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Global Climate Change Kyoto Protocol Implementation: Legal Frameworks for Implementing Clean Energy Solutions

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* This paper assumes the correctness of the IPCC findings that the high risks of climate change are derived from increases in carbon dioxide emissions. Because of space limitations, it is a synopsis of the legal frameworks for implementing clean energy solutions – many books, research reports, and analyses are available on each topic covered.

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ABSTRACT

An appropriate legal framework is essential to accomplishment of clean energy solutions. This paper discusses legislative and regulatory measures that have contributed to successes in achieving clean energy improvements and concomitant reductions in releases of carbon dioxide contributing to global warming. Examples of success stories are given in both developed and developing countries, together with the legal framework for their introduction.

The most direct legal remedy to dirty energy is removal of the subsidies provided in law by the United States and other governments for use of fossil fuels, the largest source of pollution and carbon emissions. Removal of fossil fuel subsidies can make available vast resources to fund clean energy solutions without resort to outside funding or taxation.

Getting the prices right is critical to advancement of all forms of clean energy. This requires legislative action to assure that all energy resources bear the full externality costs of their impact on society, including the mortality, health and environmental damage they impose and national security costs that are not reflected in their prices. Externalities can be dealt with by taxes or by regulations that limit harmful emissions from polluting resources.

Where energy resources are regulated by government, it is important that intermittent resources like solar energy not be disadvantaged. In selection of resources, the full life cycle cost of the resource must be considered rather than the first cost: e.g. solar may have a high first cost but, because there are no fuel costs and low maintenance costs, the life cycle cost of the resource is lower.

Market transformation measures such as energy efficiency standards for appliances, lights and motors, and miles per gallon standards for vehicles, can be an effective legal mechanism for reducing pollution and encouraging the substitution of clean

for dirty energy resources. Citizen suits are a very effective enforcement modality.

It is concluded that clean energy resources can be introduced and dirty resources discouraged by any country affordably and that no country can afford to fail to do so.

There is no greater challenge to the future generations who will inherit our earth than to resolve the threats of global warming, identified by the consensus of world scientists through the International Panel on Climate Change (IPCC) as presenting unprecedented hazards of rising oceans, flooding and inundation of coastal areas, agricultural disruption, migration of tropical diseases and increased frequency and severity of storms.[1] No bigger undertaking has ever been attempted by the international community than to devise effective means of implementing the United Nations Framework Convention on Climate Change adopted in 1992 at the Rio Earth Summit to address these threats.[2]

The IPCC identified emissions of carbon dioxide as the chief contributor to global warming.[3] The principal remedy prescribed in Article 2 of the December 1997 Kyoto Protocol for implementation of the Rio Treaty is the adoption of clean energy solutions: "enhancement of energy efficiency in relevant sectors of national economies. . .increased use of renewable forms of energy," removal of fiscal incentives and subsidies promoting greenhouse gas emissions, and limitations and reductions of emissions.[4]

The burning of fossil fuels is the most significant source of carbon dioxide emissions worldwide. The principal problem with substitution of clean energy for fossil fuels is that the present use of them is so central to the world's economies, fueling their electric utilities, industry, vehicles, heating and cooling of buildings, and often their household cooking. Developing countries have focussed on their economic development and the feeding, clothing, housing and health facilities for their populations, often regarding environmental improvements and clean energy as, at best, secondary

1. *See* United Nations Dev. Programme (UNEP) Intergovernmental Panel on Climate Change, *Climate Change 2001: Impacts, Adaptation and Vulnerability, at* http://www.usgcrp.gov/ipcc (last modified March 5, 2001) [hereinafter UNEP, *Climate Change 2001*].

2. *See* Kyoto Protocol to the United Nations Framework on Climate Change, 3d Sess., Agenda Item 5, FCC/CP/1997/L.7/Add.1 (1997) [hereinafter Kyoto Protocol].

3. *See* UNEP, *Climate Change 2001*, *supra* note 1.

4. Protection and enhancement of carbon sinks, promotion of sustainable agriculture, and methane emissions are also included, but are not dealt with in this paper. *See id.*

priorities. But it is clear that the choice for developing countries is not social development or clean energy – if present growth trends in developing country energy demand continue, world resources quite simply will be inadequate to support their needs either for energy or development.[5]

Thus, enormous economic and cultural barriers must be breached to shift from dependence on fossil fuels to clean energy resources. The perceived difficulties of this transformation were seen in the tortuous negotiations of the Kyoto protocols in 1997 and in the small accomplishments achieved in the negotiations of COP 1-5 (Conferences of the Parties). These difficulties were evidenced by the modest goals recommended compared to what the IPCC scientists have identified as the carbon dioxide reductions needed to ameliorate global warming; the lack of mandatory reductions for developing countries (though many have done more than the industrialized countries to address climate change); and the problems, still unresolved, of adopting enforcement mechanisms and of getting the United States, the largest polluter, to ratify the Treaty.[6]

The task of achieving the Kyoto carbon dioxide reduction goals, however, is not nearly as daunting or costly as some have made it appear. Many governments, utilities, and private companies throughout the world have instituted measures that have

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5. *See* José Goldemberg et al., World Resources Inst., Energy for Development 57 (1986). The challenge was well put as follows:

> If current trends persist, in about 20 years the developing countries will consume as much energy as the industrialized countries do now. Yet their standard of living will lag even further behind than it does today. This failure of development is not the result of a simple lack of energy, as is widely supposed. Rather, the problem is that the energy is neither efficiently nor equitably consumed. If today's most energy-efficient technologies were adopted in developing countries, then only about one kilowatt per capita used continuously – roughly 10% more than is consumed now – would be sufficient to raise the average standard of living to the level enjoyed by Western Europe in the 1970's.

A.K.N. Reddy & J. Goldemberg, *Energy for the Developing World,* Sci. Am., Sept. 1990, at 116 (quoting Prime Minister Indira Ghandi at the Stockholm Conference on the Environment). Studies show conclusively that a supply-oriented strategy that both accepts current projections of development energy demand and seeks to satisfy them based on acquiring capital-intensive technologies requiring imported fuels is doomed to failure. To the extent that their energy needs are thus met, it will be at horrendous cost of capital desperately needed for economic and social improvement in non-energy sectors and with tragic environmental consequences to developing countries and to the world. Congressional Office of Technology, Energy in Developing Countries, OTA-E-486 (1991).

6. *See* Kyoto Protocol, *supra* note 2, at Annex B.

achieved substantial carbon dioxide reductions.[7] Many of these measures have been funded from internal sources; most have produced large net revenues by instituting more efficient processes and using more efficient products.[8] As the world comes to realize the awesome threats and costs of global warming, many new initiatives are being taken in both the public and private sectors to address carbon dioxide emissions.[9]

This paper describes the measures that have been and can be taken and the legal mechanisms by which successes have been achieved in reducing greenhouse gases. Examples are given of success stories from around the world, but these examples are just demonstrative. Many hundreds of programs have been pursued successfully around the world in both industrial and developing countries.

What does emerge, however, is clear evidence that global warming can be effectively addressed and that many significant steps have been taken profitably in both the public and private sectors, offering significant business, export and job opportunities, and that much can be done by accessing internal resources.[10] To

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7. *See* HOWARD GELLER ET AL., AM. COUNCIL FOR AN ENERGY-EFFICIENT ECON., MEETING AMERICA'S KYOTO PROTOCOL TARGET: POLICIES AND IMPACTS (1999) [hereinafter GELLER, MEETING AMERICA'S KYOTO PROTOCOL TARGET].

8. *See id.*

9. *See id.*

10. For example, a November 1999 study by The American Council for an Energy-Efficient Economy demonstrates that ten steps taken by the United States to increase promotion of efficiency and renewables can reduce U.S. carbon dioxide emissions from base case projections of current energy use patterns by the U.S. Energy Information Agency by about 28% by 2010, or 4.5% less than 1990 emissions. By 2020, carbon emissions are cut 55% from the Base Case and 34% below energy sector emission in 1990 through these ten measures. These ten initiatives also reduce sulfur dioxide emissions 62% by 2010 and 84% by 2020 from the base case; particulates by 17% in 2010 and 35% in 2020; and NOx emissions 17% by 2010 and 30% by 2020. The cost of the measures is a total investment of $213 billion through 2010 and $627 billion through 2020 (1996 dollars and a 5% real discount rate, but would save consumers over $400 billion through 2010 and over $500 billion through 2020 in energy bills and operating savings). Implementing these policies would create income and jobs, reduce oil imports, and enable companies to export technologies as well as improving health and reducing damage to crops, forests, buildings and water resources. The measures involve strengthening appliance efficiency standards and product labeling; more stringent building energy codes and new construction incentives; stimulating building retrofits; adopting a national systems benefit charge on electric utilities to support conservation and renewables; adoption of a national renewable portfolio standard; standards and incentives to increase vehicle efficiency; motor fuel greenhouse gas emission standards; facilitating combined heat and power systems; promoting agreements and incentives to reduce industrial energy use; and application of current U.S. emission standards to all coal-fired power plants. *See* GELLER, MEETING AMERICA'S KYOTO PROTOCOL TARGET, *supra* note 7.

meet the challenges of the Kyoto Protocols and the IPCC estimates of what needs to be done, however, much more extensive and resolute changes must be taken by both governments and corporations, with much greater financing of the up front costs by them and by multilateral institutions.

ENERGY EFFICIENCY ALTERNATIVES

Energy efficiency is assuredly the most effective and economically advantageous means of reducing carbon dioxide emissions and other energy-derived pollutants.[11] Energy efficiency measures in the end use, manufacturing and transmission of electricity replace the need for fossil fuel resources and virtually always produce a net economic benefit, often substantial.[12] Efficiency measures also can reduce the great costs and risks of dependence on oil imports.[13] Many of the products required for efficiency measures can be produced domestically and have the potential for substantial export marketing.[14] Moreover, by improving the efficiency of industrial processes, such measures often result in enhanced competitiveness of domestic production in our global economy.[15]

The potential for reduction of carbon emissions through energy efficiency measures is enormous. It has been calculated that 60% of all primary energy used is lost in various stages of conversion and use, and that over 60% again is lost or wasted at the end-

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11. *See generally* AMORY B. LOVINS & L. HUNTER LOVINS, ROCKY MTN. INST., CLIMATE: MAKING SENSE AND MAKING MONEY (Nov. 13, 1997) [hereinafter LOVINS & LOVINS].

12. A 1997 Alliance to Save Energy study found a U.S. energy efficiency savings potential of 26% of carbon emissions and 15% of primary energy by 2010, saving 13% of national energy costs and $85 billion per year and creating nearly 800,000 net new jobs. *See* LOVINS & LOVINS, *supra* note 11, at 10; *see also* ALLIANCE TO SAVE ENERGY, ENERGY INNOVATIONS: A PROSPEROUS PATH TO A CLEAN ENVIRONMENT (1997).

13. Overall, it has been estimated that U.S. dependence on imported fuel had already cost the U.S. economy $4 trillion over the 1972-1991 period. U.S. oil imports reached an all-time high of 48% of total oil demand in 1997, and are now more than 50% according to the government's Energy Information Agency. S. NADEL & L. LATHAM, AM. COUNCIL FOR AN ENERGY-EFFICIENT ECON., THE ROLE OF MARKET TRANSFORMATION STRATEGIES IN ACHIEVING A MORE SUSTAINABLE ENERGY FUTURE 1 (1998). The United States oil trade deficit has been estimated at $61 billion per year in 1997. LOVINS & LOVINS, *supra* note 11, at 23; R. REPETTO & D. AUSTIN, WORLD RESOURCES INST., THE COSTS OF CLIMATE PROTECTION: A GUIDE FOR THE PERPLEXED (1997).

14. A 1997 study estimated that aggressive adoption of energy efficiency measures could result in net gains of nearly 800,000 jobs in the United States by 2010. See LOVINS & LOVINS, *supra* note 11, at 1.

15. *See id.*

use stage.[16] The IPCC in 1998 made a similar calculation, finding that almost 71% of all primary energy used is wasted.[17] Energy efficiency measures can economically avoid a large percentage of this waste.

Appliance Efficiency

Furnaces, boilers, air conditioners, heat pumps, refrigerators, water heaters, clothes washers and dryers, ranges and dishwashers consume 85% of energy consumption in the residential sector.[18] Sixty-five percent of energy use in the commercial sector is used for heating, cooling, lighting, water heating, refrigeration and office equipment.[19] In the industrial sector, lighting equipment and electric motors account for more than 75% of electricity consumption.[20] The tasks desired from these appliances can be furnished by much more efficient appliances, often using a fraction of the electricity used by less efficient, widely used models, and offering substantial savings to companies, consumers and society, including reductions of carbon dioxide and other health-damaging pollutants.[21]

Lighting

In areas that have grid electricity, replacement of incandescent light bulbs with compact fluorescent bulbs, which last four times longer and use one-quarter as much electricity, achieves great savings to the consumer and to society. Task lighting, reflectors, and use of daylight also result in significant savings at low or no cost.[22] In many countries, utilities invest in lighting efficiency measures for residential and business custom-

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16. *See* GLOBAL ENERGY PERSPECTIVES (N. Nakicenovic et al. eds., Cambridge University Press, 1998).

17. *See generally* UNEP, *Intergovernmental Panel on Climate Change, at* http://www.ipcc.ch/pub/reports.htm (last visited Nov. 30, 2000); *see also* Ctr. for Int'l Earth Science Info. Network (CIESIN) at Columbia University, http://www.ciesin.org.

18. HOWARD GELLER ET AL., AM. COUNCIL FOR AN ENERGY-EFFICIENT ECON., APPROACHING THE KYOTO TARGETS: FIVE KEY STRATEGIES FOR THE UNITES STATES, at 5 (Aug. 1998) [hereinafter GELLER, APPROACHING THE KYOTO TARGETS].

19. *See id.*

20. *See id.*

21. Advanced refrigerators alone can save over 90% of the energy used by standard models today, thus not only reducing carbon dioxide emissions but also eliminating climate and ozone disrupting CFC's from insulation and refrigerants. *See* LOVINS & LOVINS, *supra* note 11, at 7.

22. *How Energy Efficiency Works in Osage*, NATION'S BUSINESS, Aug. 1, 1992, *available at* 1992 WL 3086570.

ers, sometimes repayable out of the savings from the conversion. Many countries have started to produce the compacts for domestic use and for export, creating important business, revenue and job creation opportunities. Conversion of incandescent street lighting to sodium vapor or other efficient alternatives again creates considerable savings to municipal taxpayers and to the environment, and produces much improved lighting to boot.[23]

In the rural areas of most developing countries, which lack grid electricity, night lighting is provided at high costs and with severe pollution consequences by kerosene.[24] One consequence is that about one-third of the world population uses fuel-based lighting with very significant greenhouse gas emissions and cost consequences.[25] One study found that kerosene accounted for nearly 60% of the total energy requirement for lighting in India's residential sector in 1986 and 40% as much energy as that required to produce the electricity used for lighting in Brazil.[26]

Fuel-based lighting creates substantial amounts of carbon dioxide emissions. The results of a recent study show that between 15 and 88 billion liters of kerosene are consumed each year to provide residential fuel-based lighting in the developing countries.[27] The cost of this energy ranges from $15 to $88 billion per year.[28] This fuel-based lighting results in between 37 and 223 million metric tons of carbon dioxide emission per year.[29] The energy services provided are 1/80th of the level of electric light sources and the lumens of light provided are approximately 1/1000th that enjoyed in households in the industrialized world.[30]

Insulation

Most of the buildings in the developing countries are totally without insulation, resulting in the waste of much of the fuel (usually fossil) which is used to heat and cool them. Many of the older buildings in developed countries also lack adequate insulation.

23. *See* UNDP, ISSUES & OPTIONS: THE CLEAN DEVELOPMENT MECHANISM (José Goldemberg ed. 1998).

24. *See* Evan Mills, *Fuel-based Light: Large CO_2 Source*, INT'L ASS'N FOR ENERGY-EFFICIENT LIGHTING NEWSLETTER, (IAEEL, Stockholm, Sweden), Feb. 1999, at 1.

25. *See id.* at 9.

26. *See id.*

27. *See id.*

28. *See id.*

29. *See* Mills, *supra* note 24, at 8.

30. *See id.*

The buildings can be retrofitted with insulation at a payback of just a year or two of the retrofit costs.

Urban Heat Islands

One-sixth of the electricity consumed in the United States goes to cool buildings, at an annual cost of $40 billion.[31] In urban areas, the lack of shade for buildings, dark-colored roofs and roads create what is known as urban heat islands which consume large amounts of air conditioning energy.[32] The planting of deciduous trees on the south side of buildings and painting the buildings in light colors, routinely done in many tropical countries, are low cost/no cost means of achieving substantial savings in the energy used for air conditioning in hot climates.[33] Thus, building owners in Haifa and Tel Aviv are required to whitewash their roofs each spring.[34] The use of light colored aggregates in highway and road construction materials can also achieve substantial energy savings.[35]

The direct savings in air conditioning of the buildings treated are supplemented by an indirect saving from the lowering of temperature in surrounding buildings.[36] A program promoting urban heat island improvements would achieve multiple carbon dioxide savings from the absorption of carbon dioxide from the trees and from the reduced use of energy for air conditioning.[37] It is estimated that a tree in Los Angeles will save 3kg of carbon per year by lowering citywide air conditioning requirements plus 15kg per year in building air conditioning savings if planted to shade a building.[38] An urban tree keeps reduces carbon dioxide emissions about nine times more than a tree in the forest because of the air conditioning it will save in urban areas.[39] A single tree can evaporate 40 gallons of water a day, offsetting the heat equivalent to that produced by 100 100-watt lamps burning eight hours per day.[40]

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31. *See* A. Rosenfeld et al., *Painting the Town White Blue and Green*, M.I.T. TECH. REV., Feb.-Mar. 1997, at 56.
32. *See id.*
33. *See id.*
34. *See id.*
35. *See* Rosenfeld et al., *supra* note 31, at 54.
36. *See id.*
37. *See id.* at 56.
38. *See id.*
39. *See* LOVINS & LOVINS, *supra* note 11, at 6.
40. *See* Rosenfeld et al., *supra* note 31, at 56.

Cooking Stoves

Much of the cooking in developing countries is done on wood or coal burning stoves, exposing occupants to very concentrated emissions and contributing considerably to carbon dioxide and other pollutant emissions.[41] Inexpensive efficient stoves are available and in use in many places around the world now which both reduce the amount of fuel needed and pollutant emissions.[42] For example, Kenya has an outstanding cooking stove program, having adapted a Thai "bucket" ceramic-lined charcoal-burning stove that saves between 20% and 50% of the fuel otherwise used and now costs only $1-3.[43] There are now about 900,000 of these "jiko" stoves in Kenya, reaching about 60% of urban households and 20% of rural homes.[44] About 200 local firms produce the stoves.[45] The Kenya program has been adopted in Tanzania, Uganda and Rwanda. China established a National Improved Stove Program in 1992, which has provided over half of China's rural households with improved stoves.[46] China also started to manufacture, install and service the stoves.[47] Some 160 million cooking stoves were upgraded between 1982 and 1998 at a cost of $158 million in government support.[48]

Drinking Water Purification

The recent development of ultraviolet (UV) water purification, if widely adopted, could save the vastly greater energy consumed by existing water filtration and chlorination plants in industrialized societies or the use of fossil fuel or wood to boil water for purification in developing countries.[49] Attendant advantages are that UV processes use no chemicals, impart no taste or

41. *See generally* AMULYA K. N. REDDY, ET AL., NDP, ENERGY AFTER RIO: PROSPECTS & CHALLENGES § 3.4 & app. A (1997), *available at* http://www.undp.org/seed/energy/contents.html [hereinafter ENERGY AFTER RIO].

42. *See id.*

43. *See id.*

44. *See id.*

45. *See id.*

46. *See* ENERGY AFTER RIO, *supra* note 4.

47. *See generally id.*

48. *See generally id.*

49. *See* ASHOK GADGIL ET AL., AM. COUNCIL FOR AN ENERGY EFFICIENT ECON., ENERGY-EFFICIENT DRINKING WATER DISINFECTION FOR GREENHOUSE GAS MITIGATION 5 (1998); *see also* AM. COUNCIL FOR AN ENERGY EFFICIENT ECON., ENERGY EFFICIENCY IN A COMPETITIVE ENVIRONMENT 131 (1998).

odor to water, have no risks of overdose, do not require pressurized water and cost less than the alternatives.[50]

Approximately 1 billion people worldwide use cookstoves to boil their drinking water.[51] This process is reliable, but it demands labor, imposes high economic, environmental and human health costs and is ultimately susceptible to limited fuel availability.[52] It contributes to carbon dioxide emissions both through the combustion of the biomass and the destruction of forests needed to furnish the fuel wood.[53]

UV treatment uses approximately 6,000 times less energy than boiling over a biomass cook stove.[54] UV technology is a rapid disinfection process that acts at the DNA level without heating the water, and thus offers great energy and cost savings potential.[55] It has been estimate that if half the 500 million people in China who use biomass stoves for water purification were to use UV treatment instead, 125 metric tons of carbon dioxide emissions a year would be saved with a potential cost of $0.26 per ton of carbon saved at approximately half the cost of the wood stove technology, not counting environmental externality costs savings.[56]

Recycling

The recycling of household waste products economically saves consumers and municipal taxpayers the costs and pollution of waste incineration. The recycled waste is often convertible into useful products that can create revenues and jobs.

In the industrial and commercial sectors, the recycling of wastes is also economically and environmentally advantageous.[57] 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 95% less energy than manufacturing it.[58] Interface, the world's largest carpet-tile maker, estimates it cut its materials flow by about tenfold by leasing floor-covering services instead of selling carpet and by remanufac-

50. *See* sources cited *supra* note 49.
51. *See* sources cited *supra* note 49.
52. *See* sources cited *supra* note 49.
53. *See* sources cited *supra* note 49.
54. *See* sources cited *supra* note 49.
55. *See* sources cited *supra* note 49.
56. *See* sources cited *supra* note 49.
57. *See generally* LOVINS & LOVINS, *supra* note 11.
58. *See id.* at 7.

turing old carpet.[59] Land and coalmine gas recovery turns heat-trapping and hazardous methane emissions into a voluble fuel that also displaces fossil fueled power plants.[60]

Transmission & Power Plant Efficiency

In many developing countries, the transmission and distribution systems are inadequate, causing large losses of the power generated and also resulting in frequent blackouts or brownouts that are very costly to businesses. Even in developed countries, these systems are often neglected, resulting in outages at times of system stress, as with the blackout in New York City in a heat wave last summer. Leaky transmission systems cause unnecessary and costly pollution emissions. Upgrading inadequate transmission or distribution systems should be a high priority in these cases. Usually, these costs are borne by the utility company and paid for in the electricity charges, but legislation and financing assistance may be necessary to effectuate these efficiencies in some developing countries.

Distributed resources such as energy efficiency measures, fuel cells and photovoltaics are often economic alternatives to expansion or upgrades of transmission and distribution systems. Because of their proximity to customer loads, distributed systems can offer improved reliability, as well as carbon dioxide emission reductions, particularly efficient compared with the typical transmission losses of about 10% of central plant generated power.[61]

Most power plants in the United States and around the world also are grievously inefficient, converting most of their fuel into waste heat rather than power production.[62] While the U.S. average power plant efficiency has increased from about 23% in 1949 to 32% in 1996 due to the introduction of 52% efficient combined cycle natural gas power plants, if all plants were that efficient, power sector carbon dioxide emissions in 2010 would decline about 30%, cutting U.S. carbon emissions by about 190 MMT.[63] If this generation all came from natural gas plants, carbon emissions would decline by a further 32% (215 MMT).[64]

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59. *See id.*
60. *See id.*
61. *See Environment and Energy Newsline*, December 7, 1999.
62. GELLER, APPROACHING THE KYOTO TARGETS, *supra* note 18, at 33 (1996 United States electric generator emissions were 517 MMT, projected by the U.S. Energy Information Agency to grow to 663 MMT by 2010 under its Reference Case Forecast).
63. *See id.*
64. *See id.*

Industrial Efficiency

"Electric motors consume more than half of the electricity in the U.S. and almost 70% of manufacturing sector electricity."[65] Replacement of standard electric motors with smaller variable speed drive motors (as with the gear shift in a vehicle) and matching the motor output to the load, produces large electricity and pollution savings and economic benefits.[66] It has been estimated that variable speed electric motors would result in short-term carbon emission reductions of nearly 10 million tons per year in the United States, nearly 8 million tons in Japan and over 14 million tons in the European Community.[67] Technological improvements also have permitted manufacture of much more efficient motors.[68] Industry can also benefit itself and reduce carbon emissions by relamping, replacing their incandescent lights with compact fluorescents, reflectors and task lighting.[69]

The biggest industrial energy savings, though, frequently occur in improving the efficiency of industrial processes themselves, e.g., using continuous casting of steel and utilizing waste products for electricity and heat generation, as is often done in paper, lumber and plywood manufacturing in the United States. The U.S. chemical industry saved nearly half its energy per unit of product from 1973-1990 by plugging steam leaks, installing insulation and recovering lost heat.[70] These kinds of improvements can usually be financed through commercial loans repayable from the savings achieved.[71] Some U.S. utilities do industrial efficiency audits, provide technical assistance and participate in the financing of efficiency improvements.[72]

The industrial sector in the United States accounted for about 36 quads of primary energy use in 1997, 39% of U.S. energy consumption, with manufacturing in six sectors dominating (petroleum refining, chemicals, primary metals, paper and pulp products, food products, and stone, clay and glass products).[73]

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65. MARGARET SUOZZO & JENNIFER THORNE, AM. COUNCIL FOR AN ENERGY-EFFICIENT ECON., MARKET TRANSFORMATION INITIATIVES: MAKING PROGRESS 37 (1999).

66. *See id.*

67. *See id.*

68. *See* LOVINS & LOVINS, *supra* note 11, at 6.

69. See SUOZZO & THORNE, *supra* note 65.

70. *See* LOVINS & LOVINS, *supra* note 11, at 6 (better catalysts with matching heat to temperature needs can save 70% of the remainder with a 2-year payback).

71. *See* GELLER, MEETING AMERICA'S KYOTO PROTOCOL TARGET, *supra* note 7.

72. *See id.*

73. *See id.*

There is a great potential for cost-effective improvement.[74] For example, an in-depth analysis of forty-nine specific energy efficiency technologies for the iron and steel industry in 1999 found a total cost-effective energy savings potential of 18%.[75]

Combined Heat and Power (Cogeneration)

Utilization of the waste heat from electricity generation for industrial or district heating purposes converts as much as 90% of fuel input into useful energy, compared to 30-35% for a conventional power plant, thus saving significant amounts of fuel and pollution.[76] Conversely, some manufacturing facilities that produce substantial high temperature fluid or steam wastes have used this waste heat for electricity production.[77] Roughly 52 GW of combined heat and power (CHP) was installed in the United States as of 1998, providing about 9% of total electricity production.[78] Europe is far ahead of the United States in CHP installation, exceeding 30% in the Scandinavian countries and widely being used in the climate strategies of the U.K., Denmark, Sweden, the Netherlands and Germany.[79]

There is enormous potential to expand the use of CHP.[80] For example, the chemicals industry uses only about 30% of its CHP potential and has used only 10% of useable sites.[81] A CHP plant in Stockholm has a net overall efficiency of 86% compared to an average efficiency of just 36% for non-CHP plants in the European Union.[82]

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74. *See id.*

75. *See id.* at 12, 13.

76. *See* LOVINS & LOVINS, *supra* note 11, at 7.

77. *See id.* "The American firm Trigen instead uses the waste heat from small, off-the-shelf turbine to run industrial processes." *Id.*

78. *See id.* Waverly Junior-Senior High in New York is one example of a building that has benefited from the use of cogeneration. The 200,000-sq. ft. building was completely electric and had power bills totaling approximately $200,000 during the 1980's. In 1990 the school installed five 75 kW Tecogen cogeneration systems. The cost of installing the systems, financed by the local school board and by a grant from the New York State Energy Office, was paid off in twenty-seven months. The savings during the past eight years have amounted to over $800,000, which equals a 60% reduction in energy use and greenhouse gases. The Tecogen systems are used to both heat and cool the building, reserving the use of electricity for lighting, motors, computers and other office equipment. *See* JOSEPH J. ROMM, COOL COMPANIES: HOW THE BEST BUSINESSES BOOST PROFITS & PRODUCTIVITY BY CUTTING GREENHOUSE GAS EMISSIONS 118 (1999).

79. *See* GELLER, APPROACHING THE KYOTO PROTOCOL, *supra* note 18, at 5.

80. *See id.* at 27.

81. *See id.* at 26.

82. *See id.* at 28, 29.

All U.S. conventional power plants together convert only one-third of their fuel into electricity, thus wasting two-thirds as waste heat, which is equivalent to the total energy use of Japan.[83] The Trigen Corporation's cogeneration installation increases system efficiency 2.8 times, harnessing 90-91% of the fuel's energy content, providing electricity costing only .5-2 cents/kWh.[84] Fully adopting this one innovation would profitably reduce total carbon dioxide emissions of the U.S. by about 23%.[85] Selling waste heat from industrial processes to others within affordable distances could cost-effectively save about 45% of Japanese and 30% of U.S. industrial energy, or 11% of U.S. total energy.[86]

However, a variety of barriers including hostile utility policies, excessively onerous environmental permitting requirements, lack of regulatory recognition of CHP benefits and unfavorable tax treatment, limit CHP growth in the United States.[87] It has been estimated that legislative and regulatory action to remove these barriers could result in an additional 50 GW of installed CHP by 2010 and 144 GW by 2020 in the United States, with a net savings that pays back the first cost in 4-5 years on average.[88] These policy changes are estimated to achieve carbon reductions of about 27 million tons/year in the industrial sector and 7 million tons in other sectors by 2010.[89]

District Heating

District Heating involves the use of a single heating generator to warm and cool multiple homes in a community. Considerable energy can be saved in defined or newly planned communities by using district heating instead of less efficient heating units for each building or each dwelling unit in the community. District heating is widely used in Europe, particularly in the Scandinavian countries.

83. *See* Lovins & Lovins, *supra* note 11.
84. *See id.*
85. *See id.*
86. *See id.*
87. *See* Geller, Approaching the Kyoto Targets, *supra* note 18, at 26.
88. *See id.* at 25-29.
89. *See id.*

Transportation Efficiencies

Cars and light trucks currently account for 56% of transportation energy use.[90] The efficiency of vehicles can be greatly improved through using lighter weight materials and smaller vehicles, reducing wind resistance, improving tire performance and improving the combustion efficiency of engines.[91]

New vehicle propulsion systems are being adopted and designed which can greatly reduce or avoid altogether the use of fossil fuels, namely: electric vehicles with regenerative braking systems; electric/hybrid vehicles that combine electric motors with small, more efficient internal combustion engines; fuel cell-driven vehicles utilizing hydrogen as their fuel; and vehicles propelled by propane gas or ethanol. Toyota is now mass-producing the Prius hybrid car in Japan.[92] Toyota and Honda recently have introduced in the U.S. market their two mass-produced electric hybrid vehicles with 50-75% improved fuel efficiency.[93] Plants for the manufacture of cellulosic ethanol for use as a vehicle fuel or additive are being constructed in a number of U.S. states including Louisiana, California and New York.[94] Argentina established a program in 1984, which has resulted in there now being 450,000 compressed natural gas vehicles in use there.[95]

Many of these new transportation technologies are now being used around the world, particularly in busses and for automobile fleets.[96] The use of natural gas buses has been adopted for Flanders and Brussels in Belgium, Denmark, France and Hungary (which is replacing its old diesel engines with new compressed natural gas for all its buses in Budapest).[97] Brazil has pioneered in growing energy crops for conversion to ethanol as a vehicle

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90. *See* id. at 17.

91. *See id.*

92. *See* GELLER, APPROACHING THE KYOTO TARGETS, *supra* note 18, at 17.

93. *See* LOVINS & LOVINS, *supra* note 11. GM has announced development of cars with half the weight and drag of current models and hybrid drive. Ford has road-tested a 40% lighter than its current cars six-passenger car with hybrid drive. And before their merger, Daimler-Benz pledged to making 100,000 fuel cell cars a year by 2005 and Chrysler had developed a molded-polymer composite "China car" with half the weight of Neon, 15% lower cost, 80% lower investment and 86% lower factory space getting sixty mpg. *See id.*

94. *See* GELLER, MEETING AMERICA'S KYOTO PROTOCOL TARGET, *supra* note 7, at 10.

95. *See id.*

96. *See id.*

97. *See id.*

fuel.[98] Brazil initially subsidized the manufacture of ethanol adapted vehicles (the subsidies have since been eliminated).[99] This program has avoided the need and costs of major imports of gasoline and has significantly reduced automobile-derived pollution.[100]

Other significant measures to reduce transportation energy use include: land use planning to avoid urban/suburban sprawl that requires the use of vehicles for access to essential services;[101] promotion of mass transportation facilities that are much more energy efficient than private vehicles; promotion of car pooling; van transport to work; HOV lanes restricted to multi-passenger occupied vehicles on highways; elimination of free parking and imposition of parking fees at business and institutions; and promotion of pedestrian and bicycle paths, bicycle parking facilities, and urban bicycle lanes.[102]

Energy efficiency measures almost always result in savings to the producer, the consumer and society. They are usually inexpensive compared to new power construction and are capable of financing out of the savings achieved. For developing countries, the initial installation of energy efficient products and processes enables them to leapfrog to use of the superior technologies, thus avoiding the experience of most developed countries in having to convert inefficient products or processes to efficient ones, incurring a double cost and, while the inefficient products are in use, incurring electricity and environmental costs arising from their use.

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98. *See* HOWARD GELLER ET AL., AM. COUNCIL FOR AN ENERGY-EFFICIENT ECON., UPDATE ON BRAZIL'S NATIONAL ELECTRICITY CONSERVATION PROGRAM (PROCEL) (1999) [hereinafter GELLER, UPDATE ON BRAZIL].

99. *See id.*

100. *See id.*

101. France, Germany and the United Kingdom have provisions requiring consideration of traffic-minimization measures in their land use planning. *See* International Energy Agency, *Energy Efficiency Policies 1999 & 2000: Cornerstone for a Sustainable Energy System, at* http://www.iea.org/pubs/newslett/eneeff/intro.htm (last modified Nov. 16, 1999) [hereinafter *Energy Efficiency Policies 1999 & 2000*].

102. For example, Denver, Colorado is expecting to incur a 1% fuel expenditure decrease per year and a 1.5% reduction in carbon dioxide emissions per year from its Green Fleets program by reducing the number of vehicles in its municipal fleet, decreasing the number of vehicle miles traveled, and focusing on buying only fuel efficient vehicles. By 2005, the Green Fleets program is expected to decrease its transportation expenditures by $106,000, and reduce carbon dioxide emissions 22%. These savings will be incurred despite the fact that the actual number of miles driven by the municipal fleet will have increased 19%. *See* ICLEI, Cities for Climate Protection, *Green Fleets Program, at* http://www.iclei.org/cases/c002-dgf.htm (last visited Mar. 22, 2001).

RENEWABLE ENERGY ALTERNATIVES

Renewable energy resources hold great promise for replacement of fossil fuels in many applications. Renewables include a considerable number of proven and emerging technologies, which permit the execution of needed tasks presently performed by use of fossil fuels. Thus electricity can be produced from the light of the sun via photovoltaic cells on individual buildings or for communities of buildings, or for the production of central station power in vast arrays; from the heat of the sun, again for localized tasks like heating swimming pools, providing homes with hot water or space heating, or providing central station power using fields of parabolic collectors focused on a fixed hot water source[103] or solar ponds; from the power of the wind; from the heat below the earth through various geothermal applications; from the power of ocean tides and waves; from the temperature variations between ocean surfaces and depths; from hydropower installations; from biomass crops grown for energy use or from crop waste cellulose to produce ethanol as a power fuel.

Use of renewable resources has grown markedly in the past decade due primarily to technology improvements and cost reductions. Many countries have significant renewable installations and programs. For example, Finland accesses about 30% of its electricity from renewable resources, 80% of which comes from biomass.[104] India's Renewable Energy Development Agency

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103. The largest solar thermal project was constructed by Luz International, Ltd., which constructed nine (I-IX) Solar Electric Generating System (SEGS) plants in the Mojave Desert. Generation costs have decreased by more than half since building the first plant. The cost of the SEGS I plant was $62 million ($4,500/kW), generation costs were 24 cents/kWh (in 1988 real levelized dollars). Investing $3,400/kW in improving technology reduced the generation costs of SEGS III-VI to 12 cents/kWh; investing $2,875/kW reduced costs further to between 8 and 10 cents/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.

In the end, Luz International was forced to file for bankruptcy and turn over the SEGS plants to its investors. 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 the credit could not be applied against the alternative minimum tax established in the 1986 Tax Reform Act, and the size limitation of PURPA's Qualifying Facility specifications for mandatory utility renewable purchases. *See* 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 modified Nov. 3, 1998) [hereinafter *Profiles in Renewable Energy*].

104. *See generally* SHUKLA ET AL., PEW CENTER ON GLOBAL CLIMATE CHANGE, ELECTRIC POWER OPTIONS IN INDIA 6 (Oct. 1999).

(IREDA), created in 1987, implemented a $430 million renewables program supported by multilateral and bilateral loans of $255 million, installing 980 MW of wind power by 1998 (placing India fourth in world installations), 250MW of biomass- fueled power and about 40MW of solar.[105] Over 2.5 million biogas plants have been installed and over 450,000 solar photovoltaic systems.[106] Indonesia has a goal of providing 1 million solar homes and already has delivered 200,000 systems towards this goal;[107] installment purchases contributed to this success, with the assistance of World Bank and GEF loans.[108]

Internationally, the use of wind energy was pioneered by Denmark, which is currently generating 7% of its electricity via wind energy.[109] A goal of 10% has been set for 2005 and estimates for the year 2030 reach 40-50%.[110] The basic support mechanism for wind energy in Denmark is a partial redemption of the Danish carbon dioxide tax levied on all electricity regardless of its origin.[111] There are 4,800 wind turbines in Denmark, more than 80% are owned by wind energy co-operatives or by individual farmers.[112] 100,000 families either own shares in wind co-operatives or own their own wind turbines.[113] Wind Power has become a big business for Denmark; it exports windmills to thirty-five countries and Denmark now accounts for more than 50% of all the devices manufactured in the world.[114]

A major market for renewable resources, particularly photovoltaic power, exists in the developing countries where some 2 billion people have no access to electricity. According to the World

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105. *See id.*

106. *See id.; see also*, UNDP, PROMOTING DEVELOPMENT WHILE LIMITING GREENHOUSE GAS EMISSIONS: TRENDS & BASELINES 70 (José Goldemberg & Walter Reid eds. 1999) [hereinafter TRENDS & BASELINES].

107. *See id.*

108. *See id.*

109. *See* Soren Krohn, *Danish Wind Turbines: An Industrial Success Story, at* http://www.windpower.dk/articles/success.htm (last modified Sept. 26, 2000).

110. *See id.*

111. *See id.*

112. *See id.*

113. *See id.; see also Profiles in Renewable Energy, supra* note 103. (U.S. Windpower, Inc. (USW) is currently operating twenty-three 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 $1,200/kW with generation costs of 7-9 cents/kWh, as opposed to 12 cents/kWh in 1981. Utilities have provided financial support so that USW could develop a larger, 360-kW horizontal-axis turbine, the 33M-VS.)

114. *See* Warren Hoge, *Denmark Moves Ahead in Wind Power*, N.Y. TIMES (Int'l Sec.), October 9, 1999.

Bank, 24% of the urban population and 67% of the rural population in developing countries are without electricity today.[115] This lack of grid electricity – and the fact that most developing countries are in the sun belt — creates great opportunities for use of solar energy resources to provide basic services such as refrigeration, irrigation and lighting. Solar resources like photovoltaics are particularly economical when the very high costs of grid electrification can be avoided.

For lighting, a photovoltaic compact fluorescent light system would be 100 times more efficient than kerosene, and a half million times more efficient than candles, used in the rural areas of many developing countries to provide night lighting. Photovoltaic systems also would avoid the high costs of standard power plants and the transmission and distribution systems they require for electric lighting that ultimately converts less than 1% of their original fuel energy to light.

Renewable energy resources require substantial up front capital costs, but solar, wind and hydroelectric technologies achieve considerable savings from costless fuels and low maintenance requirements. For those technologies which are not yet commercially competitive, financing is required to assist with raising the necessary initial capital in the developing countries.

The main constraints on the more widespread use of non-hydro renewable resources are the need for improved technology and lower costs. There also are some environmental restraints. New hydroelectric dams involve flooding of large areas of land and thus create environmental problems and usually problems of displacement of people or agriculture. The dammed water also creates some carbon dioxide and methane (another greenhouse gas) emissions from decaying vegetation.[116] Adding power to existing dams, however, does not create these problems. There is a considerable potential resource of electricity from small hydroelectric projects at dams built for other purposes. Wind and photovoltaic systems have some siting problems involving their aesthetics and some wind machines have problems with killing raptor birds that fly into the blades. With solar energy, legislation is needed to protect the sunlight access to the systems.

Today, hydroelectric power, geothermal generation, biomass, wind farms, and increasingly photovoltaics in developing coun-

115. Mills, *supra* note 24, at 8.

116. *See* UNDP, World Energy Assessment 58 (1999).

tries are well enough established technologically and sufficiently inexpensive to be utilized for supplying electricity to power grids. Photovoltaic cells are also economic and are being used for remote power installations where no grid exists and for niche applications, like powering transformers, marine navigation buoys and space vehicles.

ALTERNATIVE FUELS

Hydrogen

Hydrogen is the most promising alternative fuel for carbon dioxide emission reduction. It currently is produced from natural gas in a process relatively free of carbon dioxide and other pollutants,[117] although with improved and more economic technology, it can be produced from photovoltaic-powered electrolysis, separating hydrogen from water, and from some natural seawater resources.[118] Its most likely use is in fuel cells, which can be used for vehicle propulsion or stationary electricity production. Its combustion is virtually pollution free, recombining hydrogen and oxygen to release water.[119] It is transportable in pipelines and utilizable in solid or liquid form in vehicles. The challenge for its widespread adoption is to bring down the cost of both hydrogen production and fuel cells.

Nuclear

Nuclear energy is derived from plutonium or uranium processed with high energy use into forms capable of utilization in reactors. If fossil fuels are used as the energy source to refine the uranium, which is usual at present, then nuclear energy has much of the same carbon dioxide and pollution evils as direct fossil fuel combustion. In addition, substantial unsolved environmental problems and costs are involved in nuclear power waste disposal and plant decommissioning. Lastly, there are safety problems with nuclear power plant operations and risks of diversion of nuclear fuel (particularly plutonium) to weapons production. As a result of the precautions needed to assure safety and the very large capital costs of construction, waste disposal and decommis-

117. *See* IEAGHG, *Reducing Atmospheric Concentrations of Greenhouse Gases*, http://www.ieagreen.org.uk/doc3a.htm (last modified Nov. 6, 2000) [hereinafter IEAGHG].

118. *See id.*

119. *See id.*

sioning, nuclear power is uneconomic today in the United States and no new plants have been constructed for more than forty years. Indeed, nuclear power is the world's slowest growing energy source, just 1% in 1996;[120] worldwide around ninety nuclear plants have been retired after serving fewer than 17 years.[121] Nuclear power is widely used in Japan, the rest of Asia, and Europe, although there is now considerable public resistance to construction of new nuclear plants, particularly in Japan following a major recent accident.

Nevertheless, power production itself from nuclear reactors is free of carbon dioxide emissions. It is feasible that a new generation of smaller, less expensive, safer reactors can be produced, and doing so is the subject of substantial research in the United States and other nuclear power countries. However, the environmental risks and uncertainties still need to be addressed before nuclear power can be regarded as a partial solution to climate change. The problems of safe and economic waste disposal and decommissioning, uranium enrichment using non-fossil fuels, proliferation risks and other life cycle impacts first must be resolved.

LEGAL STRUCTURES IN USE FOR CLIMATE MITIGATION

Many legal structures have been successfully used around the world for realizing clean energy solutions by both the public and private sectors and in both developed and developing countries and their municipalities. The legal instruments discussed include economic and market mechanisms, government 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 legal structure has been applied. They are categorized here according to their predominant characteristic.

120. See LOVINS & LOVINS, *supra* note 11, at 8.

121. *See id.* Since nuclear power is the costliest way to displace fossil fuels, every dollar spent on it displaces less climatic risk than would have been avoided by spending the same dollar on conservation and renewable alternatives. *See id.* Nuclear power also is thought to be heavily subsidized in Europe and Japan, although the precise subsidies are unknown because they are kept secret.

ECONOMIC & MARKET MECHANISMS

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 clean 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 or more millions of dollars. Global annual energy subsidies are estimated at about $250-300 billion in the mid-1990s,[122] and that doesn't count the huge subsidies required to secure the supply of oil imports which has been estimated to produce a true oil cost of over $100 per barrel.[123] Revenues saved from subsidy-removal can be used to promote clean energy alternatives internally. The problem in achieving subsidy removal is political; recipients of subsidies get addicted to them and feel they can not 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 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. In many countries, fossil fuels are imported at great cost, displacing the ability to invest 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, which also can be domestically produced.

Developing countries like China are eliminating coal subsidies, downsizing coal production, and creating major renewable energy industries that can export worldwide.[124] China's actions are particularly remarkable. Between 1990 and 1997, annual fossil fuel subsidies in China fell from $24.5 billion to $10 billion.[125]

122. *See id.*
123. *See id.*; *see also* ENERGY AFTER RIO, *supra* note 41.
124. *See* LOVINS & LOVINS, *supra* note 11, at 10.
125. *See* Christopher Flavin & Seth Dunn, *Rising Sun, Gathering Winds: Policies to Stabilize the Climate and Strengthen Economies*, WORLDWATCH (Nov. 1997), at 28.

Coal subsidy rates fell from 61% in 1984 to 37% in 1990 to 29% in 1995, and further since then.[126] Petroleum subsidies fell from 55% in 1990 to 2% in 1995.[127] In 1999, 26,000 coal mines were to be closed out of the 75,000 mines remaining; between 1990 and 1999 over 1.3 million jobs were lost in this sector.

Poland has decreased its fossil fuel subsidies by $3 billion per year.[128] These reductions led to an overall 30% decrease in the amount of coal used between 1987 and 1994.[129] Since 1990, Russia has lowered fuel subsidies by more than 50%, decreasing its carbon emissions beyond 30%.[130] The United Kingdom decreased coal subsidies from $7 billion in 1989 to zero in 1995.[131] This has led to an increase in the use of North Sea natural gas by 62% while carbon emissions have fallen consistently during the five-year period between 1990 and 1995.[132]

On the other hand, there are countries that are not making comparable strides in reducing incentives and subsidies promoting greenhouse gas emissions. For instance, the United States is delving out fossil fuel supports as high as $18.3 billion a year.[133] Germany is still requiring its electric utilities to purchase domestic coal, and has increased the amount of money funding subsidies by more than 50%.[134] Canada's tax incentives amount to $6 billion per year.[135] France and Japan, while reducing the amount of money available for fossil fuel supports are still providing substantial incentives for the use of coal, $722 million or $149/ton.[136]

The political difficulties of eliminating subsidies and the transition problems for local economies in fossil-producing countries can not be minimized. Nevertheless, countries such as Brazil, China, the Czech Republic, India, the Netherlands, Poland and Russia have reduced or eliminated fossil fuel subsidies successfully. Eliminating fossil fuel subsidies really is a *sine qua non* of reducing carbon dioxide emissions.

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126. *See* LOVINS & LOVINS, *supra* note 11, at 10.
127. *See id.*
128. *See* Flavin & Dunn, *supra* note 125, at 26.
129. *See id.*
130. *See id.*
131. *See id.*
132. *See id.*
133. *See* Flavin & Dunn, *supra* note 125, at 27.
134. *See id.*
135. *See id.*
136. *See id.* at 28.

Inclusion of Externality Costs

A legislative or regulatory requirement for consideration of externality costs can materially 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. 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.[137] Some of these studies calculate that the externality costs of burning coal for electricity can be greater than the generation costs.[138] No accurate assessment can be made of the comparative costs of clean energy without inclusion of externality costs. Some state utility regulatory commissions in the United States had required that externality costs be included in selection of new electric service resources, but these measures were abandoned by many utilities with the prospect of deregulation.

Use of Life-cycle Costs

The costs of introducing clean energy resources often entail substantial first cost investments, but the savings over the life of these resources make them cheaper than fossil fuel alternatives over time. This phenomenon is particularly evident with efficiency measures and with solar, hydroelectric and wind energy resources where the first cost of equipment acquisition can be considerable, but the total absence of fuel costs and very low maintenance costs result in their being much more economically competitive with fossil fuels over the anticipated life of their 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 the utilization of life cycle costing are feasible and costless. Life-cycle costing also was required by utility commission regulations in a number of states in the United States, but this requirement, too, has now been abandoned by many utilities due to perceived competitive pressures from deregulation.

137. For example, it has been estimated that just the health cost of air emissions in Cairo may exceed $1 billion a year. Mark Bernstein et al., Pew Center on Global Climate Change, Developing Countries & Global Change: Electric Power Options for Growth (1999).

138. Richard Ottinger et al., *Environmental Costs of Electricity*, Oceana Publications, Inc. (1991).

Pollution Taxes

Taxing pollutants or polluting fuels can be an effective way of promoting emission reductions in the marketplace. 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 reduce emissions.

Taxation of carbon dioxide emissions or polluting fuels is one of the most direct ways of addressing global warming.[139] Carbon 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). For example, Sweden instituted environmental taxes including one on carbon dioxide in 1991 (except on the generation of electricity), and on NOx emissions in 1992.[140] The carbon tax was levied at 25% of the rate applied to other users in 1993 but rose to 50% of that levied on other users in 1997.[141]

Pollution taxes are politically difficult since inevitably some energy-intensive industries and jobs are affected. If the pollution taxes are offset by reductions in other business taxes, they can produce a net economic benefit.[142] The political difficulty is illustrated by the fact that in a number of the countries that have legislated carbon taxes, major industries have been exempted to avoid competitive disadvantage to domestic production. Ideally, carbon taxes should be imposed internationally to eliminate adverse competitive effects, but the political difficulty is so great that such taxes are not even on the table for discussion at the Kyoto implementation negotiations of the conferences of the parties.

139. The potential of carbon taxes as a funding mechanism is enormous, however. A carbon tax of just $1 per ton on fossil fuel use in 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 R&D needs of the world over the next 20 years. Such a tax in the U.S. would increase energy prices less than 0.3% or less than $6 per capita per year. *See* World Energy Commission, *Carbon Dioxide Emissions 1990-1996 Appendix*, *at* http://www.worldenergy.org/wec-geis/publications/open.plx?file=archives/tech_papers/other_tech_papers/WECco2rpt97app.htm (last visited Mar. 22, 2001).

140. *See Research Panel on Economic Instruments such as Taxation and Charges in Environmental Policies, Chapter 1: The Situation of Environmental Taxes in Foreign Countries*, *at* http://www.eic.or.jp/eanet/en/org/tax/ch1.html (last visited Mar. 22, 2001).

141. *See id.*

142. *See* TELLUS INSTITUTE, ECOLOGICAL TAX REFORM: CARBON TAXES WITH TAX REDUCTIONS IN NEW YORK, *available at* http://www.tellus.org/energy/publicatios/nyexecsm.html (last modified Mar. 12, 2001).

The competitive effects of carbon taxes can be ameliorated with border tariffs and rebates.

Emission Trading

An interesting innovation in reducing the costs of sulfur dioxide and NOx emissions in the United States has been to provide for emission trading rights. 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. The advantage of emission trading rights over pollution tax is that the pollution cap underlying trading rights assures specified carbon dioxide emission reductions, whereas the effects on emissions of taxes is somewhat speculative. The Norwegian government, therefore, has just decided to consider replacing its carbon tax, which has not resulted in sufficient carbon reduction to meet its goals, with an emissions cap and emission trading rights.[143] Some environmental groups object to the grant of a legal right to pollute. International emission trading rights for carbon dioxide are now being debated as a means of reducing the costs of climate change measures in the Kyoto Protocol conferences of the parties' implementation negotiations.

Technology Incentives

While long-term subsidization of any fuel, technology or product distorts the market and is therefore theoretically undesirable, temporary subsidies to bring new technologies into the marketplace can be effective, useful, and often essential to accelerate their market acceptance. Also, where fossil fuel subsidies persist, non-fossil fuel subsidies are justifiable to level the playing field for them.

A good example of effective use of such temporary incentives is found in Denmark's introduction of wind power. From the start of its wind power program in 1976 through 1996, the Danish Government spent $75 million on wind turbine R&D.[144] The Government then provided subsidies for up to 30% of the investment costs of a turbine in 1980, which was reduced to 15% in 1984 and

143. *See generally* Norway Ministry of the Environment, *A Quota System for Greenhouse Gases,* http://balder.dep.no/md/publ/2000/greenhouse/report.html (Dec. 17, 1999).

144. *See* CURTIS MOORE & JACK IHLE, RENEWABLE ENERGY POLICY PROJECT, RENEWABLE POLICY OUTSIDE THE UNITED STATES (Issue Brief No. 14, 1999).

repealed in 1989 as the market accepted the new technology.[145] The Government now requires Danish power companies to pay 85% of the retail electricity price of wind energy, paid for by rebates of carbon taxes on fossil fuels.[146] Consumers now pay less for wind power than for power from coal. As a result of this program, Denmark now has over half of the world sales of wind turbines.[147] Its turbine production now provides about 60% of new wind turbines installed throughout the world, produces revenues of nearly $1 billion a year and has provided over 16,000 jobs.[148] Today, 100,000 Danish families own wind turbines or shares in wind cooperatives.[149]

The Poland Efficient Lighting Project, financed by the Global Environment Fund of the World Bank established a three year program to subsidize compact fluorescent lamp sales.[150] At the end of the program in 1997 some 1.2 million lamps had been installed and 80% of the buyers indicated an intent to buy these efficient lights again.[151] Energy savings from the program were estimated at 725GWh and 206,000 tons equivalent of carbon emissions over the lifetime of the lamps.[152] The subsidy cost less than $25 per ton of avoided carbon emissions.[153]

Germany has had great success with its Electricity Feed Law (EFL) subsidizing the purchase of renewable resources. EFL requires utilities to pay 90% of the retail residential price for electricity produced by wind, solar, hydropower and biomass resources.[154] 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 2,081 MW, the highest in the world.[155] EFL also stimulated a 450% increase in photovoltaic installations from 1991 to 1997, with a 37% drop in prices.[156] German companies such as Siemens now lead the world in photo-

145. *See id.*

146. *See id.*

147. *See id.*

148. *See id.*

149. *See* MOORE & IHLE, *supra* note 144.

150. *See* IIEC, Region and Project Office, at http://www.cerf.org/iiec/offices/e-project.htm (last modified Oct. 26, 2000).

151. *See id*

152. *See id.*

153. *See id.*

154. *See* MOORE & IHLE, *supra* note 144.

155. *See id.*

156. *See id.*

voltaic sales.[157] Germany has begun a "100,000 Roofs" photovoltaic program, with low interest loans to be issued by private banks, which promises to be the largest single photovoltaic subsidy program in the world.[158]

Sweden used a competition among suppliers to encourage manufacturers to improve the efficiency of a wide variety of home appliances. The improved performance of the winning model of a refrigerator-freezer was remarkable, using more than 30% less electricity than the most efficient model then on the market.[159] There have been similar successful competitions run by the U.S. Department of Energy under its "Golden Carrot" program discussed below.[160]

Vehicle Replacement Incentives

Since the most polluting vehicles tend to be older models, legislation creating an incentive to replace existing vehicles with new less polluting models could be very effective. Such incentives have been proposed but not adopted in the U.S. Congress. The opportunities for emission reductions are enormous. For example, 65% of the cars in Egypt are over 10 years old, 25% are more than 20 years old, and 25% of the buses are over 15 years old.[161] These figures are typical for most developing countries. "Feebates" have been suggested — charging a fee on inefficient vehicles which would pay for granting a rebate for the purchase of more efficient models, best calibrated to the difference in efficiency between the old vehicle, which would be required to be scrapped, and the newer one purchased with the rebate.[162] Unfortunately, there were no programs identified to retire older vehicles. There also are no international measures to prevent the sale of inefficient vehicles retired by industrialized countries to developing countries, a major problem for the latter.

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157. *See id.*

158. *See id.* at 3.

159. See LOVINS & LOVINS, *supra* note 11, at 17.

160. *See* M. Ledbetter et al., *US Energy-Efficient Technology Procurement Projects: Evaluation and Lessons Learned,* BATTELLE PAC. N.W. NAT'L LAB. PNNL-12118 (Feb. 1999).

161. *See id.*

162. *See id.*

Environmental Disclosure

A number of states have required disclosure by their utilities of their emissions and the sources of their power generation. Information required typically includes the reporting of generation sources, fuel mix, fuel emissions, kWh price, price volatility, and contract terms.[163] 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. Disclosure requirements have been imposed by many U.S. states.[164]

STANDARDS

Standards are a particularly effective way of assuring that emission reductions will be achieved. Standards for minimum efficiency performance of products like appliances, light fixtures, ballasts, motors, and the like, are effective in removing from the marketplace the least efficient products. Politically, standards can only be set where technological and economic feasibility has been demonstrated and where the businesses affected can be persuaded to agree to the level of control. They therefore generally represent minimum rather than maximum feasible achievements. Information programs, labels and incentives are needed to persuade manufacturers and vendors to go beyond the standards. Also, many products involve rapid technological change so that standards can become quickly obsolete. Regular updating of the standards is therefore required. Standards also must be set with care as to their applicability. For example, it makes sense to require installation of compact fluorescent lamps only where usage is reasonably high; they may be uneconomic where lamps are only used a few hours a day. Also, it is difficult to use standards for new technologies that are still relatively unproven and costly, in which case information, incentive and R&D programs may be more appropriate. Lastly, standards are ineffective if not enforced, so regular reporting, inspections and enforcement mechanisms

163. *See id.*

164. *See* MARTIN KUSHLER, AM. COUNCIL FOR AN ENERGY-EFFICIENT ECON., AN UPDATED STATUS REPORT OF PUBLIC BENEFIT PROGRAMS IN AN EVOLVING ELECTRIC UTILITY INDUSTRY 12 (Sept. 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. *See id.*

must be included, as well as training of the personnel who will be involved with their application.

Pollution Standards

Legislated standards for air polluting emissions from power plants and tailpipe emissions from vehicles can be very effective in promoting clean energy. The United States (through its Clean Air Act[165]), most European countries and many developing countries have adopted such standards.[166] Power plant standards are usually adopted for emissions of sulfur dioxide, nitrogen oxides, particulates and sometimes mercury. Legislated vehicle pollution standards place numerical limits on tailpipe emissions.[167] They usually include requirements for annual vehicle inspections for compliance with the standards as a condition of registering the vehicle; catalytic converters to remove pollutants at the tailpipe; and require elimination of lead from gasoline.[168] These standards, by making it more expensive to use fossil fuels, encourage the use of cleaner alternatives. Of course, the standards also reduce the health, mortality and environmental effects of air pollutants, so there is a double dividend. The costs in terms of more expensive electricity or automobiles, have been slight.

Environmental Impact Assessments

One of the most effective pollution control mechanisms is the environmental impact assessment or statement such as required for all major "federal actions significantly affecting the quality of the human environment" by the National Environmental Policy Act of 1969.[169] The statements 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.[170] Assessments that do not conform to the Act can be challenged in court, a measure which has been very effective in assuring that the consequences of proposed actions be considered

165. *See* Clean Air Act (CAA), 42 U.S.C. §§ 7401-7671q (1994).

166. *See* Nicholas A. Robinson, Environmental Law Methodologies to Contain Greenhouse Gases, Speech at the Millennium Conference on Energy, Environment & Clean Mobility.

167. *See* CAA, 42 U.S.C. §§ 7651-7651o.

168. *See id.*

169. *See* National Environmental Policy Review Act, 42 U.S.C. §§ 4321-4379 (1994) (particularly § 4332 (C)).

170. *See id.*

before they are implemented. The environmental impact assessment offers an immediate legal method to curb greenhouse gas emissions. More than 175 countries have enacted their own environmental impact legislation and assessments have been required in a number of international environmental treaties such as Article 206 of the U.N. Convention on the Law of the Sea.[171] The World Bank and other multilateral banks require such assessments under their administrative procedures.[172]

Building Codes & Standards

Most countries have adopted standards for construction of new buildings. Many have now included energy requirements in these building standards. All the IEA countries have energy requirements as a part of their building codes and many recently are strengthening them.[173] For example, France is adopting more stringent thermal regulations for new residential and commercial buildings with the aim of improving energy efficiency by 25%.[174] Building energy 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 Energy Conservation Code),[175] have been adopted in the United States by thirty-two states, and "good practice" commercial energy codes, as defined by the ASHRAE 90.1-1989 model standard,[176] have been adopted by twenty-nine states.[177] The Energy Policy Act of 1992 (EPAct)[178] 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. Experience in the U.S. has shown building codes can reduce space conditioning energy use in new buildings by 25% or more.[179] Legislation to give tax credits

171. *See id.*

172. *See* Nicholas Robinson, Environmental Law Systems for Sustainable Energy, Speech at the Clean Energy 2000 Conference, Geneva, Switzerland (Jan. 24-28, 2000).

173. *See Energy Efficiency Policies 1999 & 2000*, *supra* note 101.

174. *See id.*

175. *See* Bldg. Codes Assistance Project, *So What's this MEC Anyway. . .*, http://www.bcap-energy/mecbkgrd.html (last modified Mar. 30, 1999).

176. *See id.*

177. *See* GELLER, MEETING AMERICA'S KYOTO PROTOCOL TARGET, *supra* note 7.

178. *See* Energy Policy Act of 1992, Pub. L.102-486, 106 Stat. 2776, Title VII (Oct. 24, 1992).

179. *See* GELLER, MEETING AMERICA'S KYOTO PROTOCOL TARGET, *supra* note 7, at 5.

for highly efficient new housing was introduced but not passed by the U.S. Congress in 1999.[180]

Carbon emissions from existing buildings also can be substantially reduced through cost-effective retrofits. For example, an evaluation of the U.S. national weatherization assistance program found that retrofits of low-income housing carried out during 1990-96 typically reduced natural gas consumption for space heating by 34%. Also, retrofits of fifteen office buildings as a part of EPA's ENERGY STAR Showcase Buildings partnership reduced energy consumption by 30% on average. The technologies that can be used to upgrade efficiency include adding insulation to walls and attics, replacing older windows with energy efficient windows[181], sealing leaky heating and cooling air ducts, sealing air leaks in the building envelope, upgrading heating and cooling systems, replacing inefficient lighting, and installing control systems.[182] Ordinances requiring retrofits of existing buildings have been adopted in the U.S. cities such as San Francisco, CA, Minneapolis, MN, and Burlington, VT.[183] Energy audits of buildings also have been adopted in various jurisdictions, for example in Luxembourg on a voluntary basis.[184]

One measure worth pursuing is a law, adopted in some U.S. states, requiring that homes or commercial buildings be inspected at the time of resale, with a retrofit requirement for buildings that are found not to be up to standards.

Appliance Efficiency Standards

Legislated standards for appliance efficiency are particularly needed because most appliances are bought, not by bill payers, but by landlords, home builders and public housing authorities who have no economic interest in saving energy in selecting them; quite to the contrary, they are more likely to select buying the appliances which have the lowest first cost regardless of energy consumption. While incentives and appliance labeling for energy

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180. *Id.* at 4.

181. Efficient windows can insulate fourfold better and let in six times as much daylight but a tenth of the unwanted heat than conventional unglazed windows, while at the same time cutting air conditioning energy needs fourfold. This saves about enough money to pay for the extra costs of the windows. The retrofit, saving of three-quarters of the energy, then costs essentially the same as a routine renovation that saves nothing. *See* LOVINS & LOVINS, *supra* note 11, at 6.

182. *See id.* at 5.

183. *See id.* at 6.

184. *See Energy Efficiency Policies 1999 & 2000, supra* note 101.

efficiency (which is required in the United States and many other countries), can be helpful in exceeding standards, only standards can assure that at least the most inefficient models will be removed from the market.[185]

Residential and commercial buildings currently account for 36.5% of national energy use in the United States, mostly consumed by heating and cooling equipment and electric appliances. Approximately 85% of residential energy is consumed in furnaces, boilers, air conditioners, heat pumps, refrigerators, water heaters, clothes washers and dryers, ranges and dishwashers. Sixty-five percent of commercial energy consumption occurs in heating, cooling, lighting, water heating, refrigeration, and office equipment. In industry, lighting equipment and electric motors account for more than 75% of electricity consumption.[186]

The U.S. has adopted a broad range of appliance efficiency standards starting in 1987, on fluorescent ballasts in 1988, and on a variety of commercial and industrial equipment in 1992. It is estimated that the U.S. standards cumulatively will reduce electricity use in the U.S. by 2.7% in 2000 and 6% by 2015.[187] An U.S. Energy Information Administration study finds that a 10-20% increase in these standards would lead to an 8 million metric ton reduction of carbon emissions in 2010 and would further reduce carbon emissions by 20-23 million metric tons in 2020.[188]

A number of other countries have adopted appliance efficiency standards. For example, The European Union has adopted direc-

185. There are several reasons that the marketplace can and does not by itself attract the sale of the most efficient appliances. Lack of knowledge is a major factor, particularly in the residential sector. In the commercial and industrial sectors, purchasing decisions are often made by purchasing or maintenance staff who have little knowledge about or interest in the efficiency of the equipment they order they tend to purchase the equipment that is lowest first cost, regardless of the cost of the energy used by the equipment, and they are judged by their superiors accordingly. Even were they to purchase efficient equipment, the savings would not accrue to their departments. Furthermore, efficient equipment is often not stocked sufficiently by suppliers because of inadequate demand, thus requiring special orders and long lead times for delivery of the equipment. Developers and landlords have little interest in buying efficient equipment where they do not pay the energy bills. These are substantial barriers to the introduction of efficient equipment in the marketplace and a principal reason for the need for appliance efficiency standards. Incentives can be used to go beyond the standards. *See* LOVINS & LOVINS, *supra* note 11, at 5-6.

186. *See* GELLER, APPROACHING THE KYOTO TARGETS, *supra* note 18, at 5 (Aug. 1998).

187. *See id.* at 7.

188. *See* Energy Info. Admin., *Annual Energy Outlook 2000 with Projections to 2020*, *at* http://www.eia.doe.gov/oiaf/aeo/ (last modified Jan. 30, 2001) [hereinafter EIA].

tives for its members to create energy efficiency standards for hot water heaters and boilers, refrigerators, freezers, washing machines and tumble dryers. Argentina has adopted home electrical appliance efficiency standards in place for refrigerators and freezers, with labeling commencing by mid-2000, with standards and labeling for washing machines in progress.[189]

The European Commission also developed efficiency targets to reduce standby power consumption for TVs and VCRs. In implementing these targets, the Swiss Federal Office of Energy, pursuant to a Swiss statute, provided that if the industry fails to meet the target values by a specified date, it would set mandatory minimum efficiency standards for these appliances; it also provides for mandatory labeling of these products and a stiff reporting requirement. The results of the report for 1994 to 1996 show that TV and VCR sales for models with standby power of 5 Watts or less increased from 36% to 44%, while appliances using more than 10 Watts in standby power dropped from 19% to 8%. The U.S. EPA voluntary standard for standby energy in TVs and VCRs has been estimated to have a potential to save, at zero cost, about 8 million tons of carbon per year – as much as 8 million cars now emit.[190]

Over time, these standards result in considerable economic savings for consumers and society. While the first cost of the efficient appliances often is slightly more than inefficient models, the economic savings over the life of the appliance can be very significant and the savings to society from reduction of energy demand also are great, resulting in decreased use of polluting fossil fuels and thus promoting cleaner energy. In developing countries there may be a need to provide for initial assistance to enable purchasers to pay for the higher cost of the efficient appliances.

Renewable Portfolio Standards

In the United States and other countries, renewable portfolio standards have been adopted or are being considered. These standards require electric utilities to purchase a certain percentage of their power from renewable resources. As of mid-1999, nine states (Arizona, Connecticut, California, Maine, Massachusetts, Nevada, New Jersey, Texas and Wisconsin) had adopted some form of renewable portfolio standard utility requirement. Going even further, Massachusetts and Connecticut regulatory commis-

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189. *See Energy Efficiency Policies 1999 & 2000*, *supra* note 101.
190. *See* LOVINS & LOVINS, *supra* note 11, at 16.

sions have required a Generation Portfolio Standard, requiring each distribution company to offer a mix of generation sources that will meet federal and state air pollution standards.[191]

Legislation has been proposed in Congress and by the Clinton Administration to create a national renewable portfolio standard of 7.5% non-hydro renewables by 2010 and 20% by 2020 (compared to 2.3% of U.S. electricity supply today).[192] The U.S. Energy Information Administration estimates that this standard would reduce U.S. carbon emissions by 19 million metric tons by 2010.[193] If such standards were to be widely adopted, they would allow mass production of renewable energy generation equipment, substantially reducing the costs, particularly of solar photovoltaic cells and wind machines, thus making them more competitive against fossil fuels.

The United Kingdom has enacted a similar Non-Fossil Fuel Obligation (NFFO). After the UK's deregulation of its electric utility industry in 1989, it created Regional Electricity Companies (RECs) which in 1992 were required to purchase 1,500 MW of non-fossil generated power by the year 2000 in a series of auctions, five of which have now taken place. These auctions were so successful that 3,271 MW of non-fossil power has been purchased at the auctions, far in excess of the 1,500 MW requirement. The program's 15-year contracts with 5-year repayment grace periods permit reasonable financing of projects. The auction device has driven renewable prices down to about 4.3 cents/kWh (very close to the electricity pool price of 4.2 cents). 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.[194]

Argentina, Denmark and Germany also have adopted utility renewable requirements. 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 utili-

191. *See* GELLER, MEETING AMERICA'S KYOTO PROTOCOL TARGET, *supra* note 7, at 9.
192. *See id.*
193. *See* EIA, *supra* note 188.
194. *See* MOORE & IHLE, *supra* note 144, at 12-15.

ties may either develop renewable resources themselves or purchase credits from other renewable generators. The extra costs of renewable purchases are handed down to all of the utility's customers.[195]

Japan adopted a "Project Sunshine" under which the government subsidizes photovoltaic purchases by utilities to meet a Ten Thousand Roofs goal, and in 1997 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). While there is no purchase requirement, the government's requests to suppliers are the effective equivalent of a required standard under the Japanese system.[196]

Vehicle Standards

Legislation regulating the vehicle miles per gallon standards for all vehicles sold can also make a big impact on pollution reduction, thus promoting cleaner energy policies. The U.S. Congress enacted Corporate Average Fuel Economy (CAFE) standards during the energy crisis in 1975, and Canada adopted a similar Motor Vehicle Fuel Efficiency Program with voluntary standards.[197] The U.S. CAFE standards provide that the passenger automobiles produced by each manufacturer must average a prescribed miles per gallon, with a lesser standard for light trucks. As a result, the average miles per gallon of the U.S. passenger automobile fleet was increased from 17 mpg in the 1970s to a high of 25.9 mpg in 1988.[198]

However, with the recent introduction of highly popular larger "sports utility vehicles," which unfortunately were classified as light trucks, and the increased use of light trucks for passenger use, the average mpg in the U.S. has been reduced to 23.8 mpg today. Congress has resisted strengthening the standards and turned down a proposal for a modest gasoline tax increase at the beginning of the Clinton Administration.[199] In December,

195. *See id.* at 4.

196. *See id.* at 9.

197. *See Energy Efficiency Policies 1999 and 2000, supra* note 101.

198. *See* GELLER, MEETING AMERICA'S KYOTO PROTOCOL TARGET, *supra* note 7, at 9.

199. Greenhouse gas standards for motor fuels also have been proposed, similar to the renewable portfolio standards for electricity generation, at a 5% emissions reduction in 2010, increasing 1% per year to a 15% reduction by 2020, supplemented by expanded R&D and market creation programs and financial incentives to stimulate the production of low-carbon fuels such as cellulosic ethanol and biomass-or solar-based hydrogen. *See id.* at 10-11.

1999, however, the Administration was successful in reaching an agreement with the automobile manufacturers and the oil industry to apply stricter standards for sports utility vehicles and light trucks together with a mandate for production of gasoline with a lower sulfur content, both of which measures will substantially reduce vehicle pollution and carbon dioxide emissions.[200]

In other countries, similar programs have been adopted in the form of negotiated agreements between governments and that auto industry. Australia, for example, entered an agreement to reduce national average fuel consumption for new cars and required the use of a mandatory fuel efficiency label. The German auto industry is committed to a 25% reduction in cars built and sold between 1990 and 2005. Italy and Japan have similar programs. In Switzerland, a voluntary program was enacted calling for a 15% fuel consumption between 1996 and 2001, with the authority to adopt mandatory reduction regulations if this target is not reached.[201]

Other vehicle measures adopted include multiple-occupancy vehicle lanes on highways and car-pooling incentives including company-provided vanpools, elimination of free parking by business establishments and parking fees. These measures have been adopted in a good number of U.S. states.[202] France and Italy even have gone so far as to limit city parking to alternate days for odd and even license numbers and create "No Car Days."[203]

Enforcement

Effective enforcement is critical to the success of any standards program. Theoretically, the governments adopting the standards should enforce them, and any standards program, to be effective, should incorporate substantial resources for training, inspection and enforcement. In practice, however, governments and their regulatory agencies often come to identify with the indus-

200. *See* Keith Bradsher, *Clinton Allays Criticism on New Pollution Rules*, N.Y. TIMES, Dec. 22, 1999, at 1.

201. *See Energy Efficient Policies 1999 & 2000*, *supra* note 101.

202. A 1997 U.S. legal innovation permitted employers to cash out employee parking spaces, charging fair market value for each space and paying each employee a commuter allowance of equal after tax value, typically reducing demand for parking spaces which often cost $10,000-$30,000 each. Singapore charges drivers automatically registered toll fees designed to make them pay the social costs of driving and invests the proceeds in public transit and coordinated land use, with the result that it is virtually congestion-free. *See* LOVINS & LOVINS, *supra* note 11, at 16.

203. *See Energy Efficient Policies 1999 & 2000*, *supra* note 101.

tries or companies that they regulate. Also, political pressures often prevent effective government enforcement. Citizen enforcement, adopted in the United States in the Clean Air Act[204] and other environmental statutes has been found to be a most effective enforcement mechanism. NGOs in the United States are able to hold regulators' feet to the fire very effectively 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.

UTILITY PROGRAMS & REGULATORY REQUIREMENTS

Utility Incentives

Utilities in many states of the United States until recently were required by regulatory commissions to undertake integrated resource planning (IRP), including energy efficiency "demand-side management" (DSM) and renewable resources. They were required to provide incentives to their customers to purchase energy efficient lighting and appliances and to provide free or low cost energy audits to residential, commercial and industrial customers to help them identify efficiency opportunities. These utility incentives were very effective in a regulated environment, but with the prospect of deregulation, the utilities have been allowed to cut back on these incentive programs for fear that their costs would make the utilities uncompetitive with those without incentive requirements — even though efficiency investments were made profitable for the utilities by the regulators[205] and the fact that efficiency investments save energy at a cost far less than new power plant construction. Utility spending on energy-efficiency programs has declined from about $1.4 billion in 1992 to about $1.2 billion in 1996, with continuing declines to date and projected, despite the fact that only a handful of states have passed restructuring legislation.[206]

Other countries have been more aggressive in their utility regulation to promote efficiency. In Brazil, for example, a new federal utility regulatory agency in July, 1998, required all distri-

204. 42 U.S.C. §§ 7401-7671.

205. These states simply decoupled utility profits from sales, letting utilities keep as extra profit part of the savings from energy efficiency measures they financed. *See* LOVINS & LOVINS, supra note 11, at 15.

206. *See* JOSEPH ETO 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).

bution utilities to spend at least 1% of their revenues on energy efficiency improvements, with at least 1.4% of this amount (about $50 million per year) to be spent on end-use efficiency projects.[207] Utilities in Australia, Austria, Belgium, Canada, Germany and Ireland also have IRP and DSM requirements.[208] Ontario Hydro of Canada placed its primary emphasis on end-use efficiency and distribution planning to displace building transmission and generating capacity. Its first three experiments programs cut its investment needs by up to 90%, saving it $600 million.[209]

Application of utility incentives to rental apartment buildings can be a problem. The tenants have no incentive to install measures that will benefit the landlord and the landlord has little incentive to invest in measures that primarily will benefit the tenants. Some state utility regulators have addressed this problem by giving larger incentives to the landlords. To induce tenant cooperation, it is important that apartments be individually metered for electricity and gas consumption. Brazil has an extensive metering program run by PROCEL, a national electricity conservation program, and its national utility.[210]

In the U.S. states that have deregulated their utility generation, environmental advocates have been quite successful in getting utility regulators or 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; the revenues from these charges often are placed in independently administered public benefit funds. As of July 1999, fifteen U.S. states have adopted utility system benefit charges and benefit funds.[211] A national public benefits trust fund of .2 cents/kWh (which would cost the typical residential customer only about $1 per month) has been introduced in the U.S. Congress and a similar but smaller provision is included in the Clinton Administration's federal utility restructuring proposal.[212]

For example, in August 1996 the Rhode Island legislature and regulatory commission authorized electric distribution companies

207. *See* GELLER, UPDATE ON BRAZIL, *supra* note 98, at 9.

208. *See Energy Efficiency Policies 1999 & 2000, supra* note 101.

209. *See* LOVINS & LOVINS, *supra* note 11, at 14.

210. *See* GELLER, UPDATE ON BRAZIL, *supra* note 98, at 9.

211. State restructuring funds are being used to finance energy R&D, energy efficiency programs, renewable energy programs and low income programs. For a good discussion of these state programs *see* KUSHLER, *supra* note 164; *see also* ETO, *supra* note 206.

212. *See* GELLER, MEETING AMERICA'S KYOTO PROTOCOL TARGET, *supra* note 7.

to levy a charge of at least 2.3 mills per kWh for energy efficiency and renewables; about $17 million per 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. In the Pacific Northwest, the governors of the states of Idaho, Montana, Oregon and Washington recommended that each state spend about 3% 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. The California legislature adopted a charge on the distribution utilities of about $1.8 billion in funding between 1998 and 2001 for energy efficiency, renewable resources and related R&D, with program administrators to be selected competitively by the regulatory commission.[213]

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. Norway adopted a small transmission tax earmarked for energy efficiency information, and it created and funded independent regional conservation centers to provide energy efficiency services. 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 3-year period.[214]

A new entrepreneurship of Energy Service Companies (ESCOs) has emerged to perform energy efficiency retrofits for homes and businesses as a profitable enterprise, but they have so far only penetrated niche markets for large customers in the United States.[215] 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, rewarding performance measured against specific bench marks.[216] Some commissions have placed a price cap on utility charges, giving the utilities an incentive to keep costs low; a revenue cap is far superior, however, since a

213. *See* ETO ET AL., *supra* note 206.

214. *See id.*

215. *See id.* at 14.

216. *See* TRENDS & BASELINES, *supra* note 106.

price cap provides strong incentives for utilities to increase sales and thus discourages efficiency and renewable investments.[217]

Utility Purchases

A number of U.S. utilities have acquired renewable resources for their own use. For example, The Pacific Gas and Electric Company (PG&E) uses 1,100 PV systems to produce a combined total of 44 kW 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 costs from $1.50/kWh in 1980 to a range of $.30-$.40/kWh today.[218]

Utilities benefit by using PV systems that are often the most cost-effective solution for specialized applications because of their 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, in place of transformers, to handle small loads.[219]

Green Marketing

A number of U.S. utilities offer an option to customers to purchase a package of green generation products at a slight premium in cost. The programs are too new to provide a good assessment of their effectiveness in reducing carbon dioxide and other pollutants. Other countries such as The Netherlands have created a green pricing program permitting consumers to purchase renewables at a small premium.[220]

A particularly ingenious and promising *"Green Power for a Green LA"* program was just announced in June of 1999 by the Los Angeles, California municipal utility. It commits to customers that choose a 6% rate increase (about $3 per month on average) to use the entire rate increase proceeds to invest in new renewable generation sources, combined with a commitment to install free energy efficiency measures for subscribers, assuring that participating customer bills will as a result experience a net decrease – a strong incentive for participation. The utility president, David Freeman, one of the world's clean energy pioneers, has thus found

217. *See* ETO ET AL., *supra* note 206.
218. *See Profiles in Renewable Energy*, *supra* note 103.
219. *See id.*
220. *See* MOORE & IHLE, *supra* note 144.

a way to finance new renewable resources in a way which demonstrably will be at no cost to the customers, creating a unique win-win financing arrangement.[221]

GOVERNMENT SPONSORED PROGRAMS

Government Procurement

All governments are major energy users. Legislation or regulation to require purchase by federal, state and/or municipal governments of clean energy products and processes can do much to reduce green house gas emissions directly. Government procurements of green products also create markets to bring down their prices and set an example of the feasibility of their use for the private sector.

In the United States, the government is the world's largest single buyer of energy-using products, accounting for over $10 billion of such purchases each year.[222] The U.S. Government, through legislation and executive orders, has required that all U.S. federal agencies must use 30% less energy per square foot in their buildings than they consumed in 1985 and 35% less in 2010. In implementing these requirements, the Federal Energy Management Program requires the use of energy efficient lights and appliances in all its buildings and has adopted strict energy efficiency requirements for the construction of its buildings.[223] All federal agencies are required to purchase only products that qualify for the ENERGY STAR label, or, where there is no label, are among the 25% most efficient products on the market. 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. The U.S. Government also is including energy efficiency specifications in its contracting guide specifications used for 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 per year in reduced electricity use by purchasing 500,000 efficient (T-8) fluorescent lamps, 200,000

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221. *See* Ed Begley Jr., *L.A. Leads Way in Developing True "Green Power,"* L.A. DAILY NEWS, June 2, 1999, at N17.

222. *See* AM. COUNCIL FOR AN ENERGY-EFFICIENT ECON., COMMERCIAL BUILDINGS: PROGRAM DESIGN, IMPLEMENTATION, & MARKET PLACE ISSUES (1996) [hereinafter COMMERCIAL BUILDINGS].

223. *See* Exec. Order No.13,123, 64 Fed. Reg. 30,851 (July 3, 1999); *see also* Exec. Order No. 12,902, 59 Fed. Reg. 11,463 (Mar. 8, 1994).

electronic ballasts and 20,000 light-emitting diode (LED) exit signs.[224] And, as a part of a massive renovation program, the Departments of Defense and Energy just have installed photovoltaic panels on the Pentagon.[225]

Government procurement programs involve payment of a premium up front, but result in very substantial long term savings. Governments can also require the purchase for their vehicle fleets of clean and efficient vehicles. Many municipalities in the United States are now purchasing electric and natural gas turbine buses. The City of Los Angeles, California has purchased a fleet of electric cars for municipal use and has installed recharging stations for the public throughout the city.[226]

In the United States, city governments have been very aggressive about reducing their carbon dioxide emissions. Over 100 cities, representing 10% of global emissions, have joined the Cities for Climate Protection program to reduce these emissions by investing in public transportation, building efficiency measures, planting trees and installing solar collectors. Cities in other countries have taken similar action. Thus, Toronto, the first city to announce a climate plan, has undertaken to reduce its emissions by 20%. Saarbrucken in southern Germany, has already cut its emissions by 15% by measures including energy efficiency and public education.[227]

Similar efforts are being made in other countries. For example: Australia utilizes best practices in government procurement through performance contracting; Finland has adopted a target to reduce heating energy and electricity consumption in its govern-

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224. U.S. Envtl. Prot. Agency, *Energy Star Purchasing*, http://www.epa.gov/nrgystar/purchasing (last modified Jan. 29, 2001); *see also* Fed'l Energy Mgmt. Program, *Buying Energy Efficient Products, at* http://www.eren.doe.gov/femp/procurement (last visited Mar. 22, 2001). An example of a state government agency efficiency success story: The Environmental Services Department (ESD) of San Diego decreased its energy consumption by 70% when energy efficient measures were implemented in its office building. The 73,000-sq. ft. building received a new high-efficiency heating, ventilation, and air conditioning (HVAC) system; high-efficiency window films; fluorescent lamps and fixtures; and daylight and occupancy sensors. These improvements helped the building surpass California's Title 24 building code by more than 50%. Actual savings for ESD have been approximately $80,000 per year ($1.10/square foot). The building went from operating at 21-22kWh/square foot to 7-8kWh/square foot. *See* ROMM, *supra* note 78, at 51.

225. *See* COMMERCIAL BUILDINGS, *supra* note 222.

226. *See* PBS, *Online NewsHour: Electric Cars*, http://www.pbs.org/newshour/bb/environment/electric_9-9.html (Sept. 9, 1996).

227. *See* Christopher Flavin, *Last Tango in Buenos Aires,* WORLDWATCH, Nov./Dec. 1998, at 17 [hereinafter *Last Tango in Buenos Aires*].

ment operations; Ireland has a program to reduce energy consumption in all state buildings; and the United Kingdom has a five-year program for reducing energy in government facilities. Canada, through a Federal Building Initiative, has been successful in achieving energy savings by contracting with energy service companies (ESCOs).[228]

A new program sponsored by the Danish Electricity Savings Trust, builds energy savings around a labeling requirement. It organized a group of large institutional buyers, including housing companies and local governments, to jointly procure at a very favorable bulk-purchase price up to 10,000 energy-efficient refrigerators that qualify for the top European Union efficiency label rating.[229]

Government procurement actions to stimulate development of improved energy-efficient technology can also include the conduct of competitions to produce equipment with superior energy savings. A successful example was the U.S. government's "Golden Carrot" Super-Efficient Refrigerator Program under which a consortium of government, utilities and NGOs organized a competition to award a total of $30 million to the manufacturer offering the best new refrigerator that exceeded prevailing efficiency standards by at least 30%. The goal was met and many participating utilities also offered additional consumer rebates for it.[230] Sweden has a similar, very ingenious program under which purchasing offices issue requests for proposals guaranteeing to buy a large number of devices at specified prices if they meet technical standards for energy efficiency and customer savings.[231]

Governments also can aggregate procurements to make production of energy superior equipment economic for manufacturers. Technology procurement for energy-efficient products, pioneered in Sweden, subsequently has been used in the United States, The Netherlands and Finland. Sweden's initial effort recruited housing cooperatives for a 1992 procurement creating a market for super-efficient windows that saved 60% more energy than standard Swedish triple-glazed windows. In 1995, the New York Power Authority and the New York City Housing Authority created a technology procurement project for new refrigerators

228. *Energy Efficiency Policies 1999 & 2000*, *supra* note 101.

229. *See* Appliance Efficiency, *Denmark Launches 'A' Procurement Programme* (1999), *at* http://www.idea-link.org/99v03i02/news_pp.htm.

230. *See also Energy Efficiency Policies 1999 & 2000*, *supra* note 101.

231. *See* LOVINS & LOVINS, *supra* note 11, at 17.

that used 30% less electricity than those then on the market. And the International Energy Agency has sponsored a number of technology procurement projects for electric motors, heat-pump dryers, LED traffic signals and digital multifunction office copiers.[232]

The U.S. Government has a Voluntary Reporting of Greenhouse Gas Program[233] under which U.S. companies and organizations can report to the Energy Information their programs and achievements in reducing greenhouse gas emissions. As of January 4, 2000, 107 reports had been filed reporting 1,507 projects that claimed reductions or offsets of green house gas emissions in 1998 of 212 million metric tons of carbon dioxide equivalent, or about 3.2% of total U.S. emissions for the year.[234] This program is useful in allowing companies to obtain recognition for their accomplishments and to establish a record of what they have done for eventual crediting against U.S. emission reduction requirements under the Kyoto Protocol.

Technology Solutions & R&D

Greenhouse emissions from existing power plant and vehicle technologies can be alleviated by the development of new technologies for the development of cleaner fuels and processes, which also make them more economically competitive. The United States is relying heavily on the development of new technology to meet its Kyoto Protocol obligations to reduce carbon dioxide emissions.

A few examples of the results of recent relevant R&D successes include the development of combined cycle natural gas power plants with double the efficiency and one-fourth the carbon intensity of coal-fired power plants.[235] These plants are being widely adopted in the United States and around the world in countries with natural gas resources. Other relevant R&D successes include the development of variable speed drive electric motors that produce the same work for less than half the use of electricity as conventional motors; the development of compact fluorescent light bulbs which last four times longer and use less

232. *See id.*

233. *See* Energy Policy Act of 1992, Pub. L. No. 102-486, § 1605(b), 106 Stat. 2776 (1992).

234. *See* U.S. ENERGY INFO. ADMIN., EIA REPORTS (2000).

235. *See* LOVINS & LOVINS, *supra* note 11, at 8. An increase of average coal-fired power plant efficiency of 1% reduces carbon dioxide emissions by 2.5%. *See* IEAGHG, *supra* note 117.

than half the electricity of incandescent bulbs; and efficient wind machines that have drastically cut their costs. Much successful R&D has been done in the area of building efficiency, with the development of better insulation materials, double or triple-glazed windows designed to utilize the sun's heat or protect from it, and many other innovations.

For the developing countries, technology transfer is a critical factor in enabling them to take advantage of energy efficiency and renewable technologies used in industrialized countries. Technical assistance and education of key energy players is essential to success. There are many such efforts being conducted around the world sponsored by governments and international agencies.

Improved technology offers great potential for developing countries to leapfrog to cleaner energy solutions. They can adopt the cleaner technologies from the start, avoiding the economic and pollution costs of using less efficient technologies and then having to replace them, as has been done in the industrialized countries. One example is China's CFC-free Energy-Efficient Refrigerator Project begun in 1989 to develop an energy-efficient CFC-free refrigerator. The final model, completed in 1996, demonstrated a 45% reduction in energy use. The Global Environmental Facility then funded studies with several manufacturers for large scale production and distribution of the new refrigerator, demonstrating that even a 20% market penetration after 10 years would reduce China's carbon dioxide emissions by over 100 million tons over the life of these refrigerators. The United Nations Development Fund provided a $1 million technical assistance grant. The program thus leap-frogs to modern efficient refrigerator technology, providing China with major industrial opportunity with attendant jobs, consumer savings, power load reductions and significant reduction of pollutants.[236]

There are numerous other government programs around the world to introduce energy-efficient technologies into the marketplace. One of note is the Philippine Technology Transfer for Energy Management program which provided energy audits, technical assistance and below market loans to more than 120 companies for adoption of energy-saving technologies, funded by $4.6 million from the U.S. Agency for International Development in 1985. The centerpiece was a Demonstration Loan Fund to

236. *See* H. A. FINE ET AL., U.S. EPA, SINO-US CFC-FREE SUPER EFFICIENT REFRIGERATOR PROJECT PROGRESS REPORT: PROTOTYPE DEVELOPMENT AND TESTING (1997), *available at* http://eetd.lbl.gov/EA/partnership/China/pubs/eparefrig.pdf (Oct. 1997).

demonstrate efficiency technologies and practices not widely used in the Philippines. Nearly 1,100 participants from the public and private sectors attended twenty-five seminars that were conducted nationwide under the program. Sixteen projects completed had an average internal rate of return of 41%, with very significant cost and pollution savings.[237]

Some technologies not developed for energy purposes also can save a great deal of energy and pollution. For example, the Internet and telephone conferencing can reduce transportation energy, pollution and costs; e-mail and fax machines can reduce the energy, pollution and costs required for sorting and delivering mail; and cellular telephones can eliminate the need for expensive wiring which involves use of polluting fuels in its manufacture.

Some examples of technology R&D currently under way which could drastically reduce carbon dioxide emissions include development of hydrogen fuel cells utilizable in both power plants and vehicles; refinement and reduction of the costs of photovoltaic cell manufacture and of various kinds of central station solar power stations; manufacture of more affordable and efficient electric or hybrid vehicles and lighter weight more efficient batteries; coal gasification; a new generation of advanced reciprocal engine or micro-turbine engine, particularly well suited for combined heat and power applications; improved nuclear energy technologies; and development of carbon dioxide separation processes for hydrogen production and carbon dioxide sinks for storage and reuse.[238] An insulated car has been researched that will reduce heating and cooling loads by 80 and 75% respectively, saving fuel and improving safety by reduced glare and heat.[239]

Unfortunately, with the advent of increased global commercial competition and increasing privatization around the world, corporations have significantly decreased their long term R&D expenditures. Utility spending on efficiency R&D also has drasti-

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237. *See* P. RUMSEY & T. FLANIGAN, INT'L INST. FOR ENERGY CONSERVATION, ASIAN ENERGY EFFICIENCY SUCCESS STORIES (1995).

238. *See* M. BROWN & M. LEVINE, INTERLABORATORY WORKING GROUP ON ENERGY-EFFICIENT AND LOW CARBON TECHNOLOGIES, SCENARIOS OF UNITED STATES CARBON REDUCTIONS: POTENTIAL IMPACTS OF ENERGY TECHNOLOGIES BY 2010 AND BEYOND (1997). Other promising R&D efforts include new kinds of heat exchangers and motors, membrane separators, sensors and controls, rapid prototyping and ultra precision fabrication, and processes using enzymes, bacteria, and biological designs. *See id. See also* LOVINS & LOVINS, *supra* note 11, at 7.

239. *See* Jeffrey Kahn, *First Insulated Auto Enhances Comfort, Reduces Energy Use,* SCIENCEBEAT, July 9, 1999, *available at* http://www.lbl.gov/Science-Articles/Archive/insulated-auto.html.

cally declined, by 33% from 1993 to 1996, from $708 million to $476 million.[240] As a result, if the benefits of new technology are to be achieved, governments will have to conduct the requisite R&D themselves or legislate the funding of R&D efforts; they could also mandate that a percent of sales be devoted by private entities to R&D or enter into partnerships with private companies to develop technologies that will reduce greenhouse gas emissions.

Recycling Programs

Many countries today have laws providing for the recycling of their waste paper, glass and metal products. For example, in Denmark, half of all waste is recycled and 80% of new paper is made from used paper.[241] Almost every city in the United States has established a recycling program for paper, glass, plastic and metal wastes, with either curb-side pickup or establishment of a central recycling municipal facility. Many business and institutions not required by law to do so, recycle their waste products on a voluntary basis.

Education Programs

Education of the public is vital to let the people know the importance to them of taking the measures necessary to reduce carbon dioxide emissions; to build the political support necessary for enactment of appropriate legislative measures; and to inform them of the options available to them for carbon dioxide reductions, such as residential energy audits, insulation, purchase of compact fluorescent light bulbs and efficient appliances, and the financial mechanisms available to make these measures affordable. This educational process really should start at the primary and secondary school level and continue as a part of professional and technical training for those whose jobs will involve energy related-decisions.

Education is particularly important for architects, engineers, builders, commercial enterprise managers, trades people, and government officials at all levels, to inform them of the requirements of laws that have been adopted to promote carbon dioxide reductions and the costs and benefits of the measures they can take

240. *See* ETO ET AL., *supra* note 206.

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

either voluntarily or pursuant to legal requirements.[242] It is important that retail sales staff, contractor installers and maintenance/service personnel understand the benefits of efficient products and processes and can personally benefit from promoting these products to end users.

Much of this education must be conducted or contracted by governments, creating a legislative framework for this task and appropriating the funds for appropriate staff to do mailings, conduct workshops and conferences, and do media education work. As commercial enterprises learn of the economic advantages of measures that can be profitable for them, they also will participate in the educational efforts. NGOs advocating for the clean energy measures available also perform an important part of the educational efforts. Many NGOs have created Internet sites and list services to inform advocates and the public of renewable and efficiency resource opportunities and advantages. And political leaders can play an important educational role as well.

Labeling Programs

One effective educational measure has been adoption by countries and municipalities of energy efficiency product labeling requirements. Labeling is an inexpensive educational tool. The United States, many of its states and cities, and many other countries and their municipalities have adopted such labeling requirements, giving energy consumption and cost-saving information about appliances such as refrigerators, electric stoves, clothes washers and dryers, computers and other appliances, essential for customers to make an informed choice.[243] Appliance labeling has often been an effective precursor for the adoption of efficiency standards. New buildings can also be the subject of energy efficiency labeling requirements, as is required through building cer-

242. The usual means of compensating architects and engineers worldwide, as a percentage of building and equipment costs, has the perverse incentive of discouraging least cost solutions. It has been estimated that this incentive design has led the U.S. to misallocate about $1 trillion in air conditioning equipment and the energy needed to operate it than had the buildings been optimally designed to produce the same or better comfort at least cost. *See* LOVINS & LOVINS, *supra* note 11, at 18.

243. *See* GELLER, MEETING AMERICA'S KYOTO PROTOCOL TARGET, *supra* note 7, at 3-4. The ENERGY STAR labeling program was estimated to have saved about .22 quads of primary energy per year from 1993-1998. *See Id.* In Japan and Canada mandatory efficiency labeling is reinforced by a compliance policy assuring accuracy of the information on the labels. Most Australian states also have adopted mandatory energy efficiency labeling. *See also Energy Efficiency Policies 1999 & 2000, supra* note 101.

tification programs in Denmark and Canada.[244] The United States and some other countries have a miles per gallon labeling requirement for vehicles sold.

Ratings

Ratings of companies on the greenness of their products also can be an effective educational tool. For example, the U.S. major environmental organizations, 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 display of the Green-E logo if power providers meet very rigorous "green" conditions: 50% plus renewables; for the remaining 50%, non-renewables with low emissions; full disclosure of electricity sources; no nuclear power generation; 1 year after deregulation, at least 5% *new* renewables, increasing 5% per year until 25% is reached. Also required is a commitment to biannual reviews of truth in advertising; and annual independent audits of renewable offerings. The rating is designed to inform electricity consumers of assured superior green power offerings.[245] With the advent of deregulation in the United States, a Power Scorecard also has been developed to rate the greenness of power plants, permitting informed consumer choice, being considered by the regulatory authorities for requirement by a number of states.[246]

Awards

Lastly, many governments and private organizations have established award programs to recognize companies, private organizations and products that accomplish outstanding energy efficiency or renewable achievements. There also are a number of government information programs. For example, the Federal Trade Commission in the U.S. has issued "Energy Guide" labels and the EPA has its ENERGY STAR program. NGOs like the American Council for an Energy-Efficient Economy has issued guides to the most efficient home appliances.[247]

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244. *See also Energy Efficiency Policies 1999 & 2000, supra* note 101.
245. *See generally* Green-e, *Renewable Electricity Program*, http://www.green-e.org.
246. Richard L. Ottinger, Remarks at the Pace Energy Project (1999).
247. *See* GELLER, APPROACHING THE KYOTO TARGETS, *supra* note 18, at 7.

VOLUNTARY PROGRAMS

Industry Programs

One result of government education on global warming is that a remarkable number of major corporations around the world have publicly recognized the risks of climate change and voluntarily embarked on major emission reduction initiatives. Thus in 1998, British Petroleum President, John Browne, broke ranks with the rest of the oil industry and announced that, recognizing the severe threat of climate change, BP was embarking on a voluntary program to reduce its carbon emissions to 10% below 1990 levels by 2010, which constitute a 40% reduction from business-as-usual emissions growth.[248] Royal Dutch Shell, the world's biggest oil company and Enron Corp., North America's largest natural gas company have since followed suit.[249]

While this action by members of the petroleum industry is most remarkable, major companies in many other fields have taken similar action, finding that production of more efficient products and adoption of energy saving processes is adds to profits and is simply good business.[250] Thus, Toyota has started to market in Japan and the United States the Prius, the world's first hybrid electric car, with twice the fuel economy and half the carbon emissions of conventional cars. Honda has begun marketing its own hybrid vehicle, the Insight, with a fuel efficiency of more

248. *See id.* at 13.

249. *See Last Tango in Buenos Aires*, *supra* note 227, at 16.

250. That efficiency measures allow profitable reduction in emissions is demonstrated by the following examples: Southwire, the top U.S. rod, wire & cable company cut its electricity use per pound of product from 1981-87 by 40% and gas by 60% through efficiency measures, creating nearly all the company's profits during this difficult period when competitors were going under. In 1981, Dow Chemical Company's Louisiana division set up an energy saving contest in which the first year's twenty-seven projects averaged 173% return on investment; the next year's thirty-two projects averaged 240%. Twelve years later, almost 900 implemented projects averaged 204% audited return on investment. By 1993, these projects together were paying Dow's shareholders $110 million per year. Dupont expects to save 18 million tons of carbon dioxide equivalent by 2000 that will save the company $31 million per year. An efficient chiller and related improvement at a Kraft ice cream plant saved 33% of its electricity and 2,500 tons of carbon dioxide a year. Process efficiency improvements at Blandin Paper Co. in Minnesota resulted in annual savings of 37,000 tons of carbon dioxide and more than $1.8 million. The first two years of Interface Corporation's efficiency efforts saved $25 million with another $50 million estimated for the following two years as reported in the Wall St. Journal. And there are many other examples. *See* LOVINS & LOVINS, *supra* note 11, at 13.

than 60 miles per gallon.[251] These developments inspired even General Motors President John Smith, to say in a 1998 speech, "No car company will be able to survive in the 21st century by relying on the internal-combustion engine alone."[252]

A few other examples of major U.S. companies that have embarked on voluntary programs: Johnson & Johnson set a goal in 1995 of reducing energy costs 10% by 2000 in ninety-six of its U.S. facilities, and has already met 95% of that goal with a payback of 3 years or less for most of the projects undertaken. And Dupont announced in September 1999, that it would reduce greenhouse gas emissions worldwide by 65% from 1990 levels while holding total energy use flat and increasing its use of renewable resources by 10% and this is on top of a previous commitment to reduce energy intensity 15% and total greenhouse gas emissions by 2000 from 1990 levels, which it is on track towards achieving.[253]

A major problem for industrial energy managers is that the suppliers often don't stock efficient motors and other appliances because there is insufficient demand for them due to lack of information. This stock problem was solved ingeniously 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 3% to 60%, and the subsidy was phased out. Similarly, PG&E in California paid refrigerator distributors a small bonus for each efficient model stocked, but nothing for inefficient models, which quickly vanished from the shops. PG&E found that the vendor subsidy improved refrigerator efficiencies faster, at less than a third the cost of giving rebates to end users.[254]

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251. Posting of Chris Hayday, chris.hayday@sfsierra.sierraclub.org., to cons-spst-Globalwarm-alerts@lists.sierraclub.org (Jan. 7, 2000) (copy on file with author).

252. *Last Tango in Buenos Aires*, *supra* note 227, at 16.

253. *See* GELLER, MEETING AMERICA'S KYOTO PROTOCOL TARGET, *supra* note 7, at 11. Other industry measures proposed include: tax incentives to stimulate more investment in new and more efficient energy-using manufacturing equipment, and R&D to bring down the costs and speed the availability of more efficient equipment; Regulatory refinement and technical assistance to remove disincentives for industrial combined heat and power (CHP). *See* STEPHEN BERNOW ET AL., TELLUS INST., AMERICA'S GLOBAL WARMING SOLUTIONS (1999) *available at* http://www.tellus.org/energy/publications/solution.pdf.

254. GELLER, MEETING AMERICA'S KYOTO PROTOCOL TARGET, *supra* note 7, at 11.

Government Sponsored Voluntary Programs

The U.S. Government has relied heavily on voluntary programs and partnerships with industrial companies to achieve energy efficiencies that will reduce pollutants and carbon dioxide emissions. Most notable is its 1991 Green Lights program under which companies agree to capture cost-effective lighting energy savings and in turn are allowed to advertise participation in the program. Since green products are popular with consumers, this certification is of value to the companies. The program also gives informational, technical and trade-ally support. As of April 30, 2000 the program involved more than 3,124 organizations. Due to the retrofits involved in the program, participating organizations were saving over half of their lighting energy, while still realizing a 30% return on investment. As a result of these energy-efficient upgrades these organizations have cumulatively saved over 2.2 billion in energy bills, while preventing 46.9 billion pounds of carbon dioxide from being released into the atmosphere.[255]

Other countries have emulated this program. For example, in 1996, China began a Green Lights Program in cooperation with the U.S. sponsored Beijing Energy Efficiency Center and a committee of outside experts, with the on-target goal of increasing the use of high-efficiency lights to 300 million units by 2000, resulting in electricity savings of 26.8 TWh and peak load savings of 7.2 GW, along with large avoided costs for new electricity power plants. Pollution savings are estimated at 200,000 metric tons of sulfur and 7.4 million tons of carbon emissions.[256]

The U.S. Government has also initiated the ENERGY STAR program that gives technical assistance and recognition to companies that market very efficient equipment. This program has been highly successful in promoting market transformation measures, which establish new energy efficient products in the marketplace. For example, the ENERGY STAR office equipment program convinced most manufacturers to produce only copiers, computers, etc. that automatically switch to a low energy consumption mode when not in use. And an ENERGY STAR program is successfully advancing horizontal-axis clothes washers, familiar in Europe but only recently introduced in the United States, which use half the

255. *See* U.S. Envtl. Prot. Agency, *Accomplishments*, http://www.epa.gov/buildings/esbhome/about/accomp.html (last modified April 30, 2000).

256. *See* ZHOU DADI ET AL., ADVANCED INT'L STUDIES UNIT, BATTELLE PAC. N.W. LAB., CLIMATE CHANGE MITIGATION: CASE STUDIES FROM CHINA (1997), *available at* http://www.pnl.gov/aisu/pubs/noregchn.pdf.

water and one-third the energy of conventional U.S. models.[257] The program was saving half a billion dollars per year in 1997 and was estimated to save nearly double that by 2000 with a profitable 10 million ton per year carbon saving by 2005.[258] The program also encourages industry to convert to energy efficient motors and EPA is considering the adoption of motor standards.

Canada started a Voluntary Challenge and Registry (VCR) program as a part of its National Action Program on Climate Change in 1995, which became an independent private/public partnership in 1997. Its purpose is to spur voluntary actions on climate change and publicize them. Two-thirds of its funding is from the private sector, the rest from the federal and provincial governments. In its first 3 years, Canada's VCR program registered about 700 companies and organizations. Resulting carbon dioxide emission reductions totaling just over 9 metric tons of carbon were reported, about 6.5% of Canada's fossil fuel carbon emissions in 1998.[259]

Agreements between government and industry have resulted in substantial energy intensity reductions in European countries such as Germany, which committed in March 1996 to reduce carbon dioxide emissions by 20% between 1990 and 2005, the Netherlands and Denmark. Belgium, France, Spain and Norway are in the process of negotiating voluntary agreements with their principal energy-intensive industries.[260]

U.S. Foundation Programs

A number of charitable foundations in the United States have undertaken major climate change programs. A few examples: The Pew Charitable Trusts recently created a Pew Center On Global

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257. *See* STEVEN NADEL & LINDA LATHAM, AM. COUNCIL FOR AN ENERGY-EFFICIENT ECON., THE ROLE OF MARKET TRANSFORMATION STRATEGIES IN ACHIEVING A MORE SUSTAINABLE FUTURE 23-24 (March 1998).

258. *See* LOVINS & LOVINS, *supra* note 11, at 16.

259. *See Energy Efficiency Policies 1999 & 2000*, *supra* note 101.

260. *See* GELLER, MEETING AMERICA'S KYOTO PROTOCOL TARGET, *supra* note 7, at 13. Two major types of industry agreement programs are frequent: 1) Target-Based Agreements include negotiated legally binding requirements, targets that pre-empt future regulatory requirements, or targets tied to a strong regulatory threat. For example, The Netherlands Long-Term Agreements involve about 1,200 industrial companies with over 90% coverage of industrial primary energy consumption; and 2) Performance-Based Agreements based on negotiated performance goals that are not legally binding such as The Canadian Industry Programme for Energy Conservation and the Norwegian Industrial Energy Efficiency Network. *See also Energy Efficiency Policies 1999 & 2000*, *supra* note 101.

Climate Change, initiating a major program to solicit business participation in climate change mitigation. The Pew Center also has initiated a major advertising and public relations program to educate the public and government officials on the importance of action to mitigate carbon emissions and to promote U.S. ratification of the Kyoto Protocols. The Pew Center is now funding a series of studies under the rubric, *Developing Countries and Climate Change: Electric Power Options for Growth.* Studies on India and Korea were issued this year, and reports are under way for Argentina, Brazil and China.[261] The MacArthur, Pew and Rockefeller Foundations joined together to create a new Energy Foundation about eight years ago. The Energy Foundation funds programs throughout the United States promoting energy efficiency and renewables in electricity and vehicle efficiency improvements. Recently, it has joined with the Packard Foundation to promote carbon mitigation in China.[262]

One particularly successful effort has been the establishment of Energy Efficiency Centers in the formerly planned economies of Eastern Europe and China, a project overseen by the U.S. Department of Energy's Pacific Northwest National Laboratory. Start-up funding was provided by the U.S. Environmental Protection Agency and Department of Energy, the World Wildlife Fund, the Charles Steward Mott Foundation and the John D. and Catherine T. MacArthur Foundation, and 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 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 they have achieved remarkable results in reforming local laws to promote energy efficiency and effectuate technology transfers.

A few examples of Center successes: The Russian center helped develop the first regional level code for energy efficient building construction; The Czech Center helped draft a national

261. *See* BERNSTEIN ET AL., *supra* note 137; SHUKLA ET AL., *supra* note 104; JIN-GYU OH ET AL., PEW CENTER ON GLOBAL CLIMATE CHANGE, ELECTRIC POWER OPTIONS IN KOREA (1999).

262. *See generally The Energy Foundation*, *at* http://www.ef.org/aboutus/index.cfm, (last visited Mar. 22, 2001).

energy policy and legislation for energy labeling and standards provisions. The Polish center developed a program for utility energy efficiency investments. The Bulgarian center helped adopt appliance efficiency standards. The Beijing Center provided expertise in instituting Integrated Resource Planning for a major utility and persuaded it to substitute demand-side management for a planned coal-fired power plant. The centers have focused on policy reform, private sector assistance for joint energy technology and service ventures, demonstration and training, and public education and information dissemination.[263]

FINANCING MECHANISMS

The financing of the measures which have been taken and must be taken to meet the Kyoto Protocols and the greater IPCC prescriptions, are of course vital to their achievement. While many of the measures undertaken are cost-effective in the long run, the capital investments needed for their accomplishment can be very great. A brief review of available financing therefore is a necessary consideration to establish the feasibility of the accomplishment of the Kyoto and IPCC goals.

INTERNAL RESOURCES

Subsidy Removal, Pollution Taxes, Government and Utility Financing

As indicated previously, there are a number of financial resources that can be generated internally by any government. The largest of these in most countries is removal of fossil fuel subsidies. Many of the energy efficiency measures described above achieve such large savings over time as to provide very substantial revenue resources. Taxes on pollutants and fossil fuels have been used in many countries to help finance carbon reduction measures. Emission trading rights have been utilized to lower the costs of pollution reduction measures. Governments have used general tax revenues to support efficiency and renewable programs and R&D for new technologies to address climate change problems. They also have initiated programs to require purchase of energy efficient appliances, lighting and buildings for their own use. And they have required their electric utilities to do inte-

263. *See* WILLIAM U. CHANDLER ET AL., ADVANCED INT'L STUDIES UNIT, BATTELLE PAC. N.W. NAT'L LAB. (1999), *available at* http://www.pnl.gov/aisu/pubs/center.pdf.

grated resource planning which includes DSM and renewable resources and to assist customers in acquiring them.

Utility Programs Funded From Electricity Charges

As mentioned earlier, many utilities in the United States historically were required by state regulatory commissions to assist in the financing of energy efficiency and renewable resources for their customers. These programs were usually in the form of rebates for efficient equipment and energy audits of customers' homes or places of business.[264] In some cases, the utilities provided loan programs repayable by a charge on customer utility bills.[265] Similar programs persist in some states and in several countries. In a few cases, the utility may act as retailer of energy efficiency equipment. For example, Scottish Hydro-Electric offers its customers arrangements for direct purchases of energy effi-

264. An example of a spectacularly successful comprehensive utility efficiency initiative is that of Osage Municipal Utilities (OMU) in Osage Iowa. OMU conducted Aerial thermograms in order to show customers where they were experiencing heat loss, and provided 60% of its customers with free heat-loss checks using hand-held scanners. The utility provided free energy audits to local businesses as well as offered suggestions to companies as to what improvements could be made in the areas of insulation, lighting, heating, cooling, and production processes. The utility installed efficient high-pressure sodium streetlights and gave Osage citizens energy-efficient compact fluorescent light bulbs free of charge. A load-management program was introduced allowing the utility to eliminate power to customers' air conditioners for seven minutes a day during the summer. The utility also purchased an hydraulic tree planter and planted trees around Osage, which decreased air conditioner use. The total cost of the energy efficiency projects was about $350,000. The savings on energy bills for the town of Osage totaled $1 million per year. Over eight years, electricity rates decreased by 19%, and in the last five years of this period gas rates were reduced by 5%. Residential users saved approximately $200 per year on energy bills. *See How Energy Efficiency Works in Osage*, NATION'S BUSINESS, Aug. 1, 1992, *available at* 1992 WL 3086570.

265. A good example is a loan Pacific Power and Light provided to fund $1.5 million of energy efficiency renovations for BlueCross/Blue Shield, one if its industrial customers. The 106,000 square foot BlueCross/BlueShield building in Oregon implemented energy efficient practices that resulted in a 61% reduction in energy consumption, a decrease of 4.0 million kWh. Energy used for lights was cut in half by replacing incandescent lights with compact fluorescents, upgrading standard fluorescents to more efficient models, and installing daylighting systems and dimmer controls. Building insulation was added to the roof and high-performance double-glazed windows and a high-efficiency HVAC system were installed. Total savings for BlueCross/BlueShield came to $130,000/year. BlueCross/BlueShield is repaying the loan with the money it is saving from the energy efficiency practices implemented. *See* ROMM, *supra* note 78, at 51.

cient home appliances rated in the top efficiency categories of the European Union appliance label.[266]

In many instances, clean energy measures can be funded internally by electricity charges. Thus, Japan's "10,000 Roofs" successful solar PV program was funded by electricity surcharges to pay one-third the installation costs of household PV systems, with utilities purchasing any excess power at retail electricity prices.[267] Most generation, transmission and distribution efficiency improvements are financed by electricity charges.

Often utilities maintain programs of rebates, customer loans and grants to encourage the purchase of energy-efficient equipment and renewable resources. Sometimes these incentives are most effectively given to the manufacturer rather 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 can reduce paperwork and administrative costs and assist with transformation of the market by lowering the price of efficient projects and making them more widely accepted.

An example of a successful manufacturer incentive (involving both government and utility financing) is the Poland Efficient Lighting Project, initiated to increase the use and acceptance of compact fluorescent light bulbs (CFLs) in order to reduce evening peak load demand in areas with insufficient distribution capacity. The Project included an incentive to manufacturers reducing wholesale CFL prices by $2 per CFL. The Project resulted in the sale of over 1.2 million CFLs over a 2-year period and installations of two to nine CFLs in target neighborhoods, resulting in a 15% peak demand reduction. The program was also highly cost-effective for the utility compared with adding new generation, saving an average of 50% over 5 years and 20% over 10 years.[268]

As described earlier, with the advent of deregulation, direct utility financing has been replaced in many jurisdictions with non-by-passable systems benefit charges placed on the distribution utility which remains a monopoly to fund public benefit pro-

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266. *See generally Scottish Hydro-Electric, at* http://www.hydro.co.uk (last modified Jun. 27 2000).

267. *See* MOORE & IHLE, *supra* note 144.

268. *See* M. Ledbetter et al., *IFC/GEF Poland Efficient Lighting Project: Demand-side Management Pilot – Final Report,* BATTELLE PAC. N.W. NAT'L LAB. PNWD-244 (1998).

grams including efficiency and renewable energy measures. The funds collected are usually placed in an independently administered trust fund which makes grants and loans for energy efficiency and renewable projects, low income programs, etc. Increasingly, "standard offers" are being used by these funds as a payment per unit of energy saved or standard contracts are proffered in order to reduce transaction costs.

Government Financial Assistance

The Netherlands permits accelerated depreciation of renewable energy, has tax deductions for renewable investments of between 40% and 52% of the costs, subsidized loans for green projects at 1-2% below prevailing rates, a program that authorizes the use of a green label for renewable generation, and a temporary experimental program providing green mortgages that permit the borrower of houses costing $188,000 or less who installs renewable equipment to get a loan of up to $35,000 for 10 years at a rate roughly 20% below market prices (roughly 4% instead of 5%).[269]

In New Zealand, an Energy Saver Fund was established and funded by an $18 million 3-year appropriation, as part of restructuring legislation to support residential energy-efficiency programs. Like UK's auctions for renewables, the New Zealand law calls for bids against the Fund for efficiency programs.[270]

In a number of countries, support for renewable projects also is available from national and local agencies. One example is in India, where there are a Federal Ministry for Non-Conventional Energy Sources and state Renewable Energy Development agencies, which support renewable energy projects.[271] In Mexico, solar homes have received government grants of 89% of total project costs, 50% from the federal government and 30% from the states.

Brazil supplies 60% of its primary energy requirements from renewable energy sources, 37% from hydro and 23% from biomass under programs sponsored by the government. 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 over 40% of the fuel consumed by cars and light trucks. It is estimated to have saved

269. *See* Moore & Ihle, *supra* note 114, at 16-17.
270. *See* Eto, *supra* note 206.
271. *See* Matthew S. Mendis, Alternative Energy Development, Inc., Financing Renewable Energy Projects – Constraints and Opportunities (1998).

Brazil over $40 billion in oil imports, excluding the costs of the program. Ethanol was heavily subsidized by the government until 1998 when it was deregulated and taxes from gasoline sales were substituted to subsidize its costs. To get the program started, the state-owned oil company guaranteed ethanol purchases on a cost plus basis and tax incentives were provided 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 addition, the ethanol production supports about 700,000 rural jobs.[272]

In 1985, Brazil established a national electricity conservation program known as PROCEL, housed at the national electricity utility. PROCEL funds energy efficiency projects carried out by state and local utilities, state agencies, private companies, universities and research institutes. The program's energy efficiency measures are estimated to have saved about 5.3 TWh/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 1,560 MW of new capacity, saving about $3.1 billion of avoided investments in new power plants and transmission and distribution. facilities, with investments of only $260 million. It is estimated that PROCEL sponsored efficiency programs reduced greenhouse gas power plant emissions in 1997 by 30%. In addition, a number of new technologies are now manufactured in Brazil, including demand limiters, lighting controls, electronic ballasts for fluorescent lamps and solar hot water heaters[273]

The U.S. Department of Energy has joined with top finance firms to create the International Performance Measurement and Verification Protocol. Like FHA mortgage rules, the Protocol standardizes streams of energy savings in buildings so that they can be aggregated and securitized. The Protocol as of November, 1997 had been adopted by more than twenty countries including Brazil, China, India, Mexico, Russia, the Ukraine and the United States. The Protocol has been successful in stimulating a market in which loans to finance energy savings can be originated and can be affordably financed without use of internal capital or competition with other internal investment needs.[274]

272. *See* Geller, UPDATE ON BRAZIL, *supra* note 98, at 9.

273. *See id.* at 9-10.

274. *See* LOVINS & LOVINS, *supra* note 11, at 11-12.

Commercial Loans

Renewable projects such as biomass combustion/cogeneration, geothermal, hydropower and wind farms are considered to be mature, low risk and commercially ready technologies which have a reasonably established cost basis, and thus often have access to commercial lenders. However, renewable projects tend to have higher capital to O&M cost ratios than conventional systems and require longer-term debt financing, making them harder to finance. They also have difficulty establishing project cash flows because their revenues are not secured by enforceable fuel supply or power purchase contracts. Also, it is difficult to get non-recourse financing because many of the suppliers are new and do not have extensive financial performance records.[275]

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. There are problems with achieving commercial loans for disbursed efficiency and renewable energy installations, however, because the projects tend to be small in scale with numerous points of sale; some of the technologies are relatively new and unproven; and for renewables, the revenue streams may be uncertain because of the risks of unavailability of sufficient sunlight or wind.[276]

Aggregated Loans

One way to overcome the problems with small loans for distributed resources is to aggregate the loans in various ways; examples follow:

Installment Loans. An innovative credit arrangement to overcome these problems has been adopted by several countries, to make loans to credit-worthy institutions like local utilities which set up revolving funds to manage installment loans to individual and small business basis on relatively attractive terms. Such arrangements have been adopted in Indonesia for its Solar Home Systems Project, in India for a solar photovoltaic program, in Kenya for its wood stove upgrading program and for off-grid photovoltaic systems, and in Bangladesh, the Dominican Republic and Honduras.[277]

275. *See id.*
276. *See* MENDIS, *supra* note 271.
277. *See id.* at 44.

Micro Utilities. Another innovative mechanism is financing service providers with the creation of renewable energy micro utilities which sell energy services, permitting financing to be aggregated to the service provider, the end-user being required to make payments based on the level of energy services received. This approach has been successfully demonstrated in the Dominican Republic and is now being implemented in a 10,000 solar home system program by a rural electric cooperative in Bolivia; and mortgage financing, allowing homeowners to incorporate the costs of installing renewable systems into the overall costs of their homes through mortgage financing; this approach is being tested in a rural housing/electrification program in South Africa.[278]

Grameen Bank. A particularly fascinating development is the creation of micro lending organizations in some of the poorest countries for their most impoverished populations. Thus, Grameen Bank ("village bank" in Bengali) in Bangladesh has started a lending program for people earning on average less than $1 a day. Today, Grameen is established in nearly 39,000 villages in Bangladesh, lending to approximately 2.4 million borrowers. Established in 1986, it reached its first $1 billion cumulative loans in 1995. It took only two more years to reach $2 billion. The repayment rate hovers between 96% and 100%. In a typical year, 5% of Grameen borrowers, representing 125,000 families, rise above the poverty level. The Grameen model has now been applied in 40 countries. In all, about 22 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. One such enterprise is Grameen Skakti (Energy), which has been helping to install solar energy systems into village households.[279]

Leasing Programs

Leasing equipment is an innovative approach to overcoming the financing problems for small systems and to make them affordable. For example, the French government and France's largest utility developed the largest leasing program for CLF/s on the

278. *See id*
279. *See* 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 114-119; *see also* Thomas L. Friedman, *Social Safety Net*, N.Y. TIMES, Nov. 3, 1999.

island of Guadeloupe, seeking to reduce evening peak electricity demand. The leasing program's incentive was a coupon allowing customers to lease CFLs at no initial cost, the lease payments being identical to the electric bill savings. 34% of all households redeemed the coupons for an average of 7.8 CFLs each. This success stimulated an identical program for Martinique, which resulted in distribution of 345,000 CLFs in just a few months. The two programs resulted in 7 MW of peak demand savings on each island and 29-33 GWh of annual electricity savings. Also, In the Dominican Republic, the U.S. company, Soluz operates a photovoltaic leasing program.[280]

Several companies have also innovated with the leasing of services rather than of the equipment. The Carrier Corporation in the U.S. has a program to lease "comfort services," the Schindler elevator company leases vertical transportation services and Dow leases solvent services. Service leasing improves not only energy efficiency, but also incentives; the more efficient Carrier's air conditioning systems become, the greater its profits and the better service it provides at lower cost to more customers. Service leasing aligns the provider's incentive with the customer's needs.[281]

Vendor Financing

Sometimes equipment suppliers will not only construct, install and operate systems, but also offer equipment financing, sometimes 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 in order to sell the more efficient equipment. The vendor often 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.[282]

Performance Contracting

Performance contracting, involving third party financing, has been widely used to finance energy efficiency projects in the United States and Europe. The customer contracts with an Energy Service Company (ESCO) to provide the desired energy effi-

280. *See* Solstice, *Executive Summary, Results Center Profile # 119*, *at* http://solstice.crest.org/efficiency/irt/119.htm, (last visited Mar. 22, 2001).

281. *See* Lovins & Lovins, *supra* note 11, at 19.

282. *See id.*

ciency improvements, its financing, and often other related services like operations and maintenance. The financing is repaid, at least in part, from savings achieved by the efficiency measures or equipment installed; often, the ESCO also participates in the savings. To date, ESCOs have not been very successful in the United States, however, filling only niche efficiency applications for large industrial, commercial and institutional customers.[283] Adequate long-term financing for ESCO operations is critical, since the ESCO must put up initial capital that may not be paid off from savings for several years. ESCO financing is particularly important to establish ESCOs in developing countries.

EXTERNAL RESOURCES

In the past few years, the international lending organizations: the World Bank, regional banks, the International Financing Corporation (IFC), the UN Development Program (UNDP) and the UN Global Environmental Facility (GEF) have started major programs of financing energy efficiency and renewable projects in developing countries. They must do more, but their resources will never be sufficient to meet developing country requirements. The capital requirements of electric power growth in developing countries (projected at 5% to 7.5% per year) has been estimated to be $1.4 to $4 trillion over the next two decades. 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).[284] It is clear that private and public internal sources will be 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, have changed direction and are now making 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 to lend over $500 million for renewable projects in the Asia region. The World Bank also financed a Renewable Energy Small Power Project in Indonesia, a component of which funds medium-scale/isolated grid systems there. A

283. *See* ETO ET AL., *supra* note 206.

284. *See* M. LEVINE ET AL., Lawrence Berkeley National LAB., *Report to the U.S. Working Group on Global Energy Efficiency, Energy Efficiency, Develo*ping Nations and Eastern Europe 37 (1991).

World Bank Market Transformation Initiative loan of $5 million fosters a photovoltaic industry in Kenya that is selling over 20,000 systems annually with a 300kW capacity, and has already sold over 80,000 systems providing electricity for some 250,000 rural dwellers.[285]

Recent examples in other international financing institutions: The International Finance Corporation 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 Global Environmental Facility (GEF) donated $10 million to Argentina to assist Argentinean co-operatives in the removal of barriers to installation of windpower and solar photovoltaic development, including subsidies for equipment investment and technical assistance and studies.[286]

A problem that these international lending facilities have had to overcome is administering small loans because of the small size of many efficiency and renewable projects. They have started to assist in the creation of local and regional lending institutions to manage the smaller loans on their behalf.

Emerging from the negotiations of the conferences of the parties to the Kyoto Protocol are a number of mechanisms to promote the investment by companies in the industrial countries in carbon mitigation in the developing countries. Thus, a Joint Implementation Program has been instituted by which developed and developing countries can collaborate on carbon mitigation projects. Canada, Japan, Norway and Germany have very active Joint Implementation Programs that include support for renewable programs.[287] Costa Rica has an extensive pilot Joint Implementation Program, with ten projects thus far accepted, including three windpower developments, four forestry projects and water treatment projects. Similar Joint Implementation Projects have been approved in Mexico (including lighting and forestry carbon sequestration projects); Honduras (a solar electrification program, lighting and biomass project); Bolivia (solar electrification); Ecuador (forest conservation); and Belize (forest conservation). The Business Council for Sustainable Development-Latin America has been active in these endeavors.

285. *See id.*
286. *See* MENDIS, *supra* note 271.
287. *See id.*

As another example, the Czech Republic has three registered Joint Implementation Projects covering forestry rehabilitation, coal-to-gas conversion and upgrading of a cement factory.[288] 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.

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 these measures that generate greenhouse gas reductions in a developing country, an industrialized country or its companies can earn carbon emission reduction credits to meet the country's Kyoto protocol obligations. In the United States, legislation has been proposed to give companies credit now against future carbon reduction requirements for the climate mitigation measures that they finance now in developing countries. Some companies have made such investments already in anticipation of credit legislation. International emission trading allowances also have been proposed to reduce the costs of carbon mitigation measures.

However, while these measures are strongly supported by the United States and some other industrialized countries, they are highly controversial with many developing countries and environmental organizations. This is so because of doubts about their reliability and enforceability and because of the belief that they are just escape valves by which these industrialized countries can avoid reducing their own emissions.[289] The extent to which these measures may be used to meet the Kyoto Protocol carbon emission goals and the rules under which the measures will operate are key among the issues being negotiated by the Conferences of the Parties.

Nevertheless, these trading measures offer great promise of providing the means by which developing countries can acquire the resources needed by them to cover the up front costs of instituting clean energy solutions. Whatever compromise may be adopted by the Conference of the Parties, some provision is sure to

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288. *See id.*

289. *See* Sierra Club, *Risky Business: Trading Away our Responsibilities – Why Joint Implementation is the Wrong Approach* to *Global Warming Policy, at* http://www.sierraclub.org/globalwarming/articles/jifact.asp (last visited Mar. 22, 2001).

be made for the use of such measures. Care will have to be exercised to assure that, in order for the industrial country investments in developing country projects to be eligible for credits, they provide real and sustained carbon dioxide emission reductions. Provision also will have to be made to assure that there will be no backsliding and that the measures protect biodiversity. Since the developing countries are projected to produce the majority of future carbon dioxide emissions, these or other measures are vital to assure that these countries can acquire the necessary capital, information and training to permit them to participate fully in global warming solutions.

CONCLUSION

There are abundant examples, only a few of which have been identified here, in both developed and developing countries, of successful adoption of cost-effective measures to ameliorate carbon dioxide emissions in their electric utility and vehicle sectors. A wide variety of legislative and voluntary programs have been undertaken and the legal and financial mechanisms for doing so also are many and varied. It is possible to meet the Kyoto Protocol goals, and even to go beyond them to meet what the IPCC scientists find is needed to stabilize global warming. This achievement can even be done on a basis of long term profitability; indeed energy efficiency savings are so compelling that they should be undertaken just to save money, regardless of whether the scientific community is right about the risks of global warming. But achieving these goals will take determined action and political will among all governments and international institutions of the world.