Environmental Challenges and Opportunities of the Evolving North American Electricity Market
Secretariat Report to Council under Article 13 of the North American Agreement on Environmental Cooperation

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Background Paper

Assessing Barriers and Opportunities for Renewable Energy in North America

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This background paper was prepared for the CEC Secretariat in support of the "Electricity and Environment" initiative undertaken pursuant to Article 13 of the North American Agreement on Environmental Cooperation. These background materials are intended to stimulate discussion and elicit comments from the public, as well as the Electricity and Environment Advisory Board, in addition to providing information for the 29–30 November 2001 Symposium on the "Environmental Challenges and Opportunities of the Evolving North American Electricity Market." The opinions, views or other information contained herein do not necessarily reflect the views of the CEC, Canada, Mexico or the United States.

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"Through the next several decades, renewable energy technologies, thanks to their continually improving performance and cost, and growing recognition of their environmental, economic and social values, will grow increasingly competitive with traditional energy technologies, so that by the middle of the 21st century, renewable energy, in its various forms, should be supplying half of the world's energy needs." (International Energy Agency, Renewable Energy Working Party, April 2001.)

Executive Summary and Recommendations

Renewable energy can contribute substantially to the entire North American electricity supply, to biomass based transport fuels and for space and hot water heating in buildings and industry. Both distributed forms of renewable energy and central large-scale technology options are possible. The manufacturing, installation and maintenance of renewable technology can create substantial employment opportunities for North America. Both wind and biomass fuels could contribute in a major way to enhancing rural economic development in all three countries.

Worldwide, the rates of growth of wind and solar energy are the most rapid of any technology. Wind power installations have been doubling every three years between 1994 and 2001, and now total over 23,000 MW. (Brown, 2002, Sawin, 2001). Likewise photovoltaic shipments have been doubling at a comparable rate between 1996 and 2001, and now approach 400 MWp. These growth rates are from a small base, but vastly exceed any other form of energy technology. Unfortunately, North America has a declining share of this accelerating market in renewable technology.

A number of policy barriers within each of the three North American nations need to be addressed, and national and NAFTA trading rules need to be reconciled in order for renewable energy to achieve its full potential. It is also essential to adopt a long-term perspective for expanding the role of renewable energy in North America over the next several decades. An examination of successful renewable energy policies in North America and in Europe suggest that some of the following policy goals and options might be effective in accelerating the adoption of renewable energy technologies.

<u>General Policy Principles to Promote Renewable Technology</u>

- Establish a consistent and comprehensive system for monitoring renewable energy production and consumption in each country.
- Create a common and coordinated strategy for introducing renewables into North America, and identify ways in which the three nations might cooperate.
- Internalize the environmental, social and macro economic costs of energy into energy markets.
- Establish consistent, long-term policies and incentives for renewables so that investors will have greater certainty about their rates of return on investment.
- Align RPS and other domestic regulations and NAFTA trading rules to be consistent and supportive of renewable energy.

Establish Incentives for Renewables

- Demand-pull incentives such as assured prices or price increments are generally more effective than supply-push technology development strategies.
- Encourage the purchase of renewable technology by providing tax credits for its installation and use, and by removing sales and property taxes for renewable technology or infrastructure.
- Establish renewable portfolio standards for electric power generation, fuels and buildings with an increasing percentage of renewables required over time.

Renewable Electricity

- Remove impediments for adding distributed sources generally to the grid, by making the transmission and distribution system open to all producers regardless of size.
- Redesign current environmental policies to encourage companies to replace existing, polluting technology with clean renewables at a future specified date rather than locking in old technology by requiring near-term upgrades to meet present pollution standards.
- Production tax incentives for electricity are more effective than investment tax credits in most cases.

Biomass Fuels

- Encourage biomass fuel development under appropriate environmental safeguards.
- Avoid preferencing any particular crop biomass source.
- Strive to develop cellulosic-based liquid fuels in order to have the most options and greatest yield of fuels from plant material.

Economic and Social Policies

- Utilize biomass and wind as a means to promote rural development and jobs creation.
- Promote joint manufacturing of solar PV and solar thermal technologies between the US and Mexico.
- Develop wind manufacturing and implementation opportunities between the US, Mexico and Canada.
- Develop transition policies to address any dislocations that might come about through a shift from traditional energy sources to renewables.

Research and Development and Purchasing

- Create incentives for private sector renewables R&D.
- Target governmental R&D to solving systems problems and to addressing technological issues that are unlikely to draw the attention of private sector companies.
- Expand national and subnational governmental purchases of renewably generated electricity, fuels and heat.

Introduction

The technological and economic potential for renewable energy to provide a growing share of clean, secure energy for North America over the coming decades is very large. In the transportation sector, a well-designed biomass fuels program in combination with efficiency improvements could substantially reduce North America's overwhelming 97 percent reliance on petroleum. This shift would reduce the risk from unstable supply sources abroad, help guard against price shocks and lower the rapidly growing international competition for oil just as global oil production peaks sometime within the next few decades. In the electric service sector, technologies for distributed wind, geothermal, solar, small-scale hydro and biomass are available. Centralized, large-scale hydro, wind, biomass and geothermal sources also can provide significant alternatives to fossil and nuclear thermal power plants. Both distributed and centralized renewable technologies are increasingly available at competitive prices in many areas. Buildings can not only be made much more efficient, but can take advantage of active and passive solar technology for integrated electric power production, space heating, hot water and cooling. The increased adoption of renewable technologies would also reduce air pollution, lower the risk of climate change, help solve both electric power plant cooling-water problems and damage to water bodies from extraction of fossil fuels. These technologies would also decrease land disturbance from mining coal, drilling for oil and gas, and from inundation by large-scale hydropower. The development of a North American renewable energy industry would also create more jobs than are likely to be lost from the current economy, although there are important transition issues that need to be addressed (Barrett and Hoerner 2002).

Despite these multiple benefits from an expansion of renewable technology, their introduction is being held back by regulations that disadvantage them with respect to existing, conventional technologies. There is ample opportunity to shift from blocking legislation and regulations in all three North American countries to consistent policies that accelerate adoption of renewable technology. Cooperation among the NAFTA members would further accelerate the transition to a greater use of renewable technology to provide essential energy services. Many of these technologies may also need some form of financial incentives to overcome the costs of making a transition to this new type of energy system. Such incentives not only were supplied starting a century ago to create our present energy system, many direct and indirect subsidies continue to support existing energy technologies and systems.

For the purposes of this analysis, technologies that utilize any of the following energy sources will be considered to be renewable: distributed and centralized wind, biomass and geothermal energy, solar energy, small-scale biomass burning or conversion to liquid or gaseous fuels (including ethanol or methanol transportation fuels), geothermal, small-scale hydroelectricity under 50 MW. Large-scale hydropower is also renewable. It already plays an important role in North America, and involves quite different policy issues. Thus, this report will not include a major discussion of large-scale hydropower.

A slight modification of a general definition for renewable energy that was provided at the CEC meeting of 18 February 2002, is that

> *Renewable energy is any energy source for which the rate at which it is available in perpetuity exceeds the rate at which it is consumed.* (Martinez, 2002)

Since all sources of energy have economic and environmental costs, it then becomes the task of democratic societies through their governments and the markets they support to determine which energy sources will be adopted.

Renewable Energy Use—Where are we in North America?

Canada

Canada is a major producer of fossil fuels that provide approximately three fourths of its energy needs plus substantial exports (WRI 2000). Canada is also the world's leading producer of electricity from large-scale hydropower, receiving 11 percent of its total energy from this source. The ready availability of these resources provides Canada with one of the lowest cost energy supplies in the world. In addition, there are over 500 small-scale hydro projects in Canada of less than 50 MW each that are considered to be within the definition of distributed renewable resources (RETP 2002).

The major source of Canadian renewable energy, after large-scale hydro, is from biomass that amounts to six percent of the national total (RETP 2002). The extensive Canadian pulp and paper industry is the largest user of biomass energy, and currently meets an impressive 54 percent of its energy needs (heat and electricity) from forest waste (FPAC 2002). This effort substantially reduces air and water pollution associated with past forest waste disposal practices and the displaced fossil fuels that would otherwise be burned.

Small amounts of wind energy, ethanol fuels, geothermal and solar energy provide less than one percent of Canada's current use. The amounts of geothermal and solar production are too small to be recorded in standard data tables. Wind energy use is small but growing (RETP 2002).

Canada has wind potential that substantially exceeds the current electricity consumption of the nation. Much of it occurs in the Prairie Provinces and along the Atlantic coast. Wind turbines with a capacity of approximately 136 megawatts (MW) are currently operational in Canada, according to the Canadian Wind Association. These turbines produce approximately 30 million kilowatt-hours (kWh) of electricity annually, or enough for 37,000 Canadian homes. Wind energy is projected to expand to nearly 200 MW, although some of this growth may not be completed for another 10 years. The two largest projects are located in Québec, which consist of 57 MW at Cap Chat and 43 MW at Matane. The former site is expected to grow to 100 MW. The Québec government has recommended bringing on 450 MW of wind power over the next nine years. These two sites are closely followed in scale by two projects in Alberta of 40MW each at Cowley and Pincher Creek. The Cowley facility is currently operating at a capacity of 19 MW. A 5 MW project is being installed on Prince Edward Island at North Cape to take advantage of the wind potential along the Atlantic coast (CANWEA 2002).

A challenge for the development of large-scale wind electric projects in western Canada and the US is that the wind resource of the prairies is far from population and industrial centers. Developing long transmission lines adds to the economic and environmental cost of bringing this "free" wind resource to market. However, this problem is no different than that faced by many large-scale hydroelectric projects in the past, which have overcome this location challenge. The advantage of utilizing small portions of agricultural lands to simultaneously produce electricity from wind, grain or livestock and cellulosic alcohol fuels could substantially raise living standards in rural agricultural regions.

A number of small wind projects have been installed in remote rural locations, including the Yukon. A newly developed, wind-diesel hybrid system that requires no electricity storage has the potential to triple the wind market for isolated communities (CANWEA 2002).

Mexico

Mexico has the least-developed commercial renewable energy programs of the three countries; however, biomass forms a significant portion of the informal economy in many parts of the country. Firewood represents about four percent of Mexico's energy use (WRI 2000; Secretaría de Energía 2002). With its abundant petroleum and natural gas resources relative to its demand, it has only begun to explore the potential for renewables. The relative shortage of water for electric power production and, in particular, for cooling, especially along the border region with the US, has provided an additional incentive (Conae 2002). Mexico is blessed with abundant sunshine as the southern-most nation among the NAFTA countries, but all three nations have substantial solar potential. There is also significant wind potential, and biomass from sugar cane is a promising additional renewable resource. Being in a volcanic region, Mexico also has substantial geothermal energy potential. The capacity it has already developed is equivalent to about one-third that of the US, and provides two percent of its total electricity (WRI 2000).

While water is scarce there is still significant opportunities for hydroelectricity in certain regions of Mexico. Large-scale hydro capacity in excess of 9000 MW is currently in place and 34 small-scale sites are developed with a capacity of 109 MW. It is estimate that there is a potential for 3250 MW of facilities under 10 MW in size (Conae2002).

Mexico has substantial wind potential, but little of it is developed. An expansion from 1.6 MW to 54 MW is planned in Oaxaca. Mexico has identified many additional high-quality wind sites in Baja California, Tehuantepec, Yucatán, in the central and northern regions and along the coast. Wind currently contributes a modest amount to Mexico's electric grid, but proposals to expand wind generation capacity to 5000 MW by 2010 have been made (Conae2002a).

Commercial biomass is not yet a major factor in Mexico, although about 88 petajoules of bagasse is utilized for fuel at sugar mills. It is thought that additional potential of 3000 GWh exists for biomass in Mexico (Secretaría de Energía 2000).

The major use of solar energy in Mexico today appears to be for water heating. There are currently about 50 manufacturers, and in 1999 35,000m^2 of water heating panels were installed (Conae2002b; ANES 2001). Programs to bring solar PV electricity to remote regions that are inaccessible to the grid are being implemented. It is estimated that five million people live in areas without access to grid electricity. Approximately 35,000 systems of 50–75 watts have been installed to date. It is interesting that these systems are used mostly to provide power to micro enterprises such as sewing and woodworking, thereby significantly improving the rural economy. By 1999, 12.9 MW of PV systems had been installed in Mexico (Conae2002c; ANES 2001). Sandia National Laboratory in the US is working to bring additional off-grid photovoltaic electricity to Mexico.

There are already a significant number of solar panel manufacturers in Mexico, and because of the successful maquiladoras manufacturing system, there is the potential for Mexico to expand this effort to become a major manufacturer of both solar thermal and PV systems. The lower labor costs and large amount of labor required per unit could provide Mexico with a significant competitive advantage. Working in close cooperation with the major manufacturers of these technologies in the US and using the opportunities provided by NAFTA could prove highly beneficial to both countries and for the renewable energy industry. Solar technology could be manufactured both for the domestic market and for export to Europe, Asia, Africa and the rest of Latin America.

The United States

The United States relies heavily upon fossil fuels for its energy services that account for 87 percent of total consumption. The United States is the second-largest producer of oil in the world, but because of its extensive fleet of inefficient vehicles,for more than a decade it has been forced to import more than half of the petroleum it uses (WRI 2000). In 2001, the US consumed an estimated 126 billion gallons of gasoline and 38 billion gallons of diesel fuel in the transport sector (EIA 2002). Similarly, it is one of only a few countries that relies on coal for more than half of its electric power generation. At the same time, it is second only to Canada in large-scale hydropower, which accounts for 10 percent of US electricity generation (WRI 2000).

The largest source of renewable energy after large-scale hydropower in the United States is biomass and municipal solid waste. Together, they generate approximately three percent of US energy and, with landfill methane, provide fuel for about one per cent of US electricity production (WRI 2000; EIA 2002). The pulp and paper industry now meets more than 55 percent of its energy requirements using biomass fuel derived from forestry wastes (Jorling 2002).

There is also a substantial ethanol motor-fuels industry that is derived primarily from the fermentation of cornstarch and sugars. In 2001, ethanol in gasoline amounted to approximately one billion gallons or about 0.8 percent of total gasoline production. Ethanol is blended at a level of 10 percent with gasoline. An additional three billion gallons are also used to produce an oxygen-rich additive for reformulated gasoline to reduce air pollution during combustion (EIA 2002). The capture of methane from landfills for use in small turbines for the production of electricity is a small, but growing use of biomass waste.

California began the global move to develop wind energy following the energy price shocks of the 1970s. By the end of the 1980s it had installed over 1500 MW of wind capacity that constituted 90 percent of global wind power. Then, because of policy changes, this effort stalled and little capacity was added until recently. However, changes in national law made the 1990s a time of rapid growth for wind generation, and by the end of 2001, the US had an estimated 4150 MW of wind capacity. This is about one-half of the capacity of Germany, the world leader, whose production now accounts for nearly one-third of the global total. The United States, like Canada, has more wind potential than it now needs to meet its current electricity demand. Much of the wind resource is located in the Great Plains states, stretching from North Dakota to Texas, with additional resources along the Northeast coast. Much of the new capacity has been added in states such as Texas, and large additions are planned for some of the northern plains states. The addition of large wind turbines on private agricultural lands is significantly improving rural incomes. The world's largest offshore wind facility totaling 420 MW is planned for the coast of Cape Cod, Massachusetts (Sawin 2001).

California is the largest producer of geothermal power in the United States, and the US leads the world with about one-third of global geothermal production (WRI 2000).

Renewable Energy Policies in North America—What has been tried? How has it worked?

Canada

In Canada, much energy policy is conducted at the provincial level. However, the federal government has set forth a number of policies and provides tax and other incentives to encourage renewable energy development. The Canadian government is also committed to purchasing 13 million kWh of wind electricity over a ten-year period, and has made significant commitments to lowering its greenhouse gas emissions through efficiency and the use of cleaner fuels and renewable energy (NRCAN 2001).

In the electricity sector, the government will provide an incentive for wind production for facilities begun between 31 March 2002 and 1 April 2007. The incentive will be in force for the first ten years of operation, and will begin at 1.2 cents per kWh and decline to 0.8 cents per kWh. The production incentive program is expected to spend C$260 million over its 15-year lifetime. The Canadian government has also made a commitment to purchase electricity generated by renewables (CANWEA 2002).

The Renewable Deployment Initiative is a six-year program begun in 1998 to encourage the use of active solar hot water and air heating systems and efficient biomass combustion. Businesses are eligible for a refund of 25 percent up to a maximum of C$80,000 towards the purchase price of qualifying systems. A total of C$24 million is available. Natural Resources Canada also provides incentives for these types of systems for federal departments and public institutions (REDI 2002).

REDI also provides subsidies for the development of hybrid systems for remote communities. The agency will pay up to 40 percent to as much as C$80,000 towards the price of photovoltaic systems (REDI 2002).

The Canadian government also funds modest amounts of research and development of renewables through its Renewable Energy Technologies Program. This is mostly through cost-sharing and technical assistance at a level of C$8 million per year (RETP 2002).

The Canadian government has encouraged the production of biomass-based fuels by exempting biomass produced ethanol and methanol completely from the fuels tax since 1992. A number of Canadian companies are working to expand the production of biofuels. British Columbia is the only province to enact a Renewable Portfolio Standard, but Nova Scotia has introduced a voluntary effort to encourage independent power producers to make 2.5 percent of their new power facilities renewable (GOC 2002).

Mexico

Research being conducted in Mexico demonstrates the need to develop cleaner sources of electric power generation and cleaner vehicles to reduce the high levels of air pollution in Mexico City and other urban regions. Renewables would not only help to reduce urban air pollution but also decrease acid rain and lower greenhouse gas emissions. Moving onto a sustainable energy path at an early stage could be extremely advantageous to the long-term economic development of Mexico (Manzini and Martinez 1999).

The energy laws of Mexico have been recently revised to increase the amount of distributed electricity that may be provided to the electrical grid, but they are limited to small producers. The strategic objectives of the Mexican National Energy Programme for the period between 2001 and 2006 include an increase in the efficiency of conventional power systems and an expansion of renewables. A major barrier to the penetration of renewable energy technology in Mexico is the large subsidy for conventional electricity that is provided by the government, and there is current discussion as to how to address that politically difficult issue (Secretaría de Energía 2002; Sandia 1998).

Obtaining financing for renewable energy projects remains a problem in Mexico. There is a need to create a legal framework that gives investments for renewable technology access to conventional financing. Renewables would also be boosted by setting incentives that are now lacking, such as tax benefits and the establishment of Renewable Portfolio Standards. Establishing long-term prices favoring renewables and the creation and certification of green energy markets would also stimulate both domestic and foreign investment in renewables (de Buen 2002).

The United States

The Public Utility Reform Policy Act of 1978 opened the US electric market to production of small-scale (less than 80 MW for renewable facilities) independent power producers. The Energy Policy Act of 1992 created a production tax credit of 1.5 cents per kWh (adjusted for inflation) for the first 10 years of wind generated electricity. This tax benefit applies only to projects installed before the end of 2001, and an extension to

additional projects is being considered. It is estimated to have been worth $20 million in 1998. Additional production tax credits for wind, biomass and landfill methane are provided to publicly owned generators. Investment tax credits were initially used in California, but were found to be less effective in encouraging renewable electric power generation than the production tax credit (Sawin 2001).

Electric utility restructuring holds substantial promise for incorporating renewable energy into the US electric production system. National legislation has been stalled, but a number of states have now implemented some aspects of restructuring.

States that have restructured their electric power sectors have implemented a number of regulations to promote renewable energy. These include renewable trust funds collected from a system benefit charge to subsidize the higher cost of wind solar and other renewable facilities, renewable portfolio standards, exemption from sales taxes for the purchase of renewable technology, property tax exemptions, accelerated depreciation and subsidized loans. A total of thirteen states have a System Benefits Charge that in some cases can also support renewable energy. Currently, ten states have a renewables portfolio standard requiring that a specified minimum of additional installed capacity consist of renewable energy. A benefit to small-scale residential and commercial use of solar energy is a net metering requirement that permits surplus power to be sold to the grid. Consideration is being given to reinstating the types of federal and state tax credits for the purchase of renewable technology that were common in the 1970s and 80s (Sawin 2001; EIA 2002).

Some renewable energy developers have created a green pricing strategy that permits customers to pay a premium for electricity produced by renewables. The cost may range from 1 to 5 cents per kWh. A system of transferable "green tags" allows customers who are not served by renewable energy generating capacity to pay a green premium to developers of green power elsewhere in the country. While this movement is small, it is believed to have accounted for an addition of approximately 100 MW of wind power to the US system in recent years. At least one wind power developer is donating CO_2 permits for a tax deduction to an NGO as a way to assure its customers that the carbon emission savings will not be traded in the future to offset emissions form fossil generating stations (CACP 2002). Additional examples of voluntary efforts to utilize renewables by institutions, universities and businesses may also be found (TCI 2002).

Both federal and state renewable incentives have been allowed to lapse on several occasions, and have been subject to a constant alteration of the regulations governing them. Promising technologies such as solar thermal electric power generation have failed to grow, in part because the California legislature did not extend the tax benefits in a timely manner so that the company was unable to secure financing. Similarly, national incentives were allowed to lapse on several occasions, only to be reinstated retroactively many months later. This has led to a boom and bust cycle, and the eventual elimination of major domestic wind turbine manufacturing in the US (Sawin 2001).

Production and shipments of solar photovoltaic panels continues to grow in the US, reaching 60 million peak watts in 1999 and 75 in 2000. However, US global share has fallen from a first place high of 4 percent of the world market in 1996 to second place (27

percent) behind Japan (Maycock 2002). An estimated 70 percent of US production is exported to Europe and to developing countries. Programs such as the Million Solar Roofs initiative promote partnerships, but do not provide funding to implement them. A few states such as California and Maryland provide funding to pay some of the higher costs of PV technology. The US leads the world in installed solar thermal electric technology, with more than 400 MW installed. Installation of solar hot water systems has fallen from their peaks in the 1980s as tax credits have expired. Passive solar heating and cooling design continues to improve, but the US construction of such buildings lags well behind that of Europe.

To promote the adoption of ethanol for fuels, the federal government exempts ethanol from the 5.4 cents per gallon excise tax when added to gasoline. This amounts to an annual subsidy of more than $725 million annually, according to the Energy Information Administration. There are additional production tax credits as well (EIA 2002).

The US government has provided major support for renewable energy research and development. From a peak of $700 million for solar energy, and approximately $1 billion total for all renewables in the early 1980s, funding for solar has stabilized at approximately $100 million per year for the past 20 years. Biomass support is at a comparable level and is increasing, especially for ethanol, while wind and geothermal energy R&D is supported at a level of approximately $40 million each year. A 20 percent tax credit is also available for “incremental” R&D for private companies. Some joint public-private cost sharing programs exist as well (EIA 2002).

Renewable Energy Outside of North America—Are there lessons to be learned?

Europe has moved aggressively to promote renewable energy in a number of countries. Wind is the fastest growing source of energy by far. According to the IPCC, it has increased worldwide at an annual rate exceeding 25 percent since 1995. By the end of 2001, Germany led the world with installed capacity of 8,000 MW, or one-third of the global total. The US is second with 4,150 MW, Spain is third with 3,300 MW, and Denmark is fourth with more than 2,300 MW. Denmark now produces more than 15 percent of its electricity from wind power, and there are states within Germany that produce more than 20 percent. Germany’s investment in wind only began in 1990, and that country is on track to meet its target of 22,000 MW by 2010. These three nations have established goals for renewable energy and have set long-term premium prices for renewably generated electricity. The new Danish government, however, has just announced that it is removing many of the supports that have built the program to date. Denmark now manufactures more than 60 percent of all wind turbines sold in the world, followed by manufacturers in Germany and Spain (Brown 2002; Janet Sawin 2001; EIA 2002).

Germany also leads the way with photovoltaic purchases by building and home owners with a 100,000-solar roof program. The government provides interest-free loans and a guaranteed price of 50 cents per kWh of electricity sold back to the grid over a ten-year

period. The program, begun in 1998, proved so popular, adding 45 MW in 2000, that the government had to place limits on funding for budgetary reasons (Worldwatch Institute 2001).

Experience in Europe suggests that a grid can relatively easily accommodate up to 20 percent intermittent renewable energy sources without the need for storage. This is because existing generators provide the extra capacity that is needed to insure reliability in the system. For larger penetration of wind, and solar in particular, development of more advanced energy storage technology may be required. However, many say that that is a long way off.

Because the forest industry in Scandinavia is of a similar structure to that of North America, it too produces well over half of its energy needs from forest wastes. Other sources of renewable energy in Europe are electric power fromthe incineration of municipal solid waste and a modest amount of landfill gas recovery.

The European effort is linked both to expanding domestic sources of energy and to reducing greenhouse gas emissions. Interestingly, European governments have not invested heavily in R&D, but instead have utilized a demand-pull policy approach by assuring long-term higher prices for renewable energy. Another lesson from the European experience is that long-term consistency of policies that provide investors with certainty about the rules for renewables is perhaps more important than the details of the policies themselves (Sawin 2001).

Renewable Energy Futures in North America

North America has the potential to become the global leader in renewable energy technology. Such a shift will create jobs for people in each of the three nations, and produce technology for both the North American regional market and for export. (How energy is produced and used could be transformed into a sustainable process.)

US firms produce some of the most advanced solar PV technology in the world, but the industry has fallen to second place behind that of Japan. Forming alliances with Mexico to produce solar panels with lower-cost labor from Mexico could prove advantageous for both nations. The same could be true for the manufacture of labor-intensive solar thermal panels.

Another technology in which there could be major cooperation among all three nations is in the development of biomass gasification technology. The creation of integrated gasifier, combined heat and power systems could revolutionize the management of both agricultural and forestry wastes. Also, producing ethanol from cellulose rather than just from corn (maize) or sugar would open huge portions of the agricultural and forestry industry to renewable transport fuels production. Combining this fuels base with the appropriate placement of wind turbines on agricultural lands could provide a major impetus for rural development in all three countries. Improved wind and solar electricity for lighting, motors and water pumping in remote locations can also substantially

improve the quality of life of people in these regions. Research on the conversion of biomass to hydrogen to operate fuel cells would also benefit all three countries.

Canada is the leader in the race to commercialize the fuel cell for both power production and as the engine for 21st-century transport. With the large gas and oil fields in all three countries, there is also ample opportunity to develop physical options for carbon dioxide sequestration for both biomass and fossil fuels. The additional advantage of sequestering carbon from biomass is that hydrogen production actually removes carbon dioxide from the atmosphere.

During the past year the New England Governors and Eastern Canadian Premiers (CNEG and ECP 2001) declared that it is time to set specific goals to address climate change:

- Short-term – Stabilize greenhouse gas emissions at 1990 levels by 2010.
- Mid-term – Reduce greenhouse gas emissions levels 10 percent below 1990 levels by 2020
- Long-term – Reduce greenhouse gas emissions levels eventually by 75–80 percent.

Renewable energy will play a critical role along with improved energy efficiency in vehicles, buildings, appliances, lighting and industrial processes to achieving that goal.

The driving forces of improving the economy and standard of living of all North Americans, providing for a sustaining environment and having greater economic and national security all depend upon a sharply enhanced role for renewable energy.

Conclusions

Is it likely that North America can achieve the projection set by the International Energy Agency that half the world's energy could come from renewable sources by 2050? Is it really possible to meet the goal set forth by the New England Governors and Eastern Canadian Premiers of eventually reducing greenhouse gases by 75–80 percent in northeastern North America? Nothing is guaranteed, but to move in those directions will require concerted efforts to introduce more renewable energy in all three countries, develop policies that will encourage the adoption of technologies for renewables, encourage markets that improve these technologies over time, and increase cooperation among the NAFTA partners.

There are many opportunities for significantly increasing the amount of renewable electricity, heat and fuels in all three countries. Doing so would provide significant benefits for each country in terms of security of energy supply (especially in the transport sector); in reducing air, water and land degradation; and in significantly lowering the emission of climate altering greenhouse gases. Done properly, expanding renewable energy would increase jobs, promote economic and rural development, and reduce the scale of payments abroad.

Successfully creating jobs by shifting to renewables will depend upon careful attention to providing transitional support to displaced workers, to encouraging renewables through tax offsets and reductions, and to ensuring that energy-intensive industries receive transitional assistance (Barrett and Hoerner 2002).

Renewable energy technology is now available, but is disadvantaged relative to existing fossil fuel-based alternatives. In part this is because the purchase price of renewable technology is higher than conventional sources in the marketplace. However, seldom does the purchase or operating cost of energy reflect the true societal costs of local air pollution, acid rain, climate change, land disturbance, water pollution and the repeated economic disruptions and job losses caused by energy price shocks. Renewable energy also provides greater economic and national security and reduces the need for military protection of distant supply sources. Despite a higher initial purchase price for renewable technology, the fuel cost of renewables is constant and *zero* (in most cases), providing insurance against future economic disruptions.

A number of policy barriers within each of the three North American nations need to be addressed, and national and subnational laws and NAFTA trading rules need to be reconciled in order for renewable energy to achieve its full potential. While concerns have been raised that state-instituted renewable portfolio standards might conflict with NAFTA rules, proposals have appeared to resolve potential conflicts (CEC 2001; Horlick 2001; UCS 2002). It is also essential to adopt a long-term perspective for expanding the role of renewable energy in North America over the next several decades. An examination of successful renewable energy policies in North America and Europe suggests that some of the following policy goals and options might be effective in accelerating the adoption of renewable energy technologies.

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<u>Establish Incentives for Renewables</u>

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- Remove impediments for adding distributed sources generally to the grid, by making the transmission and distribution system open to all producers, regardless of size.

- Redesign current environmental policies to encourage companies to replace existing, polluting technology with clean renewables at a future specified date rather than locking in old technology by requiring near-term upgrades to meet present pollution standards.
- Production tax incentives for electricity are more effective than investment tax credits in most cases.

Biomass Fuels

- Encourage biomass fuel development under appropriate environmental safeguards.
- Avoid preferencing any particular crop biomass source.
- Strive to develop cellulosic-based liquid fuels in order to have the most options and greatest yield of fuels from plant material.

Economic and Social Policies

- Utilize biomass and wind as a means to promote rural development and jobs creation.
- Promote joint manufacturing of solar PV and solar thermal technologies between the US and Mexico.
- Develop wind manufacturing and implementation opportunities between Canada, Mexico and the US.
- Develop transition policies to address any dislocations that might come about through a shift from traditional energy sources to renewables.

Research and Development and Purchasing

- Create incentives for private sector research and development in renewables.
- Target governmental research and development to solve systems' problems and address technological issues that are unlikely to draw the attention of companies in the private sector.
- Expand national and subnational governmental purchases of renewably generated electricity, fuels and heat.

References

ANES, 2001, Asociación Nacional de Energía Solar A. C., *Estrategias para Desarrollar el Aprovechamiento de las Energías Renovables en México.*

Barrett, J.P. and Hoerner, J.A., 2002, *Clean Jobs and Industry: A Comprehensive Approach to Climate Change and Energy Policy,* Economic Policy Institute and Center for A Sustainable Economy.

Brown, L. 2002, Earth Policy Institute, Wind Energy Report described in the Japan Times, 7 January, 2002.

CACP, 2002, Clean Air Cool Planet, <http://www.cleanair-coolplanet.org>.

CANWEA, Canadian Wind Energy Association, <http://www.canwea.ca/production.htm>.

CEC, 2001, North American Commission for Environmental Cooperation, "Environmental Challenges and Opportunities of the Evolving North American Electricity Market," October 22, 2001.

CNEG and ECP, 2001, Conference of New England Governors and Eastern Canadian Premiers, <http://www.cmp.ca/neg.htm>.

Conae2002, Comisión Nacional para el Ahorro de Energía, <http://www.conae.gob.mx/renovables/minihidr.html>.

CONAE, 2002a, <http://www.conae.gob.mx/renovables/eolica.html>.

CONAE, 2002b, <http://www.conae.gob.mx/renovables/fotovoltaica.html>.

CONAE, 2002c, <http://www.conae.gob.mx/renovables/fototermica.html>.

de Buen R., Odón 2002, "Marcado de Energía Verde en México: Antecedentes y Propuesta," CONAE.

EIA, 2002, Energy Information Administration, <http://www.eia.doe.gov/oil_gas/petroleum/info_glance/gasoline.html>.

FPAC 2002, Forest products Association of Canada, <http://www.cppa.org/english/info/work.htm>.

GOC, 2002, Government of Canada, < <http://www.climatechange.gc.ca/english/whats_new/action_plan_renew.shtml>.

Horlick, G. Schuchardt, C. and Mann, H., 2001, "NAFTA Provisions and the Electricity Sector. North American Commission for Environmental Cooperation, Montreal.

Jorling, T., 2002, Interview, February 2002.

Manzini, F. and Martinez, M., "Using final energies to plan a sustainable future for Mexico," *Energy 24, 945-958.*

Martinez, M. 2002, Remarks delivered at Montreal, Quebec, meeting of the CEC, February 18, 2002.

Maycock, P. 2002, *PV News* February.

NRCAN, 2001 Natural Resources Canada, < <http://www.nrcan.gc.ca/css/imb/hqlib/2001peiea.htm>.

REDI, 2002, Renewable Energy Deployment Initiative, <http://nrn1.rncan.gc.ca/es/erb/reed/progdesc_e.htm>.

RETP, 2002, Renewable Energy Technologies Program, <http://rncan.gc.ca/es/etb/cetc/cetc01/htmldocs/programs_ret_e.html>. Also, <http://www.small-hydro.com>.

Sandia, 1998, "Market Guidebook of Renewable Energy Applications in Mexico," Sandia National Laboratories Renewable Energy Office.

Sawin, Janet, 2001, Doctoral dissertation, The Fletcher School of Law and diplomacy, Tufts University, Medford, MA.

Secretaría de Energía, 2002, <http://www.energia.gob.mx>.

TCI, 2002, Tufts Climate Initiative <http://www.tufts.edu/tci>.

UCS, 2002, Union of Concerned Scientists, Scott Hempling and Nancy Rader authors, "Comments of the Union of Concerned Scientists to the CEC in response to its 'NAFTA Provisions and the Electricity Sector' Background Paper to its October 22, 2001 Working Paper Entitled 'Environmental Challenges and Opportunities of the Evolving North American Electricity Market."

Worldwatch Institute, 2001, *Vital Signs, 2001,* W.W. Norton and Company, New York.

WRI, 2000. *World Resources 2000–2001*. World Resources Institute, Washington, DC.

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