program; and Kenya for its wood stove upgrading program and for off-grid photovoltaic systems.

ii. Micro Utilities

Another innovative mechanism is the financing of service providers through the creation of renewable energy micro utilities. These micro utilities sell energy services, thus aggregating financing to the service provider and the end-user by making payments based on the level of energy services received. This approach has been successfully demonstrated in the Dominican Republic, and it is now being implemented by a rural electric cooperative in Bolivia that has developed a 10,000 solar home system program. Additionally, a mortgage-financing program currently being tested in a rural housing electrification program in South Africa allows homeowners to incorporate the costs of installing renewable systems into the overall costs of their homes through mortgage financing.

iii. Grameen Bank

A particularly fascinating development is the creation of micro-lending organizations in some of the poorest countries for their most impoverished populations. The Grameen Bank in Bangladesh ("village bank" in Bengali) has started a lending program for people earning less than $1 a day on average. Today, Grameen is established in nearly 39,000 villages in Bangladesh, lending to approximately 2.4 million borrowers. Established in 1986, it reached $1 billion in cumulative loans in 1995. Within two years, that figure climbed to $2 billion. The repayment rate hovers between ninety-six and one hundred percent. In a typical year, five percent of Grameen borrowers, representing 125,000 families, rise above the poverty level. The Grameen model has now been applied in forty countries. In all, about twenty-two million poor people around the world now have access to small loans. Grameen has now established more than a dozen enterprises, often in partnership with other entrepreneurs, such as Grameen Skakti (Energy), which helps install solar energy systems into village households.[144]

[144] Muhammad Yunus, *The Grameen Bank: A Small Experiment Begun in Bangladesh Has Turned into a Major New Concept in Eradicating Poverty*, SCI. AM., Nov. 1999, at 114–19.

f. Leasing Programs

Leasing equipment is an innovative approach to making small systems affordable. For example, the French government and France's largest utility developed the largest leasing program for compact fluorescent lights (CFLs) on the island of Guadeloupe, seeking to reduce evening peak electricity demand. Customers used a coupon to lease CFLs at no initial cost and made lease payments identical to the electric bill savings. Thirty-four percent of all households redeemed the coupons for an average of 7.8 CFLs each. This success stimulated an identical program on Martinique that distributed 345,000 CFLs in just a few months. The two programs resulted in 7 MW of peak demand savings on each island and 29 to 33 GWh of annual electricity savings. The same kinds of lease arrangements are appropriate for renewable resources; thus, in the Dominican Republic, the U.S. company Soluz operates a photovoltaic leasing program.

g. Vendor Financing

Sometimes equipment suppliers not only will construct, install, and operate systems, but also offer equipment financing on favorable financing terms. A vendor may be the manufacturer, the wholesaler or retail distributor, or a contractor. The vendor is motivated to offer financing to sell its equipment. The vendor becomes the aggregator of capital demand for individual installations and may provide maintenance or warranty support (particularly with equipment leases) to assure the equipment remains in good working order.

h. Performance Contracting

Performance contracting, which involves third-party financing, has been widely used to finance energy efficiency and renewable projects in the United States and Europe.[145] The customer contracts with an Energy Service Company (ESCO) to provide the desired energy efficiency or renewable improvements, financing, and other related services such as operations and maintenance. The financing is repaid in part from savings achieved by the measures or equipment installed; often, the ESCO also participates in the savings. To date, ESCOs have not succeeded in the United States, filling only niche efficiency applications for large industrial, commercial, and institutional customers.[146] Adequate long-term financing for ESCO operations is critical because the ESCO must front initial capital that may not be paid off from savings for several years. ESCO financing is particularly important to establish ESCOs in developing countries.

145 ETON ET AL., *supra* note 101, at 14–17.

146 *Id.* at 14.

2. External Resources

a. International Lending Organizations

In the past few years, the international lending organizations—the World Bank, regional banks, the International Finance Corporation (IFC), the United Nations Development Program (UNDP), and the United Nations Global Environmental Facility (GEF)—have begun financing energy efficiency and renewable projects in developing countries.[147] Although they must do more, their resources will never meet the requirements of developing countries. The capital requirement of electric power growth in developing countries (projected at 5% to 7.5% per year) has been estimated at $1.4 to $4 trillion over the next two decades.[148] Unfortunately, the World Bank currently lends less than $4 billion per year to the energy sector, while commercial lending stands at about $16 billion per year (as of 1991).[149] Consequently, private and public internal sources also are required if the need is to be met.

The World Bank and its sister international lending institutions, which had for many years made wasteful investments in highly capital-intensive energy inefficient technologies, now make major funding available for energy efficiency and renewable technologies. For example, the World Bank has established the Asia Alternative Energy Unit (ASTAE) to develop only renewable and energy efficiency projects. ASTAE has helped the Bank lend more than $500 million for renewable projects in Asia. The World Bank also financed a Renewable Energy Small Power Project in Indonesia, a component of which funds medium-scale, isolated grid systems.[150] A World Bank Market Transformation Initiative loan of $5 million fosters a photovoltaic industry in Kenya that annually sells more than 20,000 systems with a 300 kW capacity. The industry has already sold more than 80,000 systems, providing electricity for some 250,000 rural dwellers.[151]

Similarly, IFC has recently launched a $100 million Renewable Energy and Energy Efficiency Fund, and the Asian Development Bank approved a $100 million loan to the Indian Renewable Energy Development Agency for biomass cogeneration projects in India. The GEF donated $10 million to Argentina to assist Argentinean cooperatives in the removal of barriers to installation of wind power and solar photovoltaic development, including subsidies for equipment investment and technical assistance and studies.

These international lending facilities have struggled with administering small loans for many efficiency and renewable projects that do not demand large capital investments. Consequently, the institutions are helping to build local and regional lending institutions to manage the smaller loans on their

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147 Bert Metz et al., *Methodological and Technological Issues in Technology Transfer* (Intergovernmental Panel on Climate Change 2000), *at* http://www.grida.no/climate/ipcc/tectran.

148 BERNSTEIN ET AL., *supra* note 1, at ii.

149 M. Levine et al., Lawrence Berkeley Nat'l Lab., *Report to the U.S. Working Group on Global Energy Efficiency: Energy Efficiency, Developing Nations and Eastern Europe* 37 (1991).

150 *Survey of PV System Standards, supra* note 19.

151 Levine et al., *supra* note 149, at 37.

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b. Kyoto Protocol Mechanisms

Article 12 of the Kyoto Protocol provides for Emissions Trading, Joint Implementation Measures, and a new Clean Development Mechanism (CDM) for encouraging industrial countries and companies to invest in greenhouse gas emission reductions in developing countries. By participating in measures that generate greenhouse gas reductions in developing countries, an industrialized country and its companies can earn carbon emission reduction credits to meet the country's Kyoto protocol obligations.[152] Some companies have made such investments in anticipation of the adoption of rules.[153]

These trading measures promise the means by which developing countries can acquire needed resources to meet the upfront costs of renewable energy technologies to promote sustained carbon dioxide emission reductions. These measures also hopefully will assure that the developing countries can acquire the necessary capital, information, and training to permit them to participate fully in global warming solutions through the use of renewable and other clean energy resources.

i. Joint Implementation Mechanism

Emerging from the Protocol's conference negotiations are a number of mechanisms to promote investment in carbon mitigation in developing countries.[154] A Joint Implementation Program has been instituted by which developed and developing countries can collaborate on carbon mitigation projects including renewable projects.[155]

ii. Clean Development Mechanism

The Clean Development Mechanism (CDM) is the most promising means for non-target developing countries to acquire the resources and expertise necessary to promote renewable and other clean energy resources. The CDM provides target countries with carbon reduction credits for investment in carbon reduction measures, including renewable energy

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152 THE CLEAN DEVELOPMENT MECHANISM: ISSUES AND OPTIONS, *supra* note 30, at 13–17.

153 *Id.*

154 *Id.*

155 *Id.* Canada, Japan, Norway, and Germany have active Joint Implementation Programs that include support for renewable programs. Costa Rica has an extensive pilot Joint Implementation Program, with ten projects thus far accepted—including three wind power projects. Joint Implementation projects have been approved in Honduras for solar electrification and biomass projects, and in Bolivia for a solar electrification project. The Business Council for Sustainable Development (Latin America) has been active in these endeavors. As another example, Indonesia has four joint implementation projects, one with Tokyo Electric Power for renewable rural electrification and others for efficient logging, recycling of paper sludge and solid waste, and installing an improved cooling system for cement clinker production.

resources in non-target developing countries; thus it provides a substantial incentive for developed countries and their industries to invest in renewables in developing countries. In advance of Protocol ratification and the adoption of the final Protocol rules for implementation of CDM measures, some developed countries and several of their industrial companies have already made CDM investments.

iii. Emission Trading

The Protocol also established international carbon emission trading based on the United States's experience in reducing sulfur dioxide and NO_x emissions costs through emission trading rights.[156] Polluters may accumulate trading rights by reducing their emissions below adopted standards and then sell these rights to other polluters for whom pollution reduction is more expensive.[157] International emission trading would provide another incentive for developed countries and their businesses to invest in renewable energy projects in developing countries.

c. U.S. Foundation Programs

A number of charitable foundations in the United States have funded renewable energy efforts. For example, the MacArthur, Pew, and Rockefeller Foundations together created the Energy Foundation that funds programs throughout the United States promoting energy efficiency and renewables in electricity and vehicle efficiency improvements. Recently, it joined with the Packard Foundation to promote clean energy systems in China.[158]

VI. CONCLUSION

Developed and developing countries provide abundant examples of successful adoption of cost-effective renewable energy measures to ameliorate pollution while aiding their economies. A wide variety of legislative and voluntary programs have been implemented, and the legal and financial mechanisms for doing so are many and varied. It is possible to meet the world's energy, development, and environmental needs, even on a basis of long-term profitability. But achieving these goals requires determined action and political will among all the world's governments and international institutions. For the developed countries and international institutions, success demands a vast increase in funding sustainable energy, technology transfer, and education and training in the developing countries. For developing countries, renewable energy goals require a commitment to

156 *See generally,* U. S. Envtl. Prot. Agency, *Allowance Trading Basics, at* http://www.epa.gov/airmarkets/trading/basics/index.html (last visited Mar. 11, 2002) (discussing market-based mechanisms for reducing pollution).

157 *Id.*

158 *The China Sustainable Energy Program, at* http://www.efchina.org/ch/index.cfm (last visited Mar. 11, 2002).

eliminating the barriers to sustainable energy measures as well as creating a climate and laws to encourage private investment in those measures.