Environmental Challenges and Opportunities of the Evolving North American Electricity Market

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Working Paper

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ENVIRONMENTAL CHALLENGES AND OPPORTUNITIES IN THE EVOLVING NORTH AMERICAN ELECTRICITY MARKET

Working Paper[1]

INTRODUCTION

The purpose of this paper is to identify some key issues pertaining to the changing electricity sector and the environment. It has been prepared by the Secretariat of the Commission for Environmental Cooperation (CEC). Given the breadth and complexity of issues related to electricity and the environment, this working paper highlights some of the main issues on a case-by-case or anecdotal basis.

North America's electricity sector is in the midst of unprecedented change. Competitive electricity markets have been introduced, or remain under consideration, in Canada, Mexico and the United States.[2] The move to competitive markets continues to spark an intense debate around the principles, design, rules, institutional structure and consequences associated with introducing free markets into a sector for so long regarded as providing a public service, shielded from markets. This dynamic energy policy context represents an opportunity for policymakers and planners to consider how best to maximize both the economic and environmental benefits of a more integrated North American electricity market.

Advocates of competitive electricity markets in Canada and the United States argue that over time, efficiency gains will be produced in a sector formerly characterized by monopolies and oligopolies. These greater efficiencies will result from greater customer choice about the power, and power services, being made available for purchase. Greater choice is also expected to result in a marginal decrease in electricity prices over and above price decreases brought about through efficiency gains.

It must be acknowledged that, to date, these benefits remain largely theoretical. In most of the jurisdictions allowing customer choice, only a tiny fraction of consumers have switched to alternate providers. While incumbent utilities or their subsidiaries do indeed face competition in these areas, they continue to dominate their competitors, who remain for the most part small and weak.

At the same time, the price reductions expected from increased efficiency have been overwhelmed by price increases—in some cases, massive ones, as in the case of California—due to the greatly increased volatility of wholesale electricity markets. It has by now become clear that the mechanisms currently in place are inadequate to prevent generators from exercising market power, i.e., from artificially raising market prices for their own benefit. Unless and until

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[1] This working paper has been prepared by Scott Vaughan, Zachary Patterson, Paul Miller and Greg Block at the Secretariat of the Commission for Environmental Cooperation. It is intended for discussion purposes only, and does not reflect the views of the CEC or its Parties. The Secretariat acknowledges the valuable work and advice of Joseph M. Dukert.

[2] Common features of open competition include the unbundling of vertically integrated power companies into distinct components, generally comprised of private electric power generation companies, for profit transmission entities, intermediary market brokers and traders, and various retail and end-use providers.

this can be accomplished, the expected efficiency gains that have largely provided the justification for restructuring are unlikely to be realized.

To be clear, not all of the approximately 90 federal, state and provincial jurisdictions in North America have enacted, or have plans to enact, market liberalization plans. However, it is likely that all jurisdictions will be affected by market changes, in part because of the close link between domestic regulatory changes and changes in the international trade of electricity.

It is expected that market restructuring and the gradual evolution of expanded and integrated transmission grids connecting regions in North America will amplify, as well as change patterns of trade in North America. US-Canada electricity trade has for some time comprised the majority of total continental trade in electricity. Cross-border trade has been expanding in both directions during the past decade, although Canada remains a net exporter by a wide margin. In 1998, Canada exported approximately 39,500 thousand gigawatt hours (GWh) to the United States. During the same period, the US exported 17,280 GWh to Canada.[3]

Net Canadian exports to the US have remained relatively stable in recent years, measured as a proportion of total Canadian electricity generation, and comprise approximately 9 percent of total electricity generated. However, it is widely expected that the structural changes currently underway in the US electricity market will lead to substantial increases in Canadian exports. For example, the National Energy Board of Canada recently noted that FERC orders are expected to further increase north-south trade between Canada and the US.[4] Canada's large hydro utilities, owned by the provincial governments of Québec, Manitoba and British Columbia, are all very active players in US markets and are actively seeking ways to increase their exports.[5]

By contrast, Mexico-US trade has been considerably smaller than Canada-US trade. In 1998, total US exports of electricity to Mexico were 1,510 GWh, or roughly 8 percent of total US exports. (All remaining exports went to Canada.) During the same period, Mexican exports to the US were small, in the vicinity of 10 GWh, and largely concentrated in the Baja California region. There are indications that this pattern of trade will shift over time, and that Mexico could become a net exporter of electricity to the US market.

The extent to which trade will change over the near to medium term depends on many factors, including projected rates of domestic electricity demand and supply growth; changes in the relative price of electricity between regions; and the extent to which electricity transmission linkages between regions and countries deepens. To date, significant constraints persist regarding interregional transmission, even though a significant increase in interregional trade continues to take place. The reform of transmission policies are closely related to overall regulatory reforms that continue to reshape the sector.

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[3] Trade data in general and electricity trade data in particular are not consistent between different reporting sources. As such, trade data used here are from the IEA, *Electricity Information (2001 Edition)*, Paris. While these numbers represent only a small portion of US production, they represent an important share of Canadian production.

[4] The National Energy Board, the federal regulatory body, recently noted that FERC initiatives such as Regional Transmission Organization (RTO) "formation could lead to more north-south trade and the further integration of US and Canadian electricity markets. To the extent that Canadian competitiveness can be maintained, high export revenue would result," due, presumably, to higher export volumes. National Energy Board (2001), *Canadian Electricity: Trends and Issues,* Government of Canada.

[5] The same is true of Ontario Power Generation, owned by the government of Ontario, which owns the generating assets formerly held by Ontario Hydro.

Competition reform and trade rules together are important catalysts in the integration of electricity markets in several key jurisdictions, and increased international trade between others.

Of the two areas of market reforms transforming the marketplace, changes in competition policies and related market restructuring have already exerted a profound effect, both within the US and between it and its neighbors. Within the United States, the introduction of Orders 888, 889 and 2000 by the Federal Energy Regulatory Commission (FERC)—which in turn are based on a mandate established by the Energy Policy Act of 1992—are key drivers of restructuring in the United States. An extensive body of literature now exists which examines these rules, their aims and likely effects on electricity markets within the US.

Given the size, proximity and importance to Canadian utilities of the United States market, it should come as no surprise that changes there continue to have important structural and rule-related implications for Canada. Alberta's electricity market was restructured in 1996, and a competitive market is expected to be launched in Ontario this spring. Furthermore, several Canadian utilities restructured their operations to conform to FERC Orders 888 and 889, in order to secure access to the US market. These utilities are closely following the implementation of Order 2000, which suggests that membership in Regional Transmission Organizations may be necessary in order to maintain market access.

In this regard, there is little doubt that FERC initiatives, beginning with Order 888, have profoundly affected Canadian energy markets.

As for Mexico, its federal regulatory body—the *Comisión Reguladora de Energía* (CRE)—has not explicitly embraced FERC Orders 888, 889 and 2000. Moreover, the CRE at one point raised concerns about the potential extraterritorial implications of those rules changes and their impact on the electricity sector in Mexico. However, as a general point, the CRE has welcomed what it calls (in approving its first export permit to a foreign owned utility in 2000) a "further step toward the integration of a North American energy market."[6]

The second catalyst toward the creation of a North American Energy Market is the North American Free Trade Agreement (NAFTA). Although it is unlikely that NAFTA has had a measurable effect on increasing trade in electricity,[7] it very likely would have a central role in arbitrating trade disputes involving electricity among the three countries. Moreover, NAFTA provides long-term investment stability and predictability to encourage large capital investments required in the sector.

The Environmental Context of the Electricity Sector

Affordable and reliable electricity provides much of the economic stability upon which prosperity depends. A sustainable, long-term energy policy remains crucial to our economic wellbeing. At the same time, there is no issue of greater environmental importance to North Americans than the evolution of a continental electricity market.

Notwithstanding the obvious benefits of the provision of electricity, the generation of electricity is a resource and environmentally intensive sector. An overview of annual emissions from the

[6] Info CRE, March-April 2000, Amx 3 No. 2 4/4.
[7] This is not to say that trade liberalization does not impact significantly on the trade of electricity, only that US-Canada trade in electricity increased dramatically with the the Canada-US Free Trade Agreement. Please refer to Section Eight.

electricity sector during the mid- to late-1990s for criteria air pollutants—NO_x, SO_2, CO_2 and mercury—will be found in Table 2, in total, as well as per capita, per km^2 and per unit of energy terms. This is believed to be the first time such a comparative air pollution inventory has been compiled, even though it represents only the 'closest match' the CEC could assemble from disparate sources and time periods. A breakdown of data, methods and assumptions can be found in Section Three, as well as in Background Paper I.[8]

The consequences of air pollution and environmental impacts of the sector are considerable, and well documented. These include the effects of acid rain on lakes, rivers, forests, buildings and human health. The generation of electricity is a major source of carbon dioxide, the principal greenhouse gas. It is also a major source of ground-level ozone and fine particulate matter.

Ozone and fine particulate matter are classic examples of the international environmental and policy implications of the fuel choices made by the electricity generation sector in North America. Precursors of these pollutants are emitted from the high smokestacks of fossil fuel power plants. These precursors, particularly NO_x, produce smog and haze in the atmosphere that easily cross the political boundaries of North America, leading to air quality problems beyond the jurisdictional control of the affected region. The scale of transport can be relatively local or long-range. Ozone and particle matter leave Mexicali, Baja California and arrive just across the border in the Imperial Valley of California. California may return the favor by sending its pollution from Los Angeles and San Diego to Tijuana.[9] Longer distance transport can extend hundreds of kilometers, as with ozone and fine particles caused by power plants in the midwestern/ northeastern US traveling in air pollution "rivers" to eastern Canada. Even transport on the scale of thousands of miles is possible, as seen in satellite images of smoke from forest fires in southern Mexico extending through the Mississippi Valley and eastern seaboard of the United States. It is not a great leap of logic to infer that if smog and haze from the burning of living trees can travel such a great distance, then the smog and haze from the burning of prehistoric trees (e.g., coal) can do likewise.

The existence of air pollution transport across national boundaries raises concerns regarding differing environmental regulatory standards that might influence siting locations of new pollution sources within a pollution pathway. For example, developers have initiated a number of new power plant projects in northern Baja California. The US Environmental Protection Agency (EPA) recently determined that the majority of particle matter causing violations of health standards in the Imperial Valley of California arises across the border in Mexico (Baja California).[10] The US Department of Energy (DOE) has observed that Mexico is an attractive location for new power plant developers that want to provide power to California due to lower environmental requirements.[11] To the north, developers are proposing a fairly concentrated number of new coal power plants in Alberta that surpasses coal development activity elsewhere in North America. At the same time, critics have argued that these plants will not be subject to the

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[8] Miller, Paul, Zachary Patterson and Scott Vaughan. 2002. Background Paper I for Article 13 Secretariat Note: *Estimating Future Air Pollution from New Electric Power Generation*. Commission for Environmental Cooperation, Montreal (printed elsewhere in this volume).

[9] CEC. 1997. *Continental Pollutant Pathways* (Montreal, Canada).

[10] *Federal Register,* Vol. 66, No. 203, pp. 53,106-53,112 (19 October 2001).

[11] US Department of Energy (DOE), "An Energy Overview of Mexico," <http://www.fe.doe.gov/international/mexiover.html> (5 Sept. 2001 update) (*stating* "Mexico's less stringent environmental regulations have provided an incentive for companies to locate their power plants in Mexico to produce electricity for export to California").

same level of pollution control for total particulates, SO_2 and NO_x found in other regions of North America.[12]

At an aggregate level, approximately 25 percent of all NO_x emissions in the United States come from the electricity sector; roughly 35 percent of CO_2 emissions; one-quarter of total mercury emissions; and almost 70 percent of SO_2 emissions. The majority of air pollution emissions come from coal and oil powered plants. The most immediate and profound costs of electricity generation have been linked to human health impacts. Despite improvements in reducing both NO_x and SO_2 emissions, 23 percent of all Americans—62 million people—live in areas that failed to meet federal ambient air quality standards.[13] Minute airborne particles—a measurable portion of which originates from fossil fuel combustion for power plants—have been estimated to lead to the premature death of 60,000 US citizens each year. In Canada, the number of people that die each year from air pollution emissions is estimated to be as high as 16,000. Each day in the US and Canada, more than 200 people die prematurely from air pollution. In addition to criteria pollutants, the electricity sector is the single largest source of toxic emissions in Canada and the United States.[14] In addition, the construction of large-scale, reservoir hydropower plants has been linked to the endangerment of freshwater fish and other species in some North American regions. As well, the flooding of areas for large-scale reservoirs has been linked with the loss of habitats in the immediate areas flooded. Hydroelectric power also mobilizes mercury deposited from other, atmospheric emissions, which allows it to get concentrated in the food chain in its methylmercury form.

In Mexico, the figures are no more promising. Non-attainment days in Mexico City numbered 337 in 2000, 211 in Guadalajara, and 111 in Mexicali—which just received approval to export electricity to the US.[15]

Assessing Future Effects of Market Growth and Integration

Given the current environmental profile of the electricity sector, a key question is whether increased trade and market integration will improve, worsen, or leave much the same environmental impacts.

Environmental assessments of policy changes linked to market liberalization—such as FERC Orders 888, 889 and 2000 or NAFTA—pose different methodological challenges than undertaking project-specific environmental impact assessments (EIA). Certainly, lessons from EIAs are invaluable in assessing upstream, downstream, cumulative and other effects, as well as the pivotal role of transparency and public participation in environmental assessment work.

In the past decade, progress has been made in assessing the environmental impacts of trade liberalization. This progress includes improved methodologies, which build upon work by the

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[12] Pembina Institute Backgrounder, "New Alberta standards for emissions from coal-fired power plant less stringent than other jurisdictions," <http://pembina.piad.ab.ca/news/press/2001/2001-06-18bg.php> (18 June 2001) (accessed 12 October 2001).
[13] EPA. 1999. *National Air Quality: 1999 Status and Trends.*
[14] CEC. 2001. *Taking Stock 1998*. *Taking Stock* does not include toxic release data for Mexico.
[15] INEGI/Semarnap 2000. *Indicadores de Desarrollo Sostenible en México*. INEGI/Semarnap, Aguascalientes.

OECD, the CEC, and others by breaking down environmental impacts of trade liberalization into the following components[16]:

- Scale Effects: The extent to which free trade increases overall economic activity, as well as sector-specific economic growth;
- Compositional Effects: The extent to which free trade induces changes in the structure of the economy, generally towards an increase in the services sector as a percentage of GDP;
- Technological Effects: The extent to which free trade and improved market access accelerates technological innovation, and capital turnover;[17]
- Product Effects: The extent to which free trade affects changes in the pattern of demand for products;
- Regulatory Effects: The extent to which free trade prompts changes in regulations and policies among trading partners.

In addition to these five, closely related effects of free trade, a sixth must also be noted: "Locational Effects," i.e., the extent to which free trade results in shifting economic activity (accompanied by environmental and social externalities) from one region or country to another.

Generally speaking, compositional, technological, product and regulatory effects have the capacity to reduce or partially offset the environmental impact of scale effects. Evidence of this offsetting effect is seen in the continued "decoupling" or delinking of total energy use from environmental impacts. Since NAFTA entered into force in 1994, the energy intensity per unit of GDP in Canada and the US has decreased by 9 and10 percent, respectively. During the same period, Mexico's energy to GDP ratio has increased marginally by one percent. (See Table 1.)

Estimating the Scale Effects of Planned New Generation

To assess probable environmental impacts of increased trade, this working paper begins with a consideration of the current scale and fuel mix of the electricity sector in Canada, Mexico and the United States. It then proceeds to examine the possible overall increase in electricity generation in the near to medium terms. These two data sets, current and future installed capacity, give some insight into the potential scale effects of the electricity sector, given current industry plans.

Numerous forecasts estimate demand and supply growth in the electricity sector to 2025. The results of these forecasts by government agencies from Canada, Mexico, and the United States are summarized in Section Three below.

To complement these forecasts, the CEC used a database called NEWGen, maintained by the consulting firm RDI/Platts.[18] The NEWGen database contains announced capacity changes in Canada, the United States (comprising additions and reductions from decommissioning). This information is complemented with data from federal authorities in Mexico, namely the *Comisión*

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[16] OECD (Organization for Economic Cooperation and Development). 2000. *Assessing the Environmental Effects of Trade Liberalization Agreements: Methodologies.* OECD, Paris. CEC. 1999. *Final Analytical Framework for Assessing the Environmental Effects of NAFTA.* CEC, Montreal.

[17] It should be noted that some have argued that economic theory predicts that competition slows stock turnover because the cost of borrowing money will go up when risk is transferred from ratepayer to shareholder. The higher cost of borrowing money will result in the deferral of large investments and the extended operation of plants that can cover their variable costs. There is, however, little empirical evidence for this point of view.

[18] RDI/Platts NEWGen Database, August 2001 issue (Boulder, Colorado, USA)

Federal de Electricidad (CFE) and the CRE. (The combined dataset is heretofore referred to as the NEWGen dataset.)

The NEWGen database includes all potential merchant plants, independent power projects with contracts for output, utility-built capacity additions, return of off-line capacity, and re-rates of existing plants. Based on this and other information, the database shows that—as of August 2001—utilities, investors and energy planners have announced plans to build more than **1,900** new power generating units in North America, to 2007.[19]

Second, in terms of total capacity, NEWGen shows a maximum increase of **50 percent** over today's installed capacity: approximately 500,000 MW of new installed capacity.

Even before the economic slowdown related to the events of September 11, it was highly improbable that all, or even most, of this new generating capacity would become operational five years from now. Even in the most favorable circumstances, many announced projects fail to see the light of day. There are too many variables that can and will change these predictions, from changes in economy wide-growth, changes in the technological advances that remain tricky for modelers to incorporate, change in the fuel mix and base versus peak load increases, to name a few. Indeed, as electricity prices began to fall from their highs in 2000, the number of project cancellations increased. The current recession, combined with the fall of Enron, have further contributed to a greatly increased attrition rate. According to the *Wall Street Journal,* 18 percent of announced capacity had already been cancelled by the end of 2001.[20]

Nevertheless, the NEWGen data does provide some limited information about technologies, and from this information, one can infer capacity factors between base-load (usually hydro power, coal and nuclear) and peak production.

In addition, a proxy of the gap between the overall announced versus actual new plants originates from the US National Energy Policy, which notes that of a total number of planned generating units announced in 1994, roughly forty percent were built in 1999. Accordingly, the CEC estimates possible emissions in 2007, taking into account this rate and other factors. (In addition to the data summarized below, the complete tabulation of these data is given in Table 9 in Section Four below.)

The NEWGen data give one indication of the potential impacts of current plans to enlarge the installed capacity of electricity generation. In the lower boundary, this includes a 3 percent increase in CO_2, no change in SO_2, a 4 percent increase in NO_X, and no increase in mercury for Canada. For Mexico, the lower boundary suggests a 29 percent increase in CO_2, a 2 percent increase in SO_2, a 40 percent increase in NO_X, and a 19 percent increase in mercury. For the US, the lower bound case suggests a 14 percent increase in CO_2, a 1 percent decrease in SO_2, a 3 percent increase in NO_x, and a 3 percent increase in mercury, to 2007.

There are other environmental impacts beyond criteria air pollutants that will arise from new generation. These include changes in toxic release emissions—primarily from coal and oil-powered plants—as well as impacts from new hydropower and nuclear plants.

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[19] The dataset used comprises operating plants that have come online since 1999 as well. This is because the most current year for comparable baseline information on emissions is 1998.
[20] Rebecca Smith, "Power industry cuts plans for new plants, posing risks for post-recessionary period," *Wall Street Journal,* 4 January 2002.

Also, the expansion of installed capacity and increased emphasis on interregional transmission will likely require an expansion in transmission capacity. The construction of high tension transmission lines is associated with habitat transformation in areas that are cleared and maintained for transmission lines.

A key question is to what extent these impacts can be offset by other factors. In addition to environmental regulations capping emissions or requiring environmental performance standards, or their equivalence, there is evidence that regulations can be used to stimulate technological innovation in generating equipment. In addition to technological effects, offsetting or decoupling potential exists on demand-side energy efficiency product standards, as well as renewable energy potential market growth.

On the demand side, the introduction of competitive markets and trade is expected to reduce electricity prices over time. There are different projections and predictions, regarding the extent of this price decrease.[21] Recent evidence suggests that the elasticity of demand for electricity can be significant. For example, following California's electricity price hikes of 2000 and 2001, total electricity demand in that state—from June 2000 to June 2001—decreased by 12 percent. Conversely, it is likely that a decrease in price, through increases in efficiency and other changes, will bring about an increase in total electricity use. However, this increase will likely be on the margins.

Of greater consequence to environmental quality than price-induced changes in final demand, are changes in demand for different fuel inputs. Analysis of factors affecting trade between regions generally points to differences in the cost of fuel inputs used in electricity generation as being an important determinant of comparative advantage between trading partners. However, at least in the near to middle term, the most important channel in which market restructuring will affect environmental quality is as a result of price differentials. For example, FERC recently pointed to "significant rate disparities" between neighbouring regions in the US, largely determined by the price of fuels. With an open access regime, FERC notes the ability of consumers to benefit from purchasing cheaper electricity from lower cost regions.[22] (Even so, it is doubtful that a single clearing price for all regions will come about in the near to middle term because of transmission limitations and other barriers, such as market power.) As a rule of thumb, low to high cost electricity generation goes from coal and nuclear, to hydro to natural gas and renewables.[23]

[21] For example, the Energy Modeling Forum (May 2001), "Prices and emissions in a restructured electricity market," *EMF Report* 17, Stanford University—which compiled the results of several models on the effects of restructuring - suggests that in the US, average wholesale generation electricity prices in the near term will be in the range of US$25 to US$34 per MWh (1997 dollars), and will decline marginally over time, to between US$25 to US$30 per MWh.[21] Given the overall elasticity of demand for electricity, one consequence of marginal declines in prices over time is a marginal increase in total demand.

[22] FERC (2000), *State of Markets 2000,* Washington, DC.

[23] Analysis sponsored by the CEC in preparation of this report shows that between 1997 and 2000, as markets underwent changes in competition policies, market conditions unfolded that could best be described as "competition favored coal" over other fuels, as FERC's "competition-favors-coal" scenario seems to have come the closest of the various scenarios evaluated describe what has taken place. The environmental effects of this shift include increased emissions carbon dioxide and mercury as these are uncontrolled and coal is a relatively greater contributor to both of them than the other fossil fuels. See the symposium background paper by Tim Woolf, Geoff Keith, David White and Frank Ackerman (2001), *A Retrospective Review of FERC's Environmental Impact Statement on Open Transmission Access.* Synapse Energy Economics, Cambridge, Massachussets, and Tufts University (printed elsewhere in this volume).

A related consequence of open markets is the potential for price formation to contribute to the internalization of environmental externalities. For example, a recent paper by the Energy Modeling Forum of Stanford University argues that with open competition, "rates that reflect actual costs will lead industry and consumers to become more efficient and conservation-oriented."[24]

With restructuring, many electricity goods and services have become exposed for the first time ever to price formation. When open markets and trade disciplines combine, there is considerable pressure brought to bear toward "getting the prices right." Evidence also suggests that dysfunctional or non-existent markets, replete with pricing, information and policy failures, worsen environmental problems. The roles of subsidy reduction as one means to reduce market distortions is discussed in Section Five below.

Another way in which price formation can lead to the internalization of environmental costs is by providing consumers with what they want. In this market competition favoring price, quality and reliability should be perfectly compatible with the evolution of a number of market-based schemes for green power.

Consumer choices like utility green pricing initiatives, green certification schemes and other measures hold the promise of enabling consumers to select green services based on their concern about the environmental implications of conventional power generation.[25]

Exactly the same holds true in offering consumers more choice in energy efficient products, both at the demand side—from household items to building standards—to improved efficiency standards for supply side generation. There are numerous success stories of green products in North America. Moreover, plans announced in mid-July 2001 to allow some Energy Star products to be marketed in Canada represents a positive step towards the adoption of uniform standards across the continent in product and services voluntary efficiency standards, supported by voluntary labeling schemes.

The opening of North American markets since the mid-1990s has led to an increase in three-way trade in electricity generating machinery. For example, US exports of capital equipment to Mexico from 1996 to 1999 has almost doubled, from US$1.059 billion to US$1.961 billion, while Canadian imports of capital equipment from Mexico over the same period have grown from US$2.1 to US$3.1 billion.[26] Conventional wisdom holds that increasing trade in capital goods is on balance welcome from an environmental perspective, since open markets are linked to accelerating capital turnover and to the diffusion of state-of-the art, generating technologies. However, the actual environmental consequences of increased trade in capital technologies obviously depends on the technologies being traded: if exclusively for large-scale generating projects, then efficiency gains can be offset by scale effects of the project.

The energy track that North America is on (at least as outlined by the NEWGen dataset) suggests an emphasis towards supply expansion to meet demand growth. A quarter century ago, this track

[24] Energy Modeling Forum (May 2001), "Prices and emissions in a restructured electricity market," *EMF Report* 17, Stanford University.

[25] It should be noted that programs including "green" electricity options are not having the success that some of their proponents had hoped. As such, one should be careful not to hype their impact, which to date has been comparatively small.

[26] The full table of three-way import-export trade volumes for electricity generating machinery, from 1994 to 1999, is contained in Annex I. Source: Trade Data Online, Industry Canada, Government of Canada.

was described as a hard energy path, one characterized by "rapid expansion of centralized high technologies to increase supplies of energy, especially electricity."[27] Another path—well-worn with proven successes since the oil-price shocks of the mid-1970s—involves a greater emphasis on energy efficiency, incentives and other measures to raise the share of renewable energy, and increased reliance on smaller-scale generating units and distribution networks.[28]

It is clear that, in many cases, it is more economically efficient to reduce energy consumption than it is to construct and operate new, large-scale power plants—especially if externalities are taken into account. However, energy efficiency—probably the best way to bring down total demand—is of little interest to investors intent on meeting demand growth in supply expansion. As well, some argue that energy efficiency potential is exaggerated because transaction costs associated with energy efficiency investments are underestimated and penetration rates overestimated. While regulatory tools have been developed to ensure that supply- and demand-side resources are compared on a level playing field, they are only infrequently used, as many regulators believe that the market alone will make the right choices.

One way in which scale effects of power generation can be checked is, as noted, through renewable energy. One way in which renewable energy is being supported in North America is through the introduction of Renewable Portfolio Standards (RPS).

Increased trade will induce some locational shifts in production between countries. This shift in the location of supply may bring about a shift in the type and magnitude of environmental effects. One question is the extent to which differences in environmental regulations can influence locational shifts. Empirical evidence suggests some migration of pollution, or toxic intensive industries towards countries with lax environmental standards. It may be argued that this shift is merely a function of compositional effects of market liberalization more generally (that is, from manufacturing to services sectors), but there is evidence that some industries have strategically used regulatory differences to reduce capital and operating costs in tightening markets. The extent of this shift is difficult to estimate, as are environmental impacts.

Indeed, while the evolution of the North American electricity market continues to be driven by uniform and converging rules involving market competition policies and trade laws, no comparable effort is underway to ensure that environmental regulations among the three governments will lead to higher levels of environmental protection in North America.

Environment in the Evolving North American Energy Market: The Political Promise

In many ways, the trajectory of North America's electricity future will depend on the policy choices made in the coming years. In April 2001, the leaders of the three NAFTA countries—Prime Minister Chrétien of Canada, President Fox of Mexico, and President Bush of the United States—declared in a common statement issued after their historic meeting:

> "We consulted on the development of a North American approach to the important issues of energy markets. Towards this end, our Energy Ministers have created a North American Energy Working Group. This technical-level forum will be a valuable means

[27] A.B. Lovins, "Energy strategy: the road not taken?" *Foreign Affairs* 55(1): 65–96.

[28] Traditionally, electricity planners think of projects in very large scale as the most effective way of maximizing scale economies. However, progress in generating technologies no longer means that one has to build a 1,000 MW facility to exploit economies of scale. Combined cycle gas turbines can be efficient at 400 MW, and aero-derivative gas turbines efficient at 10 MW.

> of fostering communication and coordination efforts in support of efficient North American energy markets that help our governments meet the energy needs of our peoples. We stressed the importance of energy conservation, the development of alternative energy sources, and our common commitment to addressing the environmental impacts of energy use."[29]

To explore these issues, this working paper is broken into eight sections. Section One provides an overview of the current electricity sector, by installed capacity, generation and fuel mix, in North America. Section Two highlights the environmental context of electricity generation, emphasising criteria air pollutants, as well as non-air environmental impacts. Section Three examines possible changes in electricity demand and supply, including forecasts to 2010 and 2020, as well as discussion of NEWGen data to 2007.

Section Four examines some possible environmental impacts of new generating capacity, based on an extrapolation of NEWGen data. Section Five examines the role of price changes and market creation in reducing environmental externalities. Section Six examines opportunities to further offset scale effects and external costs, through demand-side management, energy efficiency, renewable energy and international cooperation. Section Seven examines the role of environmental impact assessments in the sector, and opportunities for expanded regional and international cooperation to improve assessments. Finally, Section Eight examines the linkages between free trade and environmental quality and environmental policy impacts.

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[29] As of October 2001, three sub-working groups had been established under the North American Energy Working Group: energy efficiency, reliability and a working group on data comparability related to North America's electricity sector. There remains the possibility of a fourth sub-working group on renewable energy.

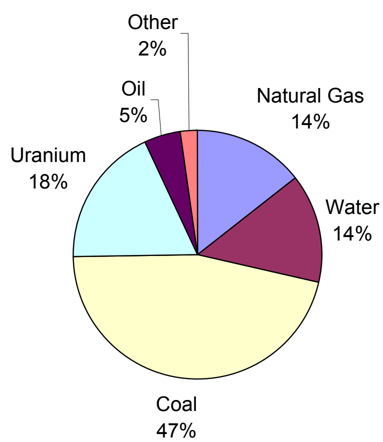
SECTION ONE: THE NORTH AMERICAN ELECTRICITY SECTOR

Until recently, the electricity sector in North America has been characterized by vertical integration in which power generation, transmission, marketing and distribution of electricity was undertaken by a single company.

This industry structure has been undergoing unprecedented change since 1996–1997 in many regions and states in the US and Canada. The pace and scope of market reforms implemented or under consideration vary widely both within countries, and between countries. In Canada and the US, some jurisdictions—such as Alberta and California—have implemented significant restructuring initiatives. Other jurisdictions, such as Ontario or Arkansas have announced plans to restructure in the future. By contrast, Mexico's electricity sector is dominated by the state-owned entity, CFE. However, as noted above, considerable private sector activity has characterized new investments in the sector since the mid-1990s, and major restructuring proposals are under consideration at the political level in Mexico.

This overview section provides a summary of some key features of the electricity sector in Canada, the United States and Mexico. For those interested, there are numerous annual reports that provide updates of the state of electricity markets in Canada, Mexico and the United States.[30]

Figure 1 - North American Electricity Generation by Fuel Source



Total installed electricity generating capacity in North America in 1999 was over 990,000 MW, which produced 4,700 TWh of electricity.

Five principal sources of energy production characterize North America's electricity sector: the single largest fuel source—coal—comprises 47 percent of total generation. This is followed by 18 percent from nuclear, 14 percent from natural gas, 14 percent from hydropower, 5 percent from oil, and 2 percent from all other sources, which range from wood to biomass to wind (see Figure 1).[31]

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[30] For Canada see the Canadian Electric Association and Natural Resources Canada's *Electric Power in Canada,* as well as other documents from the National Energy Board (NEB) and the North American Electric Reliability Council (NERC). For Mexico, see the *Secretaría de Energía's Prospectiva del Sector Eléctrico*. For the United States, see the Energy Information Administration's (EIA) *Annual Energy Outlook*, as well as other documents from the EIA, NERC, and the Federal Energy Regulatory Commission (FERC). For an updated source of information on the status of electricity restructuring in the United States, see <http://www.eia.doe.gov/cneaf/electricity/chg_str/tab5rev.html>. Information can also be found from the OECD's International Energy Agency.

[31] IEA (International Energy Agency). 2001. *Electricity Information 2001*. OECD, Paris.

Aggregating fuel mixes for North America as a whole belies important differences between countries, as well as between regions. For example, in Canada, hydroelectricity comprises around 60 percent of total generation. A large proportion of Canadian hydropower generation is from large-scale, reservoir projects. By contrast, in the United States coal accounts for more than 50 percent of total generating capacity. In Mexico, natural gas, oil (combustóleo) and coal comprise around two-thirds of total generation.

Generating electricity is only one aspect of the provision of electricity. As important as generation, is the infrastructure that enables the transportation of electricity from where it is generated to where it is consumed. North America is home to a well-developed and extensive system of electric transmission. Together, there are over 362,000 kilometers of transmission greater than 230 KV. Canada has 73,000 kilometers greater than 230 KV, the United States has over 254,000 kilometers of lines greater than 230 KV, and Mexico has just under 35,000 kilometers of lines with capacity greater than 230 KV.[32]

In addition, there are differences in per capita energy consumption between the three countries. Mexico and Canada rank roughly the same in terms of energy intensity,[33] whereas the United States uses roughly 30 percent less energy for each unit (dollar) of GDP that it produces. The reasons for the relatively high levels of energy use in Mexico and Canada are different for each country. Mexico still uses large amounts of energy in the traditional industrial sector, while Canada, even though it has a more developed industrial sector, which consumes relatively less energy, it still requires large quantities of energy for heating and transportation. However, the trade and services sectors in both Canada and Mexico consume less energy than their counterparts in the United States. As shown in Table 1, Mexico has become slightly more energy intensive (1 percent) per unit of GDP over the first five years of NAFTA (perhaps due to production volume increases), while Canada and the US have decreased their energy/GDP ratio by some 10 percent.

Table 1 – Energy Intensity of North American Economies—1994–1999 (BTUs per 1990 US Dollar)

Country	1994	1995	1996	1997	1998	1999	Change 1994–1999
Canada	19,064	18,558	18,923	18,393	17,530	17,401	-9%
United States	14,038	13,934	13,893	13,361	12,837	12,638	-10%
Mexico	17,562	18,832	18,664	18,093	18,142	17,766	1%

SECTION TWO: THE ENVIRONMENTAL CONTEXT OF THE ELECTRICITY SECTOR

There is no greater challenge to environmental policy than issues related to the generation, transmission and end-use of electricity. As we have seen, electricity generation from fossil fuels is a leading source of air pollution, greenhouse gases linked to climate change, and the release of toxic chemicals—including airborne metal and acid gases. Hydroelectric generation provides power with little or no air pollution emissions. However, hydroelectric generation has been identified by the United States Geological Service as an important cause of the endangerment of freshwater fish species in that country.

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[32] NERC ES&D 2000, *Secretaría de Energía de México,* 2000 - *Prospectiva del Sector Eléctrico 2001–2010.*

[33] Amount of energy used to produce one unit of GDP. See Table 1 above.

The generation of thermoelectric power also relies heavily on water inputs. The average amount of water used to produce thermoelectric power in the US has declined in the last fifty years, with gains in technological efficiency, from approximately 62 gallons per kWh in 1950, to roughly 20-25 gallons in the 1990s. Estimates by the US Geological Survey suggest that over 194 billion gallons of groundwater and surface water (fresh and saline) are withdrawn daily to produce electricity.[34]

Aquatic ecosystems are of course greatly affected by hydropower. Large-scale hydropower projects also have significant and—according to the World Commission on Dams—largely detrimental impacts on habitats and fragile ecosystems.[35] Hydropower is a leading cause of extinction or endangerment of freshwater fish species in North America.[36] (This while scientific studies show that fish species in the US face extinction at a rate 1,000 times greater than the background rate, such that "north American freshwater biodiversity is diminishing as rapidly as that of some of the most stressed terrestrial ecosystems on the planet."[37])

Nuclear power, which is neither a source of air pollution nor greenhouse gases (GHG), nevertheless faces enduring public distrust because of risks of accidents during operation which can lead to trace airborne leakage of radioactive materials—highly infrequent, improbable and highly publicized—as well as the risks linked to the safe storage of spent radioactive fuels, which have a lifetime of approximately 800 years.

The construction of transmission lines can also have important environmental effects on land-use change, on habitats, on migration patterns and other environmental effects. For example, a recent report from the International Agency for Research on Cancer concludes that extremely low frequency electric magnetic fields, including those from high-tension power transmission lines, "are possibly carcinogenic to humans, based on consistent statistical associations of high residential magnetic fields, with a doubling of risk of childhood leukemia."[38] However, other scientific studies report human-health risks as minimal. For example, the World Health Organization notes that the "evidence of an effect remains highly controversial. However, it is clear that if EMF (electromagnetic fields) do have any effect on cancer, then an increase in risk will be small."[39] The following sections provide a brief overview of some of the key environmental challenges related to the electricity sector.

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[34] Perhaps a more relevant, though harder-to-find, number is net withdrawal for electricity production.

[35] Berkamp, G., McCartney, M., Dugan, P., McNeely, J., Acreman, M. 2000. *Dams, ecosystem functions and environmental restoration*, Thematic Review II.1 prepared as an input to the World Commission on Dams, Cape Town. The World Commission on Dams, an independent commission created under the auspices of the World Bank and the International Union for the Conservation of Nature, carried out a three-year review of the effectiveness of large dams around the world. Its report, *Dams and Development: A New Framework for Decision-Making*, can be found at <www.dams.org>.

[36] Hydro-Quebec notes that no single fish species in Quebec has been endangered by hydropower plants. Hydro-Quebec also asserts that hydropower developments can increase the productivity of freshwater ecosystems.

[37] Anthony Ricciardi and J.B. Rasmussen, "Extinction rates of North American freshwater fauna," *Conservation Biology, v*. 13 (Oct. 99), pp. 1220–1222, quoted in Raphals, Philip. 2001. *Restructured Rivers: Hydropower in the Era of Competitive Markets*. IRN/Centre Helios, Montreal.

[38] International Agency for Research on Cancer (IARC) (June 2001), "IARC finds limited evidence that residential magnetic fields increase risk of childhood leukaemia," <www.iarc.fr>.

[39] WHO (World Health Organisation). 1999. *Electromagnetic Fields*. Public Health, no. 32.

Air Pollution

The generation of electricity from the burning of fossil fuels is a significant source of air pollutants and greenhouse gases in North America. Some major pollutants arising from the combustion of fossil fuels by the electricity generation sector are nitrogen oxides (NO_x), sulfur dioxide (SO_2), mercury (Hg), and carbon dioxide (CO_2). Nitrogen oxides contribute to ground-level ozone (smog) on an urban and regional scale. Both NO_x and SO_2 contribute to acidic deposition, commonly called acid rain. Emissions of NO_x, SO_2, and hydrocarbons from fossil fuel combustion are also sources of fine particles in the atmosphere that are a major public health concern because of their links to lung damage and premature mortality. Toxic mercury deposited in lakes and streams has led to fish consumption advisories across North America. Carbon dioxide is an important greenhouse gas that contributes to global climate change. In addition to these pollutants, electricity generation also gives rise to a host of toxics, such as hydrochloric acid, sulfuric acid, hydrogen fluoride, and heavy metals.

As a significant source of a number of air pollutants, the future evolution of the electricity generation sector in an integrated North American energy market will have a profound effect on air quality and climate change. In order to assess changes in environmental quality (both good and bad) arising from an integrated North American energy market, policy makers and the public will need a common frame of reference as a starting point. One conceivably straightforward approach is to establish a baseline of air emissions from the North American electricity generation sector for a common reference year, and track changes in emissions over time from the reference year as new sources of electricity are built and old sources are retired or refurbished.

While conceptually simple, there are obstacles to tracking changes in emissions from the electricity generation sector on the North American scale. At the most basic level, air pollution information is not uniformly available on a comparable basis in all three countries, especially at the level of individual power plants. The information, when available, may not be for the same year across the three countries. Each country may also compile emissions data using different methods, such as directly measuring air pollutants through continuous emissions monitoring on smoke stacks as opposed to estimating pollution indirectly through the application of mathematical equations using standard emission factors, fuel usage information, and other parameters. The equations and parameters themselves may differ in each country.

These differences not only affect the ability of policy makers and the public to track changes in environmental quality due to changes in the electricity sector, they also affect the potential application of policy tools such as international emission allowance trading programs. If there is inadequate comparability, transparency or confidence in North American emissions data at the level of individual power plants, then there will be little confidence that an allowance trading regime involving sources in different countries will produce emission reductions that are real, permanent and enforceable. This diminishes the public appeal for such approaches, thus hampering the viability of policy tools that hold great promise for cost-effective and flexible pollution reductions achievable through international cooperative efforts.

Despite the obstacles discussed above, the CEC Secretariat was able to compile an inventory of criteria air pollution emissions—CO_2, SO_2, NO_x, and mercury—for the electricity generation sector in Canada, Mexico and the United States. The sources of inventory information are of differing quality and do not correspond entirely to the same annual period. We use emissions information mainly from 1998 and 1999, with some older data from 1995 in cases where more recent data are lacking. Despite these problems, the reference emissions inventory is adequate to help put into some perspective the amount of projected emissions associated with new power projects through 2007 in relation to some relatively "current" set of emissions. We discuss this later in Section Four.

The national summaries of the reference inventory case are presented in Table 2 below, and a breakdown by province and state is given in Miller et al. 2002, along with descriptions of the data sources and methodology.

Table 2 – Emissions of Selected Air Pollutants from the Electricity Generating Sector in North America (1998*)

	CO_2 equivalent (tonnes)	Annual SO_2 (tonnes)	Annual NO_x (tonnes)	Annual Hg (kg)
nationwide				
Canada	122,000,000	650,195	290,211	1,975
Mexico	90,095,882	1,683,199	280,931	1,117
United States	2,331,958,813	12,291,107	5,825,982	39,241
per capita				
Canada	4.016	0.021	0.010	0.000
Mexico	0.918	0.017	0.003	0.000
United States	8.637	0.046	0.022	0.000
per km^2				
Canada	13.239	0.071	0.031	0.000
Mexico	46.128	0.862	0.144	0.001
United States	254.605	1.342	0.636	0.004
per GWh				
Canada	217.229	1.158	0.517	0.004
Mexico	495.577	9.259	1.545	0.006
United States	608.789	3.209	1.521	0.010

* Some data are estimates, and not all come from 1998. See Section Four (or Miller et al. 2002) for further details.

Population and Land Mass – Canada (Canada Economist Country Profile 1998); Mexico (Mexico Economist Country Profile 1998) and United States (United States Economist Country Profile 1999), Electricity Generation - IEA - *Electricity Information 2001*.

When examining current emission levels, it is important to note that significant decreases have been made in SO_2 emissions in the past decade. For example, a 10-year trend analysis for the 1988–1998 period in the United States shows significant declines in SO_2 and sulfate concentrations in ambient air. The average SO_2 reduction was 38 percent; for sulfate, the reduction was 22 percent. In eastern Canada, SO_2 and sulfate concentrations in air exhibited similar proportional decreases as in the US, although not by the same order of magnitude. Over the period 1986–1989 and 1993–1996, sulfate concentrations declined by 12 to 30 percent in most areas.[40]

On the other hand, NO_x emissions saw relatively little change over the same period. Emissions of CO_2 and mercury from power plants are not subject to control, and therefore rise as fossil fuel combustion rises in the electricity generation sector.

Toxic Releases from Electricity Generation

[40] United States-Canada, *Air Quality Agreement: 2000, Progress Report.*

Electric utilities rank first of all industry sectors in total toxic chemical releases—comprising on- and off-site releases—in the United States and Canada.[41] This ranking is based on comparable data reported to the US Toxics Release Inventory and the Canadian National Pollutant Release Inventory, which are compiled by the CEC in the annual *Taking Stock* report. Mexican data on toxic releases are not currently included in the *Taking Stock* report.

Electric utilities in the US and Canada released 436.1 million kilograms of toxics in 1998. Although utilities disposed of chemicals in landfills, these amounts were ten times less than the amount of chemicals that they released into the air. Indeed, electric utilities accounted for 43 percent of the total toxic air releases in the United States and Canada in 1998.

The 15 North American facilities in the Electric Utilities Industry with the largest toxic chemical releases (1998) are all coal-fired power plants, and are ranked in Table 3 below. Together, these 15 plants were responsible for 86 million kg of chemical releases. Based on a simple pollution per unit of output ratio, which may provide some insight into the relative efficiency of these power plants, the Pensacola Plant appears to release 0.75 kg of toxic chemicals for every MWh generated. By contrast, the Monroe power station produced 0.23 kg of toxic chemicals for every MWh generated, or roughly one-third the toxic releases per unit generated of Pensacola.

Table 3 – The 15 North American Facilities in the Electric Utilities Industry with the Largest Total Releases, 1998

Facility	State	Total Releases (kg)	Major Chemicals *	Primary Fuel	Releases (kg/MWh)
Bowen Steam Electric Generating Plant, Southern Co.	CA	8,507,296	HCl (air)	Coal	0.42
American Electric Power, John E. Amos Plant	WV	8,154,026	HCl (air)	Coal	0.53
Roxboro Steam Electric Plant, Carolina Power & Light	NC	7,307,075	HCl (air)	Coal	0.51
Dayton Power & Light Co. J.M. Stuart Station	OH	6,674,059	HCl (air)	Coal	0.47
American Electric Power, Mitchell Plant	WV	6,282,377	HCl (air)	Coal	0.65
Firstenergy, W.H. Sammis Plant	OH	6,044,683	HCl (air), SO_2 (air)	Coal	0.44
Cardinal Plant, Cardinal Operating Co.	OH	5,628,484	HCl (air)	Coal	0.52
Brandon Shores & Wagner Complex, Baltimore Gas & Electric Co.	MD	5,191,301	HCl (air)	Coal	0.63
PSI Gibson Generating Station, Cinergy Corp.	IN	5,120,355	HCl (air), SO_2 (air), Zn and Compounds (land)	Coal	0.27
Ontario Power Generation Inc., Nanticoke Generating Station	ON	5,114,650	HCl (air)	Coal	0.29
Scherer Steam Electric Generating Plant	GA	4,718,212	HCl (air), HF (air)	Coal	0.26
Kentucky Utilities Co. - Ghent Station, LG&E Energy Corp.	KY	4,649,310	HCl (air), SO_2 (air)	Coal	0.38
US TVA Paradise Fossil Plant	KY	4,369,346	SO_2, HCl (air)	Coal	0.34

[41] CEC (Commission for Environmental Cooperation). 2001a. *Taking Stock*. Montreal.

Gulf Power Co. - Plant Christ, Southern Co.	FL	4,346,736	HCl (air)	Coal	0.75
Detroit Edison Monroe Plant, DTE Energy	MI	4,275,784	HCl (air), SO_2 (air)	Coal	0.23
Total		86,383,694			
Source: *Taking Stock 1998* (CEC 2001), EPA's GRID, OPG Progress on Sustainable Development Report 1999					
*Chemicals accounting for more than 70% of releases at the facility.					

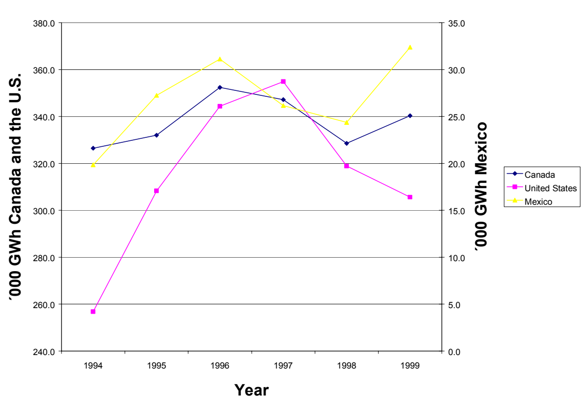
Impacts from Hydropower

The generation of electricity from hydro sources represents a significant percentage of total generating capacity in Canada, Mexico and the United States. Taken together, there are approximately 6,000 hydroelectric units in North America, with a combined generating capacity of over 172,000 MW (Table 4).

Table 4 – North American Hydroelectric Generation		
Country	**Units**	**Capacity (MW)**
Canada	1435	67121
United States	4463	95796
Mexico	182	9630
Total	5987	172547
Statistics Canada 2001 - *Electric Power Generating Stations 1999*, US EIA—EIA -*Annual Electric Generator Report Nonutility, Annual Electric Generator Report Utility,* Secretaría de Energía - *Prospectiva del Sector Eléctrico 2000-2009.*		

A salient feature of hydropower is that its output is highly dependent upon climatic variability. A heavy snow pack in Canada in the winter will increase the amount of electricity available for export to the northern United States during the peak demand summer there. This variability has important implications for electricity production, trade and the overall environmental impact of electricity generation in North America. (Please refer to Figure 2 for a graphical representation of the variability of hydropower production in the three NAFTA countries.)

Figure 2 - Hydroelectric Production in North America



There are important differences in environmental, land-use change, biodiversity and other impacts associated with hydropower projects. These differences depend on the pre-existing characteristics of the area or region prior to construction, the type of hydro project constructed (for example, river-run versus large-scale reservoir type dams, characteristics of the local hydrology, fluvial processes, sediment flows, geomorphic constraints, climate and local biota, type of generating turbines used, design and other features). As a general observation, and keeping in mind differences between hydropower facilities, the World Bank and others note that environmental impacts of hydropower are roughly proportionate to the scale of the project:[42] large-scale, reservoir hydro-projects have significant immediate and secondary environmental and biodiversity impacts.[43] The construction and operation of large reservoir-type dams—for example, the Caniapiscau reservoir alone, one of the seven reservoirs that make up the La Grande Complex of Quebec, has a storage capacity of 39.6 km^3, equivalent to 48.8 TWh of energy or 28.7 million barrels of oil[44]—have the greatest and most immediate impact on the environment. Such large-scale projects also have significant impacts on local and indigenous communities. For example, the Grand Council of the Crees recently noted their concern over the "environmental challenges posed by large-scale river diversion, and the problem of methylmercury resulting from reservoir construction, and the broad ecological and social consequences of the creation of large reservoirs on the Canadian shield."[45]

Large-scale dams also have important secondary impacts on downstream shoreline habitats and ecosystem functions. For example, change in river flows and patterns are often associated with much lower frequency of seasonal over-bank flooding: such flooding is important for the deposit of sediments and other functions. More generally, dams have been linked with the gradual reduction in total biodiversity productivity.[46]

The World Commission on Dams has concluded that the construction of dams is "one of the major causes of freshwater species extinction." Dams block or inhibit spawning grounds, change predatory relations of species, and change nutrient levels. Assessments have concluded that juveniles are especially at risk from dams. Despite these improvements, a recent assessment concludes that dams are the main reason why 75 percent of all native Pacific Salmon stocks are now classified as being at moderate to high risk of extinction.[47] At the same time, a report by Natural Resources Canada notes that climate may lead to the virtual elimination of salmon habitats from the Pacific Ocean.[48]

An intense debate continues around assessing the comparable impacts of large- and small-scale dams. On the one hand, the IEA notes that the trend is "away from reservoirs which inundate relatively large areas of valuable land, major settlements, areas occupied by indigenous peoples

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[42] World Bank (1996), *The World Bank's Experience with Large Dams: A Preliminary Review of Impacts,* Washington, DC.

[43] Unlike environmental indicators used to measure airborne emissions from fossil fuel plants, impacts of hydropower tend to be more qualitative than quantitative. This reflects the fact that most indicators of biophysical change, biodiversity, land-use and habitat change, which characterize some of the most immediate impacts of hydropower, are largely qualitative. However, progress continues, particularly by the OECD, in the development of key indicators of biodiversity. See, for example, OECD (2001), *Environmental Indicators for Agriculture: Vol. 3, Methods and Results,* Chap. 5, Paris.

[44] Hydro Quebec (1995), "The La Grande Complex Development and its Main Environmental Issues," cited in IEA Implementing Agreement for Hydropower Technologies and Programmes, (2000), *Hydropower and the Environment: Present Context and Guidelines for Future Action,* Oslo.

[45] Letter from Grand Chief Dr. Ted Moses, Grand Council of the Crees, to Executive Director, Commission for Environmental Cooperation, 10 October 2001. In late October 2001, the government of Quebec and the Grand Council signed an Agreement in Principle, whereby the Crees would drop $8 billion worth of lawsuits relating to alleged breaches of the James Bay Northern Quebec Agreement and give their blessing to a proposed hydro-electric project on the Rupert and Eastmain rivers ("The Cree turn the page," *The Montreal Gazette*, 25 October 2001). In February 2002, the agreement was ratified.

[46] USGS (1998), *Status and Trends of the Nation's Biological Resources*, Vol. 1, pp. 63-69, Washington, DC.

[47] United States Geological Survey (1998), *Status and Trends of the Nation's Biological Resources: Volume One*, pp. 63-88. Washington, DC.

[48] Natural Resources Canada. 2000. *Sensitivities to Climate Change in Canada*. sts.gsc.nrcan.gc.ca/adaptation/main.htm.

and areas with unique habitats. Generally, there is a tendency towards smaller sized reservoirs."[49] Improvements in operating features include better fish ladders, the construction of passages for spawning, better timing of water flows, and other features. A debate also continues regarding the relative merits of hydro power—an insignificant source of greenhouse gas (GHG) emissions during operation—compared to fossil fuel power generation. This debate has increased since attention has focused on the Kyoto Protocol.

On the other hand, the same IEA report notes that small-scale hydropower projects may raise concerns about reliability and the flexibility of the energy supply provided by them. Moreover, the empirical and theoretical evidence supporting arguments that small-scale hydropower is environmentally preferable is inconclusive, when examined from the perspective of the total amount of electricity generated. One model used by Robert Goodland of the World Bank suggests that the total reservoir area needed from small-scale hydro that would be needed to generate as much as existing large-scale hydropower may be as much as eight times as large.[50]

Part of the debate has turned to life cycle assessment tools (LCA), in order to suggest comparisons between hydro power and fossil fuel sources. For example, the hydropower sector has provided some useful analysis of upstream and downstream impacts of non-hydro power generation. This includes, for instance, the environmental impacts of coal mining through mercury emissions, mine tailings and other damages, environmental impacts of fuel transportation to generating sources, and the effects of fossil fuel burning for coal, oil and natural gas. Unfortunately, despite these efforts, LCA has not been used to examine upstream, downstream, operational or secondary effects of large-scale dams themselves. Moreover, the current status of LCAs provides little insight into whether 10 tons of GHG emissions are better or worse than the possible extinction of a given species (a more appropriate tool would entail turning to the remarkable progress in environmental valuation techniques in the past decade, as a means to gaining insight into some kinds of comparable environmental effects from different sources of electricity).[51]

As noted above, the actual environmental impacts of particular hydropower projects need to be determined on a case-by-case basis. That being said, a recent report from the World Commission on Dams noted that, taken together, the "impacts of dams on ecosystems is profound, complex, varied, multiple and mostly negative."[52]

Nuclear Power

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[49] IEA Implementing Agreement for Hydropower Technologies and Programmes (2000), *Hydropower and the Environment.*

[50] Cited by Hydro-Quebec in its comments to the CEC on its working paper *Environmental Challenges and Opportunities of the Evolving North American Electricity Market.*

[51] Undertaking an LCA of electricity use needs to take into account not only aspects of the electric fuel cycle, but should also compare the cycle of electrical generation to other methods of achieving energy goals which do not necessarily use electricity at all. To illustrate, the following example is provided. "For each Btu extracted from the ground, converted to electricity in a combined-cycle power plant and delivered to an electric water heater, only 0.36 Btu ends up as usable hot water. Conversely, for a gas water heater, 0.54 Btu is delivered as hot water because direct use of natural gas avoids the losses of indirect use s a fuel to make centrally generated electricity, even at "state of the art" efficiency." (From comments submitted to CEC from the American Gas Cooling Center.)

[52] Berkamp, G. et al. 2000. *Dams, Ecosystem Functions and Environmental Restoration.* World Commission on Dams, Cape Town.

While there are fewer nuclear power plants compared to other major forms of electricity generation in North America, nuclear power is an important source of electricity, representing roughly 12 percent of total generating capacity for the continent. Nuclear power represents 10 percent and 12 percent total capacity in both Canada and the United States, respectively, and 4 percent in Mexico. Capacity figures alone do not tell the whole story. Nuclear generation is marked by high capacity factors. As a result, despite the fact that nuclear power makes up only 12 percent of total capacity, it makes up 18 percent of total generation. This pattern is particularly pronounced in the United States where nuclear makes up only 12 percent of capacity, but 20 percent of total generation (please refer to Table 5).

Table 5 – Nuclear Power Contribution to Capacity and Generation in North America (1999)

Capacity			
	Nuclear Capacity (MW)	Total Capacity (MW)	% of Capacity
Canada	10,615	109,984	10
United States	103,833	845,156	12
Mexico	1,355	35,666	4
Total	115,803	990,806	12
Generation			
	Nuclear Generation (TWh)	Total Generation (TWh)	% Contribution
Canada	73.49	576.97	13
United States	777.89	3,910.16	20
Mexico	10.0	192.26	5
Total	861.38	4,679.39	18

Sources for capacity data: Statistics Canada 1999 - *Electric Power Generating Stations,* US DOE - EIA - *Existing Capacity and Planned Capacity Additions at US Electric Utilities by Energy Source, 1999,* accessed on 24 September 2001, at <http://www.eia.doe.gov/cneaf/electricity/ipp/html1/t1p01.html>; and *Electric Power Annual 2000*, Volume 1, accessed on 30 October 2001, at <http://www.eia.doe.gov/cneaf/electricity/epav1/elecprod.html#tab5>; Secretaría de Energía - *Prospectiva del Sector Eléctrico, 2000.*
Source for Generation data: IEA. *Electricity Information 2001.* Paris.

One benefit of nuclear power is that it does not release emissions associated with thermal electricity generation like CO_2, NO_x, SO_2, or mercury. Nuclear power generation, however, poses a risk to the environment through the potential release of radioactive material. Nuclear generation can release radioactive material into the environment three ways. Uranium mining is similar to coal mining in that it can take place either in open pit or underground mines. The mining process leads to similar environmental impacts as coal mining with the added hazard that uranium mine tailings are radioactive. Groundwater can be polluted from heavy metals present in tailings, as well as from traces of uranium remaining in the waste.[53]

Of greater public concern than radioactive releases from the mining of uranium are radioactive releases in high concentrations from nuclear power generation itself, or from the transportation and disposal of nuclear waste, a byproduct of the nuclear generation process. Nuclear releases from electricity generation can result from nuclear meltdowns like that of Chernobyl in the former Soviet Union or the near meltdown at Three-Mile Island in 1979. As well, there can be radioactive releases during the transport, or once transported, from the storage of nuclear waste. Nuclear releases have the potential to spread radiation and radioactive material in dangerous

[53] Union of Concerned Scientists. *Principles of Nuclear Power*. Accessed at <http://www.ucsusa.org/energy/0nuclear.html>.

concentrations over long distances affecting large areas. Since radioactive waste remains radioactive for thousands of years, the effects can also last far into the future.

Radiation is a biological hazard because it can damage or destroy cells. In humans, damaged cells can induce cancers years after exposure, or pass damage along to future generations. As well, dead cells can trigger infections or incapacitate organ functions.[54]

While the risk of radioactive emissions exists, the International Energy Agency reports that no accident in any OECD country has released significant amounts of radioactive materials ever, and that the public health effects of the releases that have occurred have been too small to measure.[55] Despite this record, nuclear power generation faces continued skepticism and apprehension from the public. This partially explains why no new nuclear plants have been built in the United Sates since the Three Mile Island Accident, and that none have been built in Canada since 1986.[56]

SECTION THREE: THINKING ABOUT OUR ENERGY FUTURE

Forecasting energy and electricity futures is increasingly sophisticated. A number of very robust models, including the National Energy Modeling System (NEMS), the Policy Office Electricity Modeling System (POEMS), MARKAL (MARKet ALlocation), and work by Jorgenson, Wilcoxen and others, have vastly improved quantitative economic models. In energy modeling, a number of extremely innovative, hybrid-type models which combine, for example, economic and engineering modeling have been developed. Often, forward looking scenarios make use of econometric models combined with sectoral input-output models, as well as general or partial equilibrium models.[57] By combining different tools, they have provided insights into the relationship between economic growth and growth in energy, market variables, changes in energy use within specific sectors as well as at the economy-wide level, and also provide analysis of price, technology and regulatory effects at home and abroad on patterns of demand and supply.

These models also provide valuable tools to estimate the relationship between changes in the composition and scale of electricity generation, and environmental—mainly pollution emissions-coefficients. However, it must be recognized that they tend to ignore impacts that are not readily quantifiable, such as those associated with hydropower. (Models used to look at the environmental effects of electricity market restructuring are discussed in detail in another background paper found in this volume.)[58]

As good as models have become, they cannot tell policy makers what the future will look like. Significant uncertainties remain, and these revolve around modeling assumptions about macroeconomic policies and average rates of growth; changes in fuel prices; changes in energy and environmental policies; the role of nuclear energy in the future; and developments in energy technologies.[59] Of these, the IEA notes that economic growth is "by far the most important factor in energy demand trends and is thus the key source of uncertainty."[60]

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[54] Ibid.
[55] IEA (International Energy Agency). 2001. *Nuclear Power in the OECD*.
[56] Ibid. Statistics Canada. 2001. *Electric Power Generating Stations.*
[57] Dale W. Jorgenson (1998), *Growth: Energy, the Environment and Economic Growth,* Volume 2, MIT Press, London.
[58] Patterson, Zachary. 2002. *Modeling Techniques and Estimating Environmental Outcomes.* Background Paper for the Article 13 study. Commission for Environmental Cooperation, Montreal (printed elsewhere in this volume).
[59] International Energy Agency (2000), *World Energy Outlook,* Paris.
[60] Ibid.

Because of these and other uncertainties, Dale Jorgenson, a pioneer in dynamic econometric modeling in the energy sector, has noted that “no single model seems to be true all of the time, or even very often.”[61] In addition to these uncertainties, price-based competition and restructuring poses new challenges to modelers. Modeling the effects of restructuring remains in an early stage, but insights have already been provided about the dynamic nature in which changes in relative price affect the sector.[62] What is clear is that models alone cannot provide all, or even most of the answers, to our energy future, because this future continues to revolve in large part upon the policy decisions that will be taken in the coming years.

One of the most important governmental policy analysis of energy futures in the last ten years is the National Energy Policy (NEP), presented to President Bush in May 2001. The Policy cautions that a “fundamental imbalance between supply and demand defines our nation’s energy crisis.”[63] Although there are numerous responses to the looming energy crisis in the United States—including increased energy efficiency and conservation—the core strategy proposed by the NEP is to meet demand growth through increased supply. The NEP warns that “our nation’s most pressing long-term electricity challenge is to build enough new generation and transmission capacity to meet projected growth in demand.”[64]

Projected growth envisioned in the National Energy Policy predicts a demand growth of 25 percent to 2010, and by 45 percent to 2020. This demand increase will in turn require an additional 400,000 MW of new generating capacity to 2020, or between 1,300 to 1,900 new power plants to 2020. This works out to the building of more than one new power plant each week starting today, to 2020.

Table 6 below highlights other recent electricity demand forecasts in Canada, Mexico and the US, covering the period 2000 to 2009:

[61] Dale W. Jorgenson. (1998). *Growth: Energy, the Environment and Economic Growth,* Volume 2, MIT Press, London.
[62] See, for example, EMF (1998), *A Competitive Electricity Industry* for an excellent overview of progress and challenges posed to modelers by restructuring.
[63] Report of the National Energy Policy Development Group (May 2001) *National Energy Policy: Reliable, Affordable, and Environmentally Sound Energy for America’s Future,* Washington, DC.
[64] Ibid, I-5.

Table 6 – Examples of Supply and Demand Estimates for Electricity in North America until 2009

CANADA					
		2000	2005	2009	% increase 2000–2009
	National Energy Board (NEB)*				
	Scenario 1				
	Peak Demand—MW	95,849	103,733	109,829	15
	Total Demand—GWh	508,122	557,420	600,094	18
	Total Capacity—MW	109,028	116,325	125,954	16
	Scenario 2				
	Peak Demand—MW	94,444	100,406	104,470	11
	Total Demand—GWh	500,680	539,632	570,784	14
	Total Capacity—MW	108,858	114,588	120,962	11
	Natural Resources Canada (NRCan)*				
	Peak Demand—MW	NR	NR	NR	
	Total Demand—GWh	557,267	583,029	600,575	8
	Total Capacity—MW	110,269	111,500	114,299	4
	North American Electricity Reliability Council (NERC)				
	Peak Demand—MW	84,928	90,383	94,769	12
	Total Demand—GWh	490,485	524,749	551,671	12
	Total Capacity—MW	100,492	102,372	103,947	3
UNITED STATES					
	North American Electricity Reliability Council (NERC)				
	Peak Demand—MW	685,816	756,445	813,264	19
	Total Demand—GWh	3,631,905	4,003,192	4,287,754	18
	Total Capacity—MW	754,662	863,200	877,760	16
	Department of Energy (DOE)—Energy Information Administration (EIA)				
	Peak Demand—MW	NR	NR	NR	
	Total Demand—GWh	3,364,455	3,760,101	4,067,825	21
	Total Capacity—MW	754,000	818,600	918,200	22
MEXICO					
	Secretaría de Energía				
	Peak Demand—MW	31,499	42,181	53,943	71
	Total Demand—GWh	167,134	229,399	296,209	77
	Total Capacity—MW	40,101	55,254	67,868	69

* Data for 2010 were used instead of from 2009 because only those for 2010 were reported.[65]

[65] The highbound estimate of all planned capacity from the NEWGen dataset used by the CEC implies installed capacity of 127,000 MW, 59,000 MW, and 1,300,000 MW by 2007 for Canada, Mexico and the US, respectively.

While supply and demand projections are not perfect, there is universal consensus that demand is outstripping supply, that new investments are required to cover the deficit in some regions in the near term, and that generation reserve margins—with an ideal range of 10–15 percent—are shrinking quickly—it is clear that North America will require new capacity. Table 7 below shows expected reserve margins for all NERC regions based on NEWGen data demand projections by NERC region and with capacity information from NEWGen which includes only Existing and Operating plants. This data is suggestive both of the accelerating decline in reserve margins overall, as well as comparative declines between regions. The latter is useful for investors and planners in identifying where new installed capacity might go. It is also one proxy that suggests the extent, and pattern, of interregional trade. That is, regions with higher deficits would be expected, all other factors being equal, to import electricity from those regions with surplus capacity. The map (Figure 3) below identifies the NERC regions.

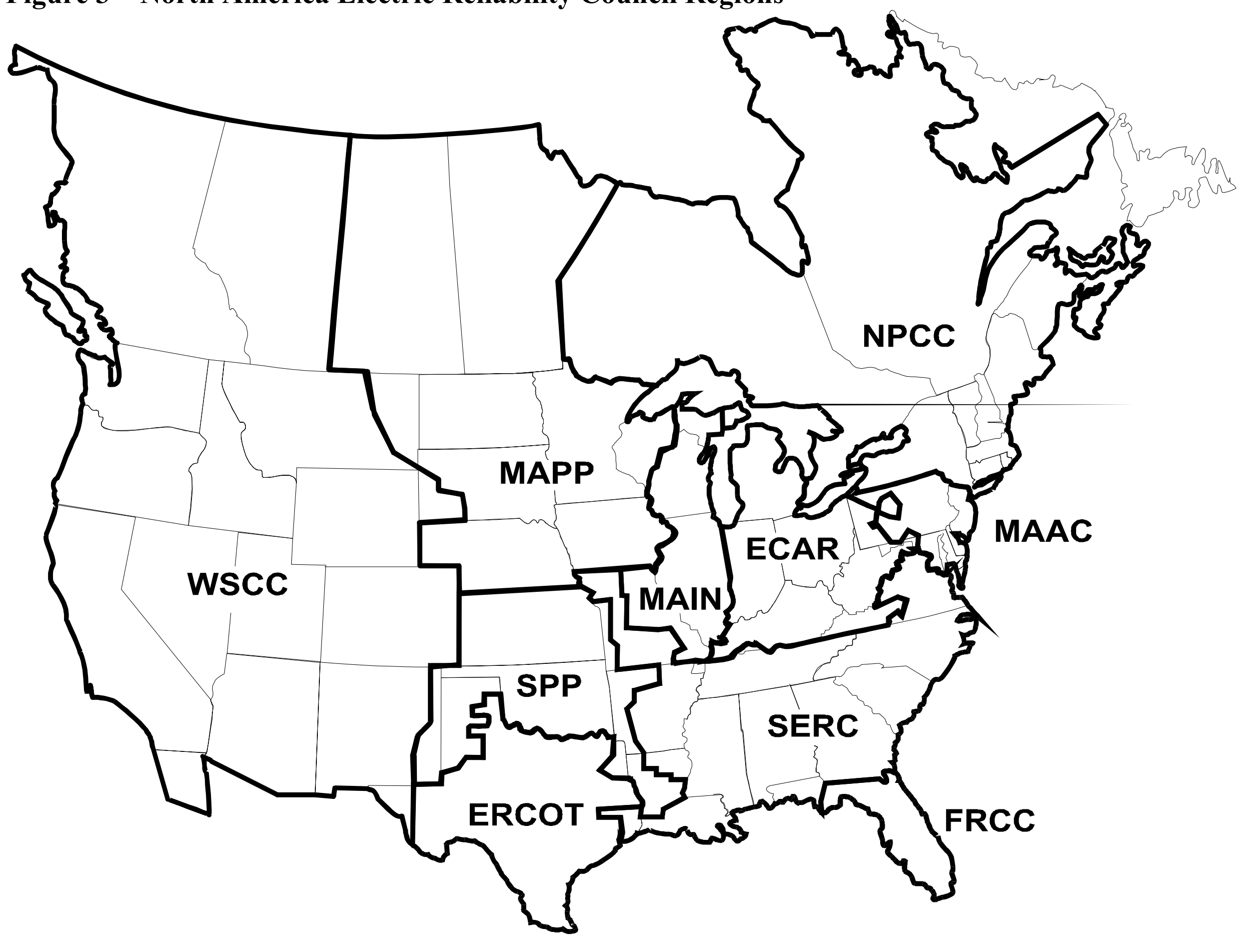
Table 7 – Reserve Margins with only Existing and Operating Plants (%)

	2000	2001	2002	2003	2004	2005
All NERC	21.32	23.14	20.61	18.08	15.52	13.06
ECAR	17.20	18.40	17.15	15.07	13.34	11.21
ERCOT	19.01	24.67	20.79	17.24	14.06	9.42
FRCC	5.82	5.04	2.49	-0.73	-5.36	-8.82
MAAC	16.45	16.73	15.07	11.85	10.04	7.84
MAIN	23.64	33.91	34.60	32.99	30.95	30.76
MAPP	13.47	12.64	11.41	11.23	10.54	8.67
NPCC	23.58	23.29	20.14	16.80	13.58	10.83
SERC	19.96	21.33	18.26	16.10	13.85	11.38
SPP	25.92	31.34	28.78	26.92	21.82	18.89
WSCC	22.87	22.73	18.73	15.61	12.36	10.36

Source: NEWGen Dataset August 2001 issue.

ECAR - East Central Reliability Coordination Agreement, ERCOT - Electric Reliability Council of Texas, FRCC - Florida Reliability Coordinating Council, MAAC - Mid-Atlantic Area Council, MAIN - Mid-America Interconnected Network, MAPP - Mid-Continent Area Power Pool, NPCC - Northeast Power Coordinating Council, SERC - Southeastern Electric Reliability Council, SPP - Southwest Power Pool, WSCC - Western System Coordinating Council.

Figure 3 – North America Electric Reliability Council Regions



New Generating Capacity in the Planning Pipeline

Given the variety of modeling and forecasting efforts, this working paper did not offer new modeling results, but rather, examined potential environmental effects from new generating projects that have been announced by utilities or investors, and are at different stages of development up to 2007. This approach has both strengths and weaknesses.

By looking at planned expansion in new generating facilities—based on the NEWGen dataset– one gets an insight into where markets and investors are going *at the moment*. However, changes in investment following the 11th September 2001 tragedy, likely to be at least of the order of magnitude of economywide effects following that date, are not reflected in the data.

Included in the NEWGen dataset are planned electricity generating projects comprising 1,926 separate generating units, falling into one of six phases: projects that are tabled, proposed, are in early development, advanced development, under construction and operating. (The reason for the inclusion of operating plants is that the baseline year for analysis is 1998.) As noted, the data includes planned electricity expansion to 2007. This cut-off date was chosen for two reasons. First, after 2007, the data become increasingly thin.

Second, 2007 is the final year prior to the first 2008 to 2012 implementation period under the Kyoto Protocol of the UN Framework Convention on Climate Change. While Canada appears to be the sole North American country that will ratify the Protocol as an Annex One country, all three NAFTA partners are signatory to the UN Framework Convention on Climate Change. Article 4 of the Convention calls for domestic and international cooperation to reduce greenhouse gas emissions. It is generally expected that the implications of a carbon constrained environment will lead to increased emphasis on climate policies, including some kind of emissions trading, joint implementation or measures taken pursuant to the general goals of the Clean Development Mechanism. It is also expected that these actions will begin on or before the beginning of the first implementation period of the Kyoto Protocol of 2008. To illustrate, starting in 2008, the Canadian Electricity Association has proposed that all oil- and coal-fired plants older than 40 years will be required to reduce their GHG emissions to specified levels.[66]

Table 8 below provides information on the fuel mix, total capacity increase and country of location of new generating units derived from the NEWGen dataset.[67]

Table 8 – Breakdown by Fuel Type of Planned Electricity Generating Capacity (until 2007) in North America (MW and Number of Units)

		Natural Gas	Water	Coal	Uranium	Oil	Other	Total
Canada	MW	8949	5757.35	1750	0	0	666.63	17122.98
	Units	65	30	4	0	0	32	131
United States	MW	407256.6	2293.1	30005.66	576	-798.82	21053.44	460385.9
	Units	1344	12	67	17	34	233	1707
Mexico	MW	21397.2	1027	1750	0	-1028.33	350.5	23496.37
	Units	58	8	2	0	13	7	88
	Total MW	437602.8	9077.45	33505.66	576	-1827.15	22070.57	501005.3
	Total Units	1467	50	73	17	47	272	1926

Source: NEWGen dataset.

Two important features contained in the above data are worth emphasizing. First, an extremely large amount of total planned capacity increase is under market consideration. In fact, roughly 500,000 MW of additional capacity is identified in the above data, representing a more than 50 percent increase in total North American electricity generating capacity to 2007, compared to 1999 levels.

This growth rate is clearly unrealistic. However, how much, where, and which technologies and fuel choices will become reality from the data is a hard estimate: free markets simply do not provide standard proxies indicating how many announced plants become operational. As noted above, a useful proxy is suggested by the NEP analysis: of the 43,000 MW planned expansion in generating capacity announced in 1994 to come on line from 1995 to 1999, approximately 18,000 MW of new capacity was actually built. Hence, roughly 40 percent of projects announced were built.[68]

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[66] Canadian Electricity Association, "Emission performance equivalent standard," 21 October 1999.

[67] The dataset used in the analysis is available upon request, from the CEC.

[68] Report of the National Energy Policy Development Group (May, 2001) *National Energy Policy: Reliable, Affordable, and Environmentally Sound Energy for America's Future,* Washington, DC.

The second most important feature of the NEWGen data—arguably of more significance than either total MW planned or number of units—is the fuel mix of new generating plants. Projects in the pipeline show that natural gas will comprise 88 percent of total new generating capacity in the United States to 2007, and 91 percent in Mexico for the same period. By contrast, natural gas comprises 52 percent of Canada's total generating expansion, with hydropower accounting for 34 percent and coal for 10 percent new generating capacity reported by NEWGen.

The prominent position of natural gas in all three countries is relatively welcome news from an environmental perspective: of the three major fossil fuels, it is recognized by the Intergovernmental Panel on Climate Change (IPCC) and other scientific bodies as being the one with the lowest levels of environmental impacts. However, as noted below, natural gas and the overall fuel mix suggested in the NEWGen data still present new and serious environmental challenges.

SECTION FOUR: POSSIBLE ENVIRONMENTAL OUTCOMES OF PLANNED GENERATING CAPACITY INCREASE TO 2007

Air Pollution

Section Two described the environmental context of air pollution from the North American electricity generation sector in terms of an air emissions reference case for four air pollutants. The air pollutants considered were carbon dioxide (CO_2), sulfur dioxide (SO_2), nitrogen oxides (NO_x), and mercury (Hg). In this section, the reference case inventory is used to gain some perspective on the relative scale of future air emissions estimated for 2007 associated with potential generation capacity changes in North America. The scale of potential capacity changes is based on information contained in the NEWGen dataset. Two "boundary" scenarios are developed for 2007. The high boundary scenario contains all uncancelled power projects in the NEWGen database. While it is extremely unlikely that a major portion of these announced projects will be built, it gives a sense of where the greatest activity in terms of new power plant sitings are occurring. This in turn may reflect differing environmental regulatory regimes as one of a number of siting decision factors. The low boundary scenario includes only power projects in the advanced, under construction and beyond operating stages. This gives a sense of projected emissions associated with new power projects that are most likely to be completed.

Table 9 presents a national summary of the results, with a more detailed description given in Miller et al. 2002, which breaks down emissions by province and state. The table presents only the estimated emissions for projected future capacity changes, and does not include potential future reductions due to any new controls on existing sources. Therefore, the table should not be interpreted as a prediction of increases or decreases of total emissions from the electricity generating sector, rather it compares the increment we estimate for new capacity changes with the reference emissions case to give a sense of the extent of new emissions that could arise from future capacity growth.

Table 9 – Summary of national emission totals in the reference inventory case and the high and low boundary future projections (percent of reference inventory case shown in parenthesis). CO_2, SO_2, and NO_x amounts are in metric tonnes. Mercury (Hg) amounts are in kilograms.

Country scenario	Annual CO_2	Annual SO_2	Annual NO_x	Annual Hg
Canada reference inventory	122,000,000	650,195	290,211	1,975
Canada high boundary 2007	18,828,537 (+15%)	-3,917 (-1%)	41,910 (+14%)	221 (+11%)
Canada low boundary 2007	3,743,487 (+3%)	20 (0%)	10,890 (+4%)	9 (0%)
Mexico reference inventory	90,095,882	1,683,199	280,931	1,117
Mexico high boundary 2007	48,199,112 (+53%)	36,131 (+2%)	175,707 (+63%)	270 (+24%)
Mexico low boundary 2007	25,712,762 (+29%)	34,779 (+2%)	110,978 (+40%)	212 (+19%)
US reference inventory	2,331,958,813	12,291,107	5,825,982	39,241
US high boundary 2007	875,036,007 (+38%)	64,580 (+1%)	459,286 (+8%)	5,762 (+15%)
US low boundary 2007	333,347,795 (+14%)	-77,468 (-1%)	147,150 (+3%)	1,039 (+3%)

The percent value given in parentheses is the relative size of the new 2007 emissions in the boundary case compared to the reference inventory. For example, in the Canada 2007 high boundary case, the estimated CO_2 emissions from projected electricity capacity changes would be 15% of the reference inventory emissions. This provides a relative sense of the scale of potential emission changes. This, however, is not a projection of the total emissions increase from all electric power generation, as emissions from existing sources could decrease due to potential generation displacement by newer power plants or the installation of new pollution controls.

Toxic Releases

Estimating future toxic release emissions from electric power generation from current emissions is difficult, for a number of reasons. Foremost is the difficulty in extrapolating metal gas emissions from current rates. Unlike acid gases, which can be estimated on emission factor averages with some accuracy, metal gas emissions can vary within (and between) coal- and oil-fired plants. These variations arise from differences in the coal or oil burned between plants; whether the plant is in a controlled or non-controlled area; and other factors.

However, a general observation is that if natural gas becomes, as the NEWGen data suggests, the fuel of choice for most new generating stations to 2007, then hazardous air pollutants are unlikely to see a significant increase. This observation is based on the findings of an EPA report to Congress, which found that hazardous air pollutant (HAP) emissions from gas-fired plants are "negligible."[69] At the same time, if changes in the fuel mix other than that suggested in the NEWGen data lead to an increase in coal- and oil-fired power plants, then the level of acid gas emissions that currently characterize the sector will increase.

Hydropower

The NEWGen database includes 50 new hydropower plants currently in the planning stages in North America, the vast majority of which are located in Canada.

As noted above, assessing the environmental impacts of new hydro projects is difficult, without information on the specific location and construction and operating characteristics of the new projects. However, to reiterate conclusions of the World Commission on Dams, the World Bank and the International Energy Agency—size matters: the magnitude of environmental damages from future hydropower will largely be a function of the size of those projects.

To mitigate some environmental impacts, a reasonable assumption is that advances in design and technologies to mitigate some adverse environmental effects will be incorporated into new projects. These include turbines that are less destructive to fish (fish-friendly turbines), fish ladders, screens or other improvements intended to reduce damages to freshwater fish. However, minimum flow requirements and other constraints on streamflow modifications—arguably the most significant measure to limit environmental harm, rarely exceed those imposed by regulators (or those that result from negotiated settlements).

The relicensing process currently underway in the US for approximately 400 hydropower plants is of considerable importance in determining future environmental outcomes, not only for existing but also new plants. Every 30 to 50 years in the US, non-federal hydropower projects must obtain new operating licenses from FERC. The relicensing process presents the opportunity to either add new environmental provisions to existing hydropower plants, to roll back environmental provisions that are in place, to leave current provisions in place, as well as the possibility that licenses may not be renewed.

The DOE recently noted that opportunities to upgrade environmental equipment and procedures in individual relicensing proceedings are being foregone. Among the reasons suggested for roll-backs are the constraints that environmental measures impose on hydropower output. Estimates cited in a recent DOE report suggest those losses range in the vicinity of 1 to 8 percent.[70] Several nongovernmental organizations, notably American Rivers, has also noted that the relicensing procedures might roll back important environmental protection measures already in place.

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[69] EPA (1997), *Study of Hazardous Air Pollutant Emissions from Electric Utility Steam Generation Units—Final Report to Congress,* Volume 1.

[70] Hunt and Hunt, 1998 cited in DOE, "Scenarios for a Clean Energy Future."

Factors Likely to Affect Environmental Outcomes

First, the fuel mix noted in the NEWGen data is of importance in future environmental outcomes. Although less clean than renewables, natural gas and combined cycle gas turbines produce lower levels of CO_2, SO_2, NO_x, and hazardous air pollutants per unit of electricity generated, compared to coal or oil**.** For example, based on US national averages, natural gas produces 40 percent less CO_2, 99 percent less SO_2, one-sixth less NO_x, and 99 percent less mercury than coal per unit of electricity generated.

The key question from an environmental perspective is: will planned expansion of, or in Mexico, switch to, natural gas take place, or will increases over time in natural gas prices pull investments away from gas, and towards other fuel sources? There are signs that over time, natural gas prices—which at the time of this report are comparatively low—may inch upwards once again. Industry analysts suggest that after years of expansion, the gas industry may be facing its first prolonged scarcity of supply at exactly the time that US and Mexican utilities have announced an overwhelming interest in it.[71] Finding rates for natural gas continue to decline, gas producers are near capacity, and readily accessible natural gas is getting harder to find. Indeed, for over a decade there has been a gap in the US market between demand and supply: the latter has been covered by imports of surplus reserves from Canada and elsewhere. However, in the late 1990s signs began to emerge that capacity in Canada for readily available gas reserves had been met.

The Williams Capital Group recently noted that "natural gas supplies are inadequate to support new electricity generation sufficient to meet our 3 percent long-term electricity demand growth projection."[72] Like wise, the Energy Modeling Forum notes that its projected expansion in natural gas will not be as pronounced if gas prices remain high.

There is no clear indication as to where planned expansion would shift, and by what extent, if natural gas prices increase. However, some industry analysts believe that coal will displace some of the planned expansion currently favored by natural gas. For example, the National Energy Board of Canada notes that natural gas volatility is renewing investor interest in constructing coal-fired power plants to meet projected energy demand in the future.[73] However, the extent of this switch from gas to other fossil fuels will be determined (in part) by different price elasticities of demand, both for own-price elasticity of natural gas, as well as the cross-price demand elasticity of gas, coal, oil, nuclear and hydro.[74]

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[71] Other factors that could influence the environmental outcomes in future years include technological advances in clean energy, including hydrogen-based fuel cells, and the extent to which distributed generation develops on the continent.

[72] Williams Capital Group. 2001. *US Electricity Supply & Demand Analysis: Tight Gas Supplies Tell the Story*. WCG, New York. The period of projection is to 2010.

[73] National Energy Board (2001), *Trends and Issues,* Calgary, Canada. Among the most important factors affecting the energy sector over the past year has been the dramatic increase in natural gas prices. For example commercial natural gas prices in the United States jumped 70 percent between February 2000 and 2001, partially adding to California's energy crisis of late 2000 and early 2001. Since prices peaked in early 2001, the price of natural gas has declined from February to September. Most analysts anticipate that gas prices will continue to decline until 2003, after which existing surpluses of natural gas are expected to be fully exploited. After 2003, exploitation of known reserves will become more expensive, and the reserves themselves are expected to become increasingly scarce, with price volatility between 2003 to 2006 expected to give way to a steady price increase in natural gas.

[74] Changes in the price and availability of one fuel will generally shift demand onwards to other fuels. The extent of that shift is a function of the cross-price elasticity of supply and demand for major fuel imputs to electricity generation. Obviously, where own-price and cross-price elasticities for fuel are both small, then

Recent changes in the fuel mix in the US suggest that coal has been the substitute fuel of choice during the natural gas price hikes of 2000 and 2001. During this period, coal-use in that country increased dramatically, and industry projections suggest an all-time record high in coal use in the United States at the close of 2001—roughly 1.085 billion tons. This represents an increase in total coal use of 21 million tons from 2000.[75]

There is also evidence that with the US administration's emphasis on energy security, policy support for coal is strong. In February 2001, President Bush noted that "coal will be central to the administration's energy policy of reducing dependence on foreign oil and avoiding crises like the energy shortage in California." It could be assumed that following the September 2001 terrorist attacks in the United States, interest in energy security will be even stronger than laid out in the May 2001 National Energy Policy report. Some analysts (for example, from the *Financial Times Energy*)[76] suggest those events will increase resolve to lower dependence on foreign oil supplies, strengthen further continental ties, and explore and exploit domestic energy sources. (In this regard, the Illinois Clean Coal Institute asserts that demonstrated reserves of underground and surface coal in the US amount to roughly 500 billion short tons.[77])

One insight into how future markets will respond to competition-based changes in related prices is by looking at recent history. One analysis finds that recent conditions are favorable for a re-emergence of coal. A retrospective analysis of changes in fuel mix arising from competitive markets in the US, and the environmental implications, was sponsored by the CEC in support of this working paper. More specifically, the analysis compared the emission projections contained in FERC's final environmental impact statement (FEIS) of Order 888 (1996), with actual emissions in 2000.

The report found that emission projections under the competitive scenarios underestimated actual emission levels, and that the FERC scenario that most resembled the actual emission trends was the "competition-favors-coal" scenario. For the US as a whole, the FEIS projection for 2000 NO_x emissions was 5.4 percent lower than actual for the base case (favoring coal) and 4.3 percent lower than for the "competition-favors-coal" scenario. Projections of national CO_2 emissions for

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price-induced changes on final demand will be small. However, when differences between individual fuel price elasticities are larger than elasticity of demand for all sources, then important shifts in the market will occur. Estimates by Atkinson and Manning (1992), summarized in Martin (1998), show that the own-price elasticity of demand for all energy is on average –0.2. However, elasticities of demand for individual fossil fuels appear much greater, with values of above 1.0 to as high as 2.0. Martin notes that when own-price elasticitites are large, then cross-price elasticities usually are as well, suggesting a greater propensity toward product-fuel substitution. The following provides estimates by Jones (1996) on own-price and, more importantly, cross-price elasticities of demand for direct use of the core fossil fuels:

Long-run Elasticities of Demand in the Industrial Sector of the G-7

	Coal	Oil	Gas
Coal	-1.55	0.72	0.15
Oil	0.63	-2.23	0.78
Gas	0.13	0.79	-0.86

Source: Jones, C.T. (1993), "A Pooled Dynamic Analysis of Interfuel Substitution in Industrial Energy Demand by the G-7 countries," *Applied Economics* 28:815–21. Also cited in Martin (1998), J. Atkinson and N. Manning (1995), "A survey of international energy elasticities," in Barker, T., Ekins, P., and N. Johnstone, eds, *Global Warming and Energy Demand,* Routledge; London.

[75] Illinois Clean Coal Institute <www.icci.org>.

[76] Roberts, John. 2001. "Attacks to throw world energy in turmoil." *Energy Insight Today.* <FTEnergy.com>.

[77] See <www.icci.org/fact.html>.

2000 were lower than actual by 8.5 percent in the base case, and by 7.9 percent in the competition-favors-coal case.

In short, as of 2000, the "competition-favors-coal" scenario underestimated actual emissions by a significant margin. All regions examined showed a significant increase in coal-fired generation between 1996 to 2000, to meet higher than expected demand. The study also found that predictions that low-cost generation in the Midwest and Southeast would lead to an export to other regions did not occur. However, these regions did increase coal generation to meet higher than expected demand within the regions.[78]

SECTION FIVE: SUBSIDIES AND THE INTERNALIZATION OF ENVIRONMENTAL COSTS

Markets and Price Formation

Despite considerable uncertainties related to restructuring and market integration, it is clear that with competitive markets, prices become of crucial importance in shaping to some extent demand, supply, investment and technological choices. With price formation in electricity markets, many goods and services that had previously been shielded from markets by monopolies or oligopolies are now being priced and exchanged in the market. To find the best deals, thousands of brokers, intermediaries, power marketers and others are making decisions about electricity sales in near real-time.[79]

Given that information failures in electricity markets represent an important cause both of market failure and environmental degradation, continued improvements in price formation and transparent and efficient pricing and structures should bring about both gains in efficiency, as well as the creation of new opportunities for price-based environmental policy. These environmental opportunities involve two broad areas.

First, competitive markets provide customers with more choice in purchasing environmentally preferable products and services. In explaining the broad goals of restructuring, FERC notes that increased competitiveness of energy markets has "led to an increased awareness of consumer needs."[80] To what extent customers are aware of the environmental impacts of the electricity they use, and how much and under what conditions they are willing to purchase renewable electricity and energy-efficient products and services, are questions being answered now by an array of market-based schemes aimed at customers.[81] These include green pricing initiatives offered by utilities, green or renewable electricity certification schemes and products and services that are awarded green labels because of their energy efficiency. These and other schemes, are described in Section Six.

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[78] See Woolf et al. (2001)

[79] For an excellent discussion of the role that short term spot markets played in the California electricity crisis, see R. Cavanagh (2001), "Revisiting 'the Genius of the Marketplace': Cures for the western electricity and natural gas crises," *The Electricity Journal*, June 2001.

[80] FERC (2000), *State of Markets,* Washington.

[81] See for example Farhar, BC. 1999. *Willingness to Pay for Electricity from Renewable Resources*. NREL, Golden, Colorado, CEC (Commission for Environmental Cooperation). 2001b. *Market for renewable electricity in Mexico's industries*. Montreal, or Rowlands, Ian, Daniel Scott and Paul Parker. 2000. *Ready to Go Green?: The Prospects for Premium-priced Green Electricity in Waterloo Region, Ontario.* Environments 28 (3).

Text Box 1 – Health Effects of Electricity Generation
A recent study by Levy et al looked at the pollution emissions from two coal-fired plants in New England: the Salem Harbor power plant, with a capacity of 805 MW burning one million tons of coal a year, and the Brayton Point power plant, with a capacity of 1,611 MW, burning approximately three million tons of coal per year. The study examined the human health costs of three pollutants from the two facilities—SO_2, NO_x and PM_{10}—affecting a population of 32 million people within proximity of prevailing emissions. Among the conclusions of this one report:

- 53 premature deaths per year are linked with the Salem plant, and 106 premature deaths per year from the Brayton Point plant;
- 570 emergency visits per year are linked with the Salem plant, and 1,140 from Brayton Point;
- 14,400 cases of asthma per year are linked to Salem, and 28,900 asthma cases from Brayton Point;
- 99,000 daily incidents of upper respiratory symptoms are linked to emissions from Salem, and 199,000 incidents from Brayton Point.

The study finds that health risks are greatest near the plants—an issue that raises again questions of environmental justice related to the siting of new plants—while health risks decline over distance. The study found that secondary effects from emissions had greater long-term health impacts than direct effects.

The study then found that if the two plants reduced their level of emissions to be in compliance with current US federal air emissions standards, then there would be a reduction in health damages of US$280 million per year from Salem Harbor, and US$530 million for Brayton Point.

The second area in which prices might reduce environmental impacts is related to "getting prices right" more generally. The notion of correcting prices to reflect environmental damages forms the basis of commitment from all three governments of North America to the Polluter Pays Principle, adopted in the OECD. By introducing more efficient prices into North America's electricity market, it is argued that the public will take more notice of environmental damages that currently remain "outside the domain of markets, unowned, unpriced and unaccounted for."[82] In short, transparent pricing *may* present new opportunities to internalize some of the environmental externalities that characterize the sector.

Clearly, electricity rate payers do not pay anywhere near the cost of pollution damages. Environmental externalities range from climate change and acid rain, to habitat and biodiversity losses, to risk of cancer from the release of large amounts of mercury and methylmercury—which have been directly linked to neurotoxicity.[83] Electricity generation from oil and coal-fired plants also emits trace amounts of dioxins, arsenic, radionucleide and other hazardous and toxic emissions. There is now a considerable body of literature linking fossil-fuel generation to environmental and human health damages, and valuing the impacts of those damages (see Text Box 1).

A more recent study using valuation techniques compares the cost of wind versus coal. As noted, market costs of coal power are low, at 3–4 cents per kWh. However, the study argues that if the 2,000 deaths that occur each year in the US were counted, together with the US$35 billion that

[82] Theodore Panayotou, *Green Markets: The Economics of Sustainable Development,* International Center for Economic Growth, 1993.
[83] In its report to Congress, the EPA concluded, after undertaking risk assessments of the main hazardous air pollutants from oil and coal-fired power plants, concluded that the "…available information, on balance, indicates that utility mercury emissions are of sufficient concern for public health to merit further research and monitoring." EPA (1998), *Study of Hazardous Air Pollutant Emissions from Electric Utility Steam Generating Units—Final Report to Congress,* Volume one, Washington, DC.

the country has paid thus far to compensate for black lung disease, then the real costs of coal would be much higher. The authors then argue that, if coal paid its full costs, then wind power—which can be built for 3–4 cents per kWh, with up-front capital costs, siting, operating and decommissioning costs included—would be competitive with coal on a price basis.[84]

The role of subsidies has received considerable attention from environmentalists in recent years. Subsidies and other financial transfers intended to create a price wedge between world and domestic prices impose numerous economic costs—including general welfare costs—as well as various environmental costs. Subsidies can contribute to over-capacity, to the inhibition of capital turnover and the retention of older, inefficient and environmentally damaging equipment that otherwise would be driven out of the market. In addition to greater interest from economists and environmentalists, the ability of governments to use subsidies has been—to some extent—defined and constrained through rules in trade accords like NAFTA and the WTO agreements in general. The emergence of transparent pricing in an open grid may make it more difficult for jurisdictions within the grid to levy certain kinds of subsidies.

Estimating Subsidy Levels

Estimating exact subsidy levels in the electricity sector is difficult; how subsidies are tallied up is very much a function of how a subsidy is defined. The OECD narrowly defines a subsidy as a "direct government payment to support the production, sale or purchase of a good or service." However, this limit on explicit government expenditures excludes numerous indirect public interventions—from defraying transport costs for fuel inputs to capital depreciation rates—that have similar price depressing effects as direct subsidy payments.[85]

Work by the OECD and others suggests that estimating the environmental effects of subsidies is best done on a case-by-case basis, and falls outside the scope of this report. However, in general three main categories of energy subsidies can be identified:

(a) Direct Payments to Producers and/or Consumers;
(b) Tax Expenditures; and
(c) Research and Development Support.

While some of these subsidies contribute to environmental degradation, others—notably measures that support research and development (R&D) in renewable energy, measures to support energy efficiency programs like improved insulation, or other kinds of energy conservation support projects—have as their objectives supporting environmental goals. Accordingly, almost all debates about removing or eliminating subsidies end up classifying whether they are environmentally damaging, environmentally beneficial, neither, or a combination of both. For example, a six-year debate in the World Trade Organization Committee

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[84] Marck Jacobson and Gilbert Masters (August 2001), "Exploiting wind versus coal," *Science,* Vol. 293.

[85] One way in which the OECD has sought to capture direct and indirect subsidy levels is through the producer subsidy equivalent (PSE), which includes broader areas of market support, such as government policies that support certain producer prices, market creation activities or technology or product/service differentiation practice. The PSE has been useful in identifying levels of subsidy support in the farm sector. However, it has been less useful in pinpointing subsidy levels in the energy sector. Hence, the OECD, together with UNEP and others, tend to rely on case studies to calculate subsidy levels, the associated environmental impacts, and the probable environmental gains from their removal. OECD, "Reforming coal and electricity subsidies," Annex 1, Expert Group on the UNFCC, Working Paper No. 2, OCDE/GD(97)70, Paris, 1997).

on Trade and Environment continues to revolve around how to differentiate "green" subsidies from environmentally damaging ones.

However, as a general observation, the OECD notes a distinction between subsidies that support environmentally friendly outcomes and those that have negative environmental effects.[86]

Extensive state and provincial subsidies, numerous indirect subsidies—especially in fuel input side—are important, and warrant a more comprehensive analysis. The following examples are intended to identify some, but hardly, all subsidies in place in North America related to electricity.

Canada

In Canada, there are numerous projects and policies in support of energy efficiency, as well as the development of cleaner generating technologies. Some of these programs, which are supported by Natural Resources Canada, are described in Section Six.

However, the largest federal subsidy intervention in the energy sector is related to the continued support for the Alberta Tar Sands Project. That project is expected to extract approximately 300 billion barrels of oil, more than the estimated reserves of Saudi Arabia. Subsidy support for the project (1997) was approximately C$600 million, through tax measures applied to defer capital costs of project development.

A 1997 report noted that while federal subsidy support for the fossil fuel sector appeared to be lowering, support for the Tar Sands project remained 10 times greater than all federal government energy efficiency and renewable energy support schemes. These schemes include changes to the eligibility status of Class 4.1 of the tax code, intended to assist in the financing of renewable energy by defraying capital cost expenditures. Despite these and other initiatives, a late 1997 report by the Canadian House of Commons Committee on Environment and Sustainable Development noted that the "playing field in the energy sector is far from level," with most federal tax policies biased in favor of "conventional, carbon-intensive energy industries at the expense of energy efficiency and renewables."[87]

The Environmental Effects of Subsidy Removal

Several studies and reports have examined the environmental effects of subsidies, and the effects of subsidy removal. Many recent studies concentrate on the farm and fisheries sectors, replete with subsides and other pricing distortions. However, the OECD, World Bank, the World Resources Institute and the International Institute for Sustainable Development continue to do valuable work in estimating the benefits to the environment of subsidy removal. Again, some of this analysis is based on findings from models. The US Environmental Protection Agency, for example, commissioned several studies in the 1990s to estimate the effects of subsidy reductions on total CO_2 emissions. One,[88]using a general equilibrium model combined with other models,

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[86] This distinction is recognized, at least in part, in the Uruguay Round of the WTO. In Article 8 of the Agreement on Subsidies and Countervailing Measures, provisions are outlined for non-actionable (or exempt) subsidies; these include (in Article 8.2 (c), measures covering investments to meet "new environmental requirements." (Comparable exemptions are not contained in NAFTA).
[87] Standing Committee on the Environment and Sustainable Development (December 1997), "Kyoto and beyond."
[88] Jorgenson (1998)

found that removing US$15.4 billion in subsidies world-wide would result in the reduction of 64 million tons of CO_2 by 2010—that is, roughly a reduction of four million tons for each one billion dollars of subsidies removed.

Of interest, the same study found that subsidy support to renewables and energy conservation had a price depressing effect on markets, which in turn led to an increase in total CO_2 emissions. The report noted that reducing subsidy support would also lead to reductions in such emissions.

As a general point about subsidy levels and their effects, the relative market impact of subsidies to the fossil fuel sector, as a proportion of the total market size of that market, is significantly smaller than subsidy support for renewable energy.

Mexico

In Mexico, official budget estimates for 2000 show the annual subsidy for electricity use is US$3.4 billion. The bulk of this amount—roughly 85 percent—is allocated to offset electricity tariffs for residential and agricultural users. By contrast, commercial end-users of electricity are not entitled to rate subsidies.

The pattern and level of subsidy support and allocation in Mexico has been roughly constant for several years. However, between 1999 and 2000 a marginal increase in subsidies, directed at residential rate support, was introduced. Over the past 5 to 6 years, efforts have been growing to align costs and prices for most sectors and—with the exceptions noted above—subsidy support ratios appear to be moving closer to one in the electricity sector. Official estimates suggest that the CFE does not receive any direct subsidy support from the federal government. However, there are numerous tax expenditures that have similar effects as subsidy outlays. A noted example is the *aprovechamiento* tax for exploitation rights, which provides tax rate deferrals as a proportion of the total fixed assets of the CFE.

United States

In the United States, direct federal subsidy support for primary energy use in 1999 totaled approximately US$4 billion. This represented a decrease of approximately US$1 billion from fiscal year 1992.[89] Total US federal government subsidies to oil, natural gas, coal and nuclear power was approximately US$2.8 billion. Of the primary fossil fuels, natural gas received the largest amount of subsidy support from the US federal government, at US$1.2 billion, most of which came from a tax credit in support of alternative fuels, mainly from coal-bed methane and tight sands. Direct expenditures for renewable energy during the same year were roughly US$4 million.

Tax expenditures related to primary energy were US$1.7 billion (1999 dollars), with an additional US$0.7 billion for the exemption of ethanol from Federal excise taxes. In fiscal year 1999, the two largest tax credits were for alternative fuels production, used to develop coal-bed methane and tight sands (US$1.0 billion) and a percentage depreciation allowance for the oil, gas and coal sectors.

The US General Accounting Office (GAO) estimates that total US subsidies in support of renewable energy since the 1970s have exceeded US$10 billion, with a large proportion of total

[89] Energy Information Agency (1999), “Federal financial interventions and subsidies in energy markets, 1999: Primary energy,” Department of Energy, <www.eia.doe.gov/oiaf/servicerpt/subsidy>.

spending or tax credits going to wind and solar power. The GAO also estimates that "clean coal" has received approximately US$119 million in subsidies from 1987 to 1998.[90]

The 2002 US budget proposal under the Office of Management and Budget (OMB) calls for DOE to spend US$2.8 billion, plus an additional US$2.1 billion in the form of tax benefits, mainly for "traditional and alternative energy sources." Under the OMB proposals (as of late September 2001), energy conservation support from the federal government is proposed to be US$795 million. For fossil fuels, the OMB notes that "federal tax incentives (are) mainly designed to encourage the domestic production or use of fossil and other fuels." The numerous tax credits, incentives and other measures contained in the budget are too lengthy and complex to summarize here.[91]

The projected subsidy support from DOE to renewable energy in 2002 is approximately US$1.2 billion, with this amount tied to revenues from the proposed drilling of ANWR in Alaska.

This tallying of direct US federal budgetary support for the energy sector is useful in comparing, for instance, levels of support between primary and renewable energy sources. However, there are numerous indirect or secondary subsidy interventions that characterize the electricity sector, and these interventions have been the subject of various studies, and widely varying estimates. For example, one estimate—a 1997 study by Management Information Services—suggests that the cumulative effects of energy subsidies from 1947 to 1997 amounted to US$564 billion. Roughly half of entire outlays went to the oil industry in the form of tax expenditures.[92]

A 1992 study by the EIA estimated direct expenditures (1992) in the electricity sector at US$3.9 billion, and R&D subsidies at US$2.3 billion, of which roughly half went to nuclear power. The EIA study also compared financial outlays with excise taxes deferred through exemptions or offsetting liabilities, and calculated a negative net subsidy of US$2.4 billion.

A second 1992 study—prepared by the Alliance to Save Energy—gives a very different picture of subsidy levels. Using 1989 estimates, the Alliance calculated a total subsidy range in the US electricity sector of between US$27 billion to US$46 billion. The study estimated subsidies based on any government-owned good or service (including risk bearing instruments) which would otherwise have to be obtained under market conditions, and any tax burden compared to the standard treatment for a comparable activity. The study included several programs that had been discontinued at the time of its writing in 1992, notably the accelerated depreciation of machinery and equipment—estimated at US$12 billion—which was eliminated under the Tax Reform Act.

Subsidy-like Effects of Regulatory Waivers and of Regulatory Non-Comparability

The granting of regulatory waivers is in effect an indirect subsidy, allowing the recipient to avoid the direct or indirect costs it would otherwise incur to meet the regulatory requirements. In the same way, indirect subsidies also result when one partner in a free trade environment maintains regulatory requirements significantly weaker than those of its partners.

In this respect, a key concern of environmentalists continues to be the fate of more than 300 gigawatts of coal-fired generating plants in North America that operate at far less than their full

[90] US General Accounting Office (2000), "Clean coal technologies: status of projects and sales of demonstrated technologies," Washington, DC.

[91] Please see <http://www.whitehouse.gov/omb>.

[92] These studies have been compiled in a very useful report by the US Energy Information Agency (1999).

capacity. Most of these are in the US, and they have to date been sheltered by the "grandfathering" provisions of the Clean Air Act (CAA). When the CAA was first adopted over thirty years ago, an "old source" exemption—commonly referred to as grandfathering—was granted to existing, and mainly coal-fired plants on a temporary basis. These provisions were maintained in amendments to the CAA adopted in 1977 and 1990. In the case of coal-fired power stations, roughly two-thirds were built prior to 1970. It was assumed that these regulatory exemptions would remain until the coal-fired plants were retired 20 or 30 years hence.

These exemptions allow older, coal-fired plants to operate with pollution emissions levels anywhere from 4 to 100 times higher than newer plants.[93] More than three decades after the original grandfathering exemptions were first introduced, there are hundreds of coal-fired plants that operate in the US with substantive exemptions to air pollution emission caps and other controls.

In well functioning markets, open competition both accelerates the retirement of older capital stock, and the acquisition of new and efficient stock. From an economic perspective, grandfathering has subsidy-like effects, in maintaining older and inefficient generators that otherwise would be uncompetitive in competitive markets.

Regulatory quasi-subsidies also result from the differences in licensing practices with respect to hydropower. In the US, most hydropower facilities operate under 30- to 50 year licenses issued by the Federal Energy Regulatory Commission (FERC). Since 1986, the Federal Power Act has required FERC to give equal consideration to environmental protection in its licensing decisions.[94] As a result, as new projects are presented or as older ones come up for relicensing, they are held to considerably higher environmental standards than were in effect when the original licenses were issued, notably with respect to flow regimes.

SECTION SIX: ENERGY EFFICIENCY AND RENEWABLES

Since the oil price shocks of the 1970s, promoting energy efficiency has been part of the energy policies of all three North American federal governments. One of the clear lessons of energy efficiency after more than a quarter century of performance is a simple one: it is often cheaper to save energy through efficiency gains than it is to build and operate new plants. Energy efficiency has proven that total energy demand can be lowered, while delivering comparable or even enhanced services.

Just how much of future electricity demand can be absorbed through proven efficiency technologies obviously has huge implications for our environmental future. That is, the environmental projections noted in Section Three, above, reflect a supply-intensive vision of energy needs. By promoting energy efficiency, the total amount of new installed capacity could be lowered, potentially substantially.

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[93] Cohen, A. 1997. "Unfinished business: Cleaning up the nation's power plant fleet." *Clean Power Journal,* Summer.

[94] According to the Electric Consumers' Protection Act of 1986:

> ... in deciding whether to issue any license [for a hydroelectric project], the Commission, in addition to the power and development purposes for which licenses are issued, shall give equal consideration to the purposes of energy conservation, the protection, mitigation of damage to, and enhancement of, fish and wildlife (including related spawning grounds and habitat), the protection of recreational opportunities, and the preservation of other aspects of environmental quality.

Between the mid-1970s and the mid-1980s, during a period of very high oil prices, energy efficiency in the US increased by 40 percent. A 1991 report from the Office of Technology Assessment found that energy efficiency should reduce CO_2 emissions by 20 to 35 percent.

These gains came about by concentrating on a few areas, notably improving residential building efficiency improvements. A 1992 report from the National Academy of Sciences found that the least-cost option for efficiency gains came from energy improvements in buildings.[95]

Incentive Programs

Similarly, a recent report by the American Council for an Energy Efficient Economy found that total spending by DOE on its 20 top energy efficiency programs over the past 20 years cost US$712 million, and resulted in energy costs avoided of roughly US$30 billion.

Most such programs rely on providing incentives to consumers. For example, programs may provide rebates to customers who purchase energy efficient equipment, or rewards to wholesalers or retailers for selling such equipment.

In addition to government programs, during the 1990s, utilities throughout the US were often encouraged, or obliged, to deliver energy efficiency programs to their clients, where the costs of such programs were deemed less than the alternative costs of new supply.[96] In the early 1990s, utility investment in such programs was expected to exceed some $30 billion by decade's end.[97]

However, as the industry began bracing itself for price deregulation and the opening of markets to competitive forces, utilities and their regulators reduced "non-necessary" spending, including many DSM programs. Overall spending for the decade has been a full 30 percent lower than originally expected, and annual spending 60 percent less, as seen in the following graph.

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[95] (DOE IWG) Department of Energy Interlaboratory Working Group. 2000. *Scenarios for a Clean Energy Future* (Oak Ridge, TN; Oak Ridge National Laboratory and Berkeley, CA; Lawrence Berkeley National Laboratory), ORNL/CON-476 and LBNL-44029, November.
[96] In many States, the supply cost threshold took into account estimates of the environmental externalities of electricity generation or natural gas supply and combustion.
[97] Eric Hirst, 1993. *Electric-Utility DSM Program Costs and Effects: 1991 to 2001,* p. 20 (revised version).

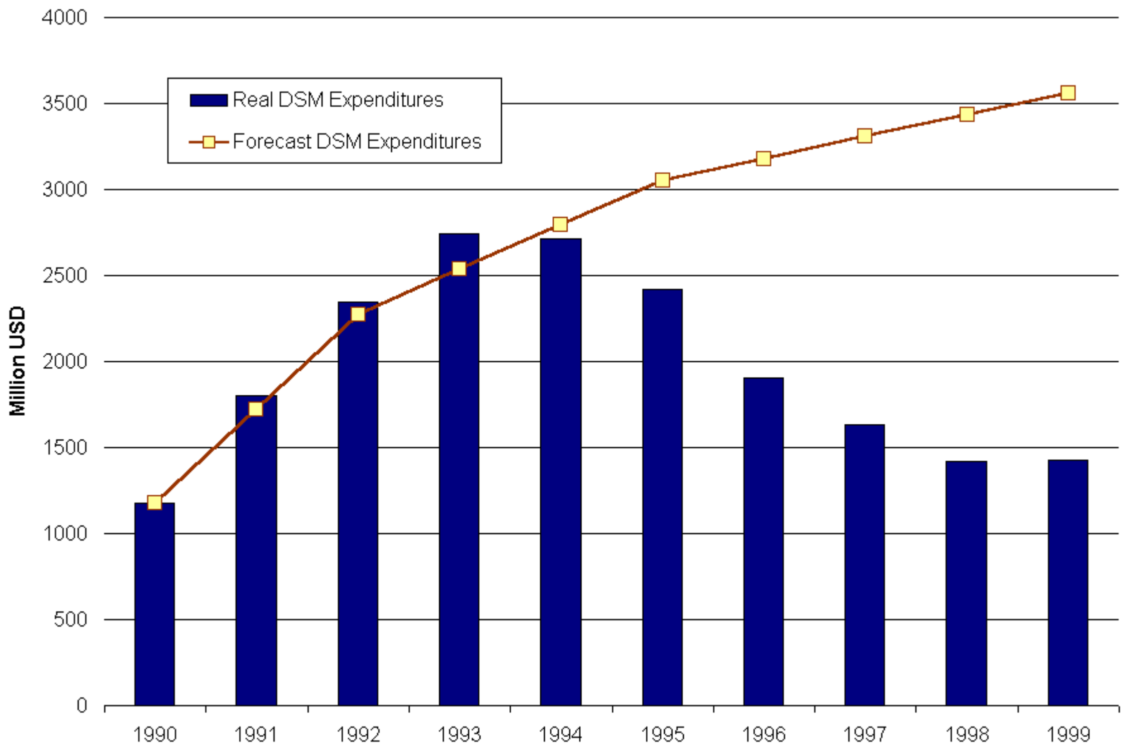

Figure 4 – US Forecast and Actual Utility DSM Expenditures (1990–1999) [98]

Toward the end of the 1990s, energy efficiency spending began to recover, reinforced by the California crisis of 2000–2001. Currently, 18 US states have approved public benefits charges (PBCs) directed toward energy efficiency programs, with other states soon to follow suit.[99] The 18 PBCs alone guarantee nearly $1 billion in annual efficiency programs for the electricity sector. Actual delivery of programs—whether by utilities, governments, para-governmental agencies or independent non-profits—differs from state to state.

In Canada, utilities have significantly reduced their DSM efforts since the mid-1990s, and governments have generally not compensated with increased investments of their own. However, as the push for competitive markets continues and as prices themselves become increasingly volatile, discussion regarding the possible implementation of provincial PBCs has begun.

[98] P. Dunsky, 2000. *L'efficacité énergétique: manuel pour la régulation des marchés monopolistiques et concurrentiels* (Montreal: Helios Centre). Prepared for the Québec Energy Efficiency Agency, p. 33.

[99] Furthermore, a number of bills before both chambers of the US Congress call for adoption of a national public benefits charge for funding energy efficiency (and, in some cases, other public goods).

Labeling

There are many options for consumers interested in buying energy efficient or *green* products to make informed decisions in the North American marketplace. Of the approximately 75 green labeling and certification schemes in the market, energy efficiency comprises the single most important category.

Enormous choices are available now at the demand-retail side to reduce total energy demand in ways that maintain economic prosperity. For example, compact fluorescent lamps are on the market that use some 75 percent less energy than standard lamps and last 10 times longer, yielding substantial savings at the household level.

In Canada, the main environmental labeling program in place is the Environmental Choice program. Created in 1998, Environmental Choice—which is a federally-owned trademark managed by an arms-length company TerraChoice Inc.—has awarded the Ecologo to approximately 20,000 products and services—assembled in roughly 100 categories. Although precise market estimates change, total sales of products and services labeled under the Canadian program were in the vicinity of C$3.5 billion in 2000.

Examples of product categories for energy efficiency include household appliances, which account for 20 percent of total residential electricity consumption and more than 4 percent of total national Canadian energy consumption. The Environmental Choice Program, like many labeling schemes, uses life-cycle analysis to some degree: that is, it examines the environmental characteristics of the product during its manufacturing, as well as its end-use energy profile. (Typically, total energy required to manufacture a household appliance accounts for two months of the products end-energy use.) Examples of products covered under the Environmental Choice Program include dishwashers, office products such as fax machines, photocopiers, printers and rechargeable batteries.

In Mexico, there have been recent efforts to increase environmental labeling schemes. An important area of recent labeling efforts is the launching of the Sello FIDE label for energy-efficient and energy saving products. The program, entitled "Trusteeship for Saving Electrical Energy" (*Fideicomiso para el Ahorro de Energía Eléctrica*—FIDE). Among the product areas under the FIDE program of the greatest relevance to electricity use are air compressors; lamps and light bulbs; various electrical appliances, such as air conditioners, refrigerators and washing machines; and various energy saving equipment such as sensors, photo cells and timers. There are also house insulation programs and financing for energy conservation in hot weather areas.

In the United States, two major product and service energy labeling programs exist. The first, Energy Guide labels, is a mandatory labeling program that provides information on the energy efficiency of products. These include all refrigerators, freezers, clothes washers and dishwashers. These mandatory labels provide an estimated average of annual energy operating costs.

The US federal government promotes higher levels of energy efficiency, beyond minimum performance standards, through the Energy Star program. The Energy Star labeling program extends to approximately 40 product categories and over 500 environmental management companies. Once a company or manufacturer meets the criteria, companies are entitled to use the Energy Star seal of approval on products, in their product promotion and advertising campaigns, etc. The main categories of products covered are: office equipment, including fax machines, printers, copiers, computers and monitors; residential light fixtures; exit signs; transformers;

residential heating and cooling equipment; insulation; and major household appliances such as consumer electronics, televisions and VCRs.

The labeling program is part of the broader scheme which includes the Energy Star New Homes program, Energy Star Buildings program, and the Energy Star Small Business program. Products and services eligible for Energy Star labels are assessed based on their energy efficiency. Among the key objectives of the labeling scheme is to promote energy-efficient products as a means to lower pollution from fossil-fuel energy use. The program estimates that in 2000, over 864,000 pounds of CO_2 emissions were avoided because of Energy Star products, and that cumulative cost savings from the program will exceed US$60 billion in saved energy bills, to 2010.

The US National Energy Policy calls for the expansion of the Energy Star program beyond office buildings to include schools, retail buildings, health care facilities and homes. Recommendations also include the extension to product labeling to include more appliances.

In an important move at the international level, in July 2001 the EPA announced a joint program with Government of Canada (through Natural Resources Canada) making Energy Star labels available to Canadian consumers.

Energy Efficiency: Supply-side Opportunities

Considerable progress has already been made in increasing the energy efficiency and overall performance standards of electricity generating technologies. It is difficult to obtain unambiguous, standardized results of current levels of operating efficiency by generating plant, measured by way of total air pollution emission avoided. For example, the US DOE notes that for gasification combined cycle coal and natural gas units, efficiency gains appear to be in the range of 10 percent compared to conventional coal combustion technologies,[100] and that advanced turbine systems will result in an increase to 60 percent efficiency within the next few years.[101] Under the Vision 21 program, plans are also underway to expand the operation of hybrid power plants, with a long-term goal of zero emissions. Under the "clean coal" program work, advanced coal technologies, for example, supercritical steam technology or integrated combined-cycle gasification technologies, are expected to become cost competitive in the next 10 to 20 years. Likewise, technologies such as selective catalytic reduction, which is designed to reduce NO_x emissions from coal-fired power plants, are expected to be used by roughly one-third of all coal-fired plants in the next few years.

A recent publication from DOE reports on technological improvements which, it is believed, will be able to improve generating efficiency for fossil fuel power plants by between 30 and 70 percent, reduce generating costs for renewable sources to the point where wind is cost competitive and where solar photovoltaic generating costs can be reduced by 75 percent within the next 20 years.[102]

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[100] Efficiencies of 45–50% as compared to current levels of around 35%. See <http://www.fe.doe.gov/coal_power/gasification/index.shtml>.
[101] See < http://www.fe.doe.gov/coal_power/turbines/index.shtml>.
[102] DOE IWG 2000.

Renewable Energy

A large gap exists between actual and potential market shares for renewables. However, there is evidence that this gap is closing somewhat. In the European Union, plans were recently approved by the Council of Ministers to double its reliance on renewable energy, from 6 to 12 percent, in the next nine years. In Germany, wind power has a generating capacity of 6,000 MW—the world's largest—while in Denmark and Spain, roughly 2,000 MW of capacity is powered by the wind.

In the US, wind power has a generating capacity of approximately 2,555 MW, although this is expected to almost double by 2002. By contrast, in Canada, total wind generating capacity is 140 MW: the bulk of that generating capacity, roughly 100 MW, comes from one generating station in Gaspe, while the remainder comes mainly from Alberta. Total wind generation in Mexico is currently limited to small pilot projects. However, recently the state of Oaxaca announced that its current capacity of approximately 2.1 MW of installed capacity of wind power will increase to 200 MW by 2010.

Market incentives, direct procurement by government agencies, the adoption of Renewable Portfolio Standards and other market interventions continue to be an important part of the debate around renewables.

At present, 22 states have considered, and of those, 11 have enacted, legislation which establish RPSs. Generally speaking, an RPS requires that a certain percentage of the electricity sold by generators and/or suppliers in a given jurisdiction be produced from eligible electricity sources. The enabling legislation thus must define two important dimensions—the percentage requirements, and eligible sources of "renewable" electricity.

Percentage requirements range between 0.2 percent of sales (Arizona) to 30 percent of sales (Maine), and in many cases increase over time. In some cases, there are two or more classes, with different eligibility definitions and different percentage schedules. These classes can distinguish either between "existing" and "new" resources, or between degrees of environmental preferability. Eligibility definitions are generally based on the type of generation, along with other criteria such as facility size.

In the 11 jurisdictions there are 12 forms of electrical generation that are commonly considered to be renewable. Solar, wind, tidal and biomass are among the most common to be so considered. For example, while most jurisdictions include hydro electricity to be a renewable form of electricity production, others (e.g., Arkansas) do not. With respect to generation size restrictions, some jurisdictions impose no constraints on size, e.g., Kansas, considers all hydroelectric generation to be renewable, whereas Arizona only considers hydroelectric installations of less than 5 MW to produce renewable electricity. Other criteria also set the requirements related to where the fuel is sourced (Arizona requires biomass to be from Arizona) or the type of technology used to generate electricity. For example Massachusetts only considers hydro generating stations to be renewable if they do not have reservoirs.[103]

Various tax credits and other schemes have been in place, or are being proposed, in support of renewable energy. For example, a US tax incentive of roughly 1.7 cents per kWh has had a positive effect on producers. Proposed changes to the Canadian tax code by the CARE alliance

[103] For more information see the CEC's RPS database, <www.cec.org/databases>.

includes, for example, a 2–3 cent per kWh Green Energy Credit for consumers, to help defray the cost premiums of renewables, and a 2-cent-per kWh investment credit for capital technologies.[104]

The willingness of consumers to pay a price premium directly for renewables has been the subject of numerous market surveys in the US and Canada. (A description and discussion of market surveys is contained in a background discussion prepared by the CEC in January 2001, and be found on line at <www.cec.org>.) In October 2001, the CEC and CONAE jointly supported the release of a Gallup Mexico survey measuring the extent of interest in, and willingness of industrial consumers in Mexico, to purchase renewable electricity. The survey, the first of its kind undertaken in Mexico, questioned the 100 top companies in that country measured by total electricity use. The survey results suggest a strong interest in Mexico's industrial sector in purchasing green power. The expressed preferred source of power is solar. Roughly one half of respondents to the CEC-Conae survey said they would be willing to pay a 10 percent price premium for renewable electricity, even though only 35 percent believed that additional costs could be passed along to customers.[105]

At the same October 2001 meeting, the Ministry of Energy of Mexico announced plans to increase the role of renewable energy in that country, with measures focusing on rural electrification. Emphasis would include the introduction of incentives, special rules on access to the government owned grid for green sources that generate power intermittently, and the development of a green certification scheme for green power.[106]

Clearly, there is an inverse relationship between consumer willingness to pay a higher price premium, and the need for tax credits or other support schemes from governments. In Canada, anecdotal evidence shows that some clients are willing to pay a 10 percent price premium for renewable electricity: for example, the Canada Hydro Developers—a generating company with small hydro, wind and gas plants in western Canada, most of which are Ecologo-certified—charges clients a 10 percent markup for its power.

Green Choices in Open Markets

In addition to mandatory RPS schemes, three market-based, demand-driven avenues exist to enable or assist customers in purchasing environmentally preferable electricity. The first involves third-party, green power certification schemes like “Green E” and Ecologo.[107] The second approach involves providing information on the comparative environmental impacts of different energy sources. The Power Scorecard, a rating mechanism designed by six large environmental organizations, including the Pace University Energy Project, the Union of Concerned Scientists and the Natural Resources Defense Council, compares the environmental “footprint” of each electricity product offered for sale in those states where consumers can choose their electricity provider.[108] California-based Scientific Certification Systems has also developed a proprietary system for evaluating and comparing energy portfolios.[109]

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[104] CARE Coalition (2000) *Working together to Advance Renewable Energy.*
[105] For more information on the survey, see the CEC press release <http://www.cec.org/news/details/index.cfm?varlan=english&ID=2423>, or the media backgrounder <http://www.cec.org/pubs_docs/documents/index.cfm?varlan=english&ID=373>.
[106] See <http://www.cec.org>.
[107] There are a limited number of examples of single-party, self declaration schemes—including, for instance, Hydro Quebec’s label showing its level of air pollution emissions from large-scale hydropower plants.
[108] See <http://www.powerscorecard.org>.
[109] See <http://www.scs1.com/index.shtml>.

The third, and by a long measure, most successful market based system consists of utility green pricing programs. In the US, 85 utilities in 29 states have in place or are planning to introduce green pricing programs for customers. Recent analysis by the US National Renewable Energy Laboratory estimates that these programs account for 110 MW of installed capacity for *new* renewables, and firm development plans for another 172 MW of additional power.[110] Although no uniform definition of renewable power exists among the utilities, the fuel of choice is wind. The NREL notes that wind dominates utility green pricing programs, in part because of its economic efficiency in areas that have access to favorable wind conditions, and partly because of a favorable view of wind energy among the public.

Price premiums vary among the programs offered by different utilities. These range from as low as 0.17 cents per kWh to as high as 17 cents. The former is for power from wind, landfill methane and solar power, while the latter is from power exclusively derived from solar. Table 10 below presents the leading ten utilities supporting renewable generating sources through green pricing programs:

Table 10 - Leading 10 Utilities Supporting New Renewable Generating Sources

Rank	Utility	Resources Used	Capacity
1	Los Angeles Department of Water and Power	Wind and various	25.0 MW
2	Austin Energy	Wind-PV	23.2 MW
3	Public Service of Colorado	Wind	15.7 MW
4	Sacramento Municipal Utility District	Landfill methane-PV	10.2 MW
5	Madison Gas and Electric	Wind	8.2 MW
6	Wisconsin Electric	Wind-hydro-landfill methane	7.2 MW
7	Eugene Water and Electric Board	Wind	6.5 MW
8	Wisconsin Public Power Inc.	Hydro	6.0 MW
9	Platte River Power Authority	Wind	5.3 MW
10	Alliant Energy	Wind-landfill methane	4.6 MW

Another kind of demonstration of consumer choice in supporting green power involve procurement purchasing decisions of many large companies, as well as municipalities, state and federal authorities and federal governments to purchase green power. For example, the state of New York announced earlier in 2001 that 20 percent of its power purchases would be from renewable sources by 2010. Similarly, the federal government of Canada has announced that 20 percent of its power purchases will come from renewables by 2006. In a related initiated supported by the World Resources Institute and the Business for Social Responsibility Educational Fund, the Green Power Market Development Group—composed of General Motors,

[110] Blair Swezey and Lori Bird (August 2001) "Utility green pricing programs: What defines success?" National Renewable Energy Laboratory, NREL TP.620.29831

IBM and other large corporations—have plans to purchase 1,000 MW of new renewable power by 2010.[111]

Defining Renewable Power

The emerging North American energy market offers an opportunity (and a challenge) to begin work at the trinational level on a common definition of "renewable energy." The Canadian Electricity Association notes that its members "believe it to be critical for the Canadian government to develop a clear and consistent stance with respect to the definitional question of renewable 'green power'."

The lack of a common definition for renewables is of particular concern to large-scale hydropower producers, because they are excluded from this designation in certain jurisdictions.[112] As noted above, some RPSs exclude hydro altogether, and others exclude hydro facilities larger than a certain limit, presumably on the grounds that the creation of large reservoirs behind high dams causes damage to the natural environment.

In fact, the International Energy Agency has recently noted that any large-scale energy project is likely to be at odds with the goal of sustainable development.[113] Nevertheless, legitimate debate continues around questions of scale, the comparative environmental impacts of various fuel sources and technologies, and just what properly constitutes "renewability." Non-uniform definitions of "renewable energy" thus remain a source of controversy between rival energy producers, as well as a potential source of conflict in regard to trade rules.[114]

Avoiding trade disputes is, of course, an important goal, but an additional reason for seeking more definitional clarity in respect to renewable electricity is that this could be a key to maximizing environmental benefits. Experience with "green pricing" programs offered by utilities, for instance, has shown that the renewable message is more effective when it stays simple. Multiple definitions can lead to distrust among customers about competing claims, and more generally to labeling or certification "fatigue."

Definitional clarity is not an end in itself, or simply an effort to make things neat. The goal of efforts towards harmonization in this area is to achieve the highest levels of common, clear, and predictable environmental standards for the North American market.

SECTION SEVEN: ENVIRONMENTAL IMPACT ASSESSMENTS AND INTEGRATED RESOURCE PLANNING

An unprecedented degree of regional cooperation will be required to maximize the potential environmental benefits of cross-border electricity trade, while avoiding or at least mitigating negative impacts to human and ecosystem health. This is particularly true in regions likely to attract clusters of new electricity generation, where environmental considerations may have to address entire airsheds, watersheds, and wildlife corridors (or complex ecosystems). Various

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111 See <www.thegreenpowergroup.org>.
112 These issues have been raised by Hydro-Québec in a paper submitted to the CEC, and by the Government of Canada in letters to several American legislators. Hydro-Québec, *Environment and Electricity Restructuring in North America,* Paper presented to the North American Commission for Environmental Cooperation, June 2000: <www.cec.org>.
113 IEA, "Towards a sustainable energy future," 2001: <www.iea.org/public/studies/futurehigh.pdf>.
114 Trade issues raised by RPS are addressed in Section 8, below.

bilateral mechanisms[115] have already been useful in addressing regional and cross-border planning and assessment issues that have arisen from the siting of facilities and the necessary accompanying improvements to infrastructure, and these will continue to be of value. Yet major gaps remain. As described below, fundamental concerns persist about access to information and about effective participation in decision-making processes involving projects with the potential, either individually or cumulatively, to cause long-range and/or cross border impacts.

As noted earlier, public processes to address these planning issues at the utility or state (or provincial) level through integrated resource planning (IRP) were in many places abandoned as part of the shift to competitive electricity markets. However, the extreme volatility that has been seen in electricity markets over the last two years has led some to seek to reinvigorate state and utility planning processes. The tools developed for IRP remain relevant, though much work remains to be done to apply them in the context of restructured markets.

Long-range and cross-boundary impacts and their assessment

Environmental impacts associated with most conventional forms of electricity generation often reach beyond the immediate vicinity in which they operate. The medium- and long-range transport properties of ozone precursors (SO_2, NO_x), acid rain, particulates, and mercury (to name a few) are well documented. Other emissions—such as CO_2 and ozone depleting gases—are of global concern, regardless of where they are emitted. Pollutants or habitat alterations may even impact biodiversity, affecting species far from an activity site. This is especially true for migratory species that depend on corridors and specialized ecosystems in multiple regions.

The local environmental impacts of major projects, including those associated with the generation and transmission of electricity, are usually assessed pursuant to state, provincial or federal law. Often this is accomplished through environmental impact assessment ("EIA")—which includes considering the scope of the project in question, estimating likely environmental impacts, and evaluating mitigation measures where appropriate.[116] Electricity generation projects not subject to a formal EIA procedure usually undergo some scrutiny in state, provincial, or local permitting processes; but these may take a less disciplined approach to assessing long-range and cumulative impacts and may not examine impacts across all media. Opportunities for the public to be informed about, and to participate in, such decisions vary widely across jurisdictions.[117] In practice, local siting determinations that are not subject to EIA tend to leave communities beyond the immediate locality unaware of the impacts such facilities might have on them.

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[115] Some of the binational organizations or agreements involved, in one way or another, with cross-border planning include: the International Joint Commission, International Boundary and Water Commission, Border Environment Cooperation Commission, North American Development Bank, Agreement on Cooperation for the Protection and Improvement of the Environment in the Border Area (the La Paz Agreement). Numerous additional federal, local, state and provincial cross-border arrangements provide important opportunities for regional planning and assessment. See generally < http://www.cec.org /pubs_info_resources/law_treat_agree/transbound_agree/abouttrans.cfm?varlan=english>.

[116] For a comparative survey of the environmental impact assessment legal frameworks in North America, see *North American Environmental Law and Policy: Environmental Impact Assessment Law and Practice in North America* CEC Winter 1999.

[117] Ibid. The report includes a description of how each country determines which projects or proposals are subject to federal EIA and includes examples of provincial and state EIA processes.

Cumulative Effects

Most formal EIA procedures require that cumulative environmental effects from the project be considered, including those resulting from the combination of effects from other projects or activities that have been, or will be, carried out.[118] In the North American context, cumulative impact assessment is especially important in light of the large number of electricity generation proposed for the near future, with likely concentration in specific regions. However, a cursory examination of a number of electricity generation projects where environmental reviews were not performed under federal EIA procedures showed that consideration of cumulative impacts in those cases was uneven and patchy.

In recent years, advances in fate and transport modeling, remote sensing, and other monitoring techniques have increased our appreciation of long-range source/receptor relationships. For example, it is now feasible to track any number of emissions from area sources and to estimate their deposition rate and impact on distant communities. Yet these tools are not yet employed systematically throughout North America in assessment processes, often because affected parties may not even be aware of proposed projects or because reliable emissions databases (upon which such analysis depends) are unavailable. Projects that are not subject to EIA are especially unlikely to employ such tools to consider the potential effects on a regional or transboundary scale.

The study of cumulative effects with respect to hydro projects raises yet another series of questions, even more complex. How are the impacts of a hydropower facility affected by the existence of other such projects, in the same or neighboring watersheds? Or by other resource development, such as forestry or mining? These questions have been raised in recent years in the environmental assessment of hydro megaprojects,[119] but have yet to find satisfactory solutions, even on the methodological plane.

Transboundary Environmental Impact Assessment (TEIA)

Transboundary Environmental Impact Assessment is well recognized by now, and it continues to gain acceptance worldwide.[120] TEIA implies a cooperative mechanism to extend environmental impact assessment across borders. It allows members of the public and government in areas that could be affected adversely to participate in the environmental impact assessment, according to procedures established in the country where the project originates.[121]

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[118] See e.g., Canadian Environmental Assessment Act, section 16(1)(a).
[119] See e.g., Great Whale Public Review Support Office, *Guidelines* (1992).
[120] See e.g., Espoo Convention on Environmental Impact Assessment in a Transboundary Context of 1991; European Directive on Environmental Assessment of 1985; and the Antarctic Treaty Protocol on Environmental Protection of 1991. For more information on transboundary environmental impact assessment in international law, *see* P. Sands, *Principles of International Environmental Law I,* Chapt. 15 (Manchester Univ. Press, 1995); D. Hunter et al. *International Environmental Law Concepts and Principles* (UNEP Trade and Environment Series, No.2)(1994); N. Robinson, "*International Trends in Environmental Impact Assessment*", 19 BC Envtl. Aff. Law Rev. 591 (1992).
[121] See *North American Law and Policy,* Vol. 4 (spring 2000) (CEC).
Article 10:7 of the North American Agreement on Environmental Cooperation provides: Recognizing the significant bilateral nature of many transboundary environmental issues, the Council shall, with a view to agreement between the Parties pursuant to this Article within three years on obligations, consider and develop recommendations with respect to:

- assessing the environmental impact of proposed projects subject to decisions by a competent government authority and likely to cause significant adverse transboundary effects, including a full evaluation of comments provided by other Parties and persons of other Parties;

While no formal continent-wide agreement has been reached in North America, certain bilateral institutions have participated in TEIA-type assessment; and a growing number of states and provinces are adopting TEIA procedures. For example, the environmental impacts of BECC/NADBank projects are subject to assessment, as are specific activities within the purview of the International Joint Commission. The province of British Columbia and the neighboring state of Washington appear to be the first state and province to conclude a formal TEIA arrangement.[122] In an important step towards TEIA, the ten Mexican-US border states have declared their intention to notify each other of projects with the potential to affect neighboring jurisdictions adversely,[123] and the state of California recently invited neighboring Baja California residents to participate in its environmental impact assessment for a new generation facility in the border region.[124] Another example of transborder cooperation is the Border Energy Forum, established in 1994, which has worked with a wide variety of partner agencies in the US and Mexico whose goal is to improve the exchange of information regarding energy and its relationship to the environment throughout the border region.[125]

At the federal level, officials continue to discuss a means of expanding TEIA in North America.

Access to Information

Information plays a crucial role in integrated resource planning, assessment (including the consideration of cumulative impacts and trans-border effects), and public participation in either. Paradoxically, while the electricity sector often appears awash in information on almost every aspect of generation, transmission, and consumption, the lack of timely, comprehensive, affordable and accessible data on many of the variables that impact the environment hampers significantly our ability to plan, forecast and mitigate regional and long-range effects.

Information on certain regulated emissions is reported by operating generators or is estimated by authorities, but only a handful of jurisdictions employ or maintain a database or clearinghouse of proposed projects that could enable authorities and the public to evaluate cumulative, regional or transboundary issues efficiently.[126] Even where considerable data exist, their usefulness is often diminished because information is dispersed among multiple agencies and departments, is displayed in formats that are hard to access, and/or is available only at excessive cost.

- notification, provision of relevant information and consultation between Parties with respect to such projects; and
- mitigation of the potential adverse effects of such projects.

[122] Joint Statement of Cooperation on the Georgia Basin and Puget Sound Ecosystem.
[123] <http://www.westgov.org/wga/publicat/annrep99.htm>.
[124] Personal communication with EPA employee.
[125] See <www.glo.state.tx.us/energy/border> for more information.
[126] In the US, projects subject to NEPA are posted at <http://es.epa.gov/oeca/ofa>. A clearinghouse approach has been successfully adopted in some jurisdictions such as California, which maintains an on-line inventory of all proposed sites at <http://www.energy.ca.gov/sitingcases/>. Canada lists projects subject to the authority of the National Energy Board <http://www.ceaa-acee.gc.ca/0008/index_e.htm> as well as those projects undertaken under federal assessment procedures <http://www.ceaa-acee.gc.ca/0008/index_e.htm>; Mexico lists projects evaluated under federal assessment law at <http://www.ine.gob.mx/dgoeia/impacto/index.html>.

SECTION EIGHT: INTERNATIONAL TRADE AND TRADE POLICY ISSUES:

When examining data on "North American" trade in electricity, there are actually two discrete bilateral trade patterns in play: Canada-US trade, and US-Mexico trade. Trade in electricity between Canada and Mexico is very limited, due in part to physical barriers of transmission lines in moving electric power efficiently over very long distances. When thinking about emerging patterns of electricity trade, the analogy suggested by the US Trade Representative's office during the NAFTA negotiations of a "hub-and-spoke" trade pattern, with the US at the center, appears most appropriate in the case of electric power.[127]

Trade in electricity in North America will very likely amplify import and export patterns established during the past two decades. Forecasting changes in trade patterns, trade volumes and trade diversion as new generators access the grid is more complex than forecasting changes in domestic supply and demand. A recent, and extremely useful report by the Energy Modeling Forum of Stanford University (EMF), summarizes the findings of five models: NEMS, POEMS, RFF (Haiku), IPM, and Energy 2020. In the compilation of the EMF baseline scenario, all the models examined changes in interregional transmission to 2010. [128]

Using the 13 NERC regions, the NEMS model projects 259 billion kWh of imports into NERC regions from another region. POEMS projects 209 billion kWh, RFF projects 238 billion kWh. As a total of US generation, the estimates of trade between NERC regions range from 4.1 percent to 6.2 percent. However, the models also project important differences between regions: for example, RFF calls for more imports into the midwestern states (ECAR and eastern MAAC regions), and fewer imports into Illinois and Wisconsin (MAIN) and into California and Nevada.[129]

The models also suggest that imports from Canada and Mexico will range from 29 to 44 billion kWh in 2010. EMF suggests that close estimates between Canadian and US models reflect that both models project electricity trade between the countries, based on current permits. Examples of recent permits, or applications for permits, are provided below for illustrative purposes.

The import estimates by the Energy Information Administration of the United States Department of Energy are considerably higher. The table below shows projected US imports and exports with Canada and Mexico.

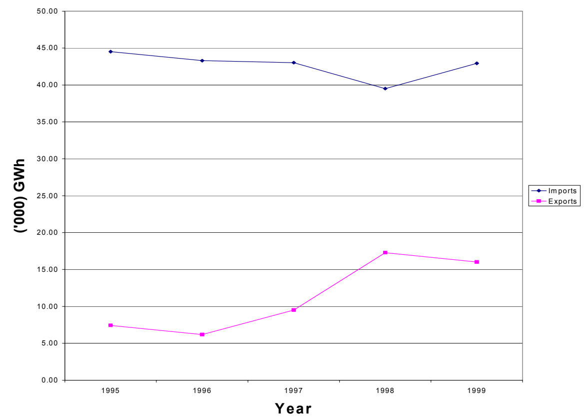
Table 11 – United States Projected Gross Trade in Electricity (Thousand GWh)

	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Imports from Canada and Mexico	38.9	47.9	48	45.5	57.6	60.3	66.1	57.9	54
Gross Exports	13.5	13.0	13.1	13.1	12.7	16.6	16.7	16.8	16.9

Source: Annual Energy Outlook, 2002. EIA

[127] Government of the US (1994), *Environmental Review of NAFTA,* Washington, DC.
[128] EMF (2001), "Prices and emissions in a restructured electricity market," *EMF Report* 17.
[129] Please refer to NERC map in Section Three.

Figure 5 – United States Electricity Trade with Canada
(Source: IEA 2001)



Canada-US Electricity Trade

The large majority of North American electricity trade is between Canada and the United States. Imports and exports occurred between the two countries, on relatively low levels, prior to the mid-1970s. However, with the OPEC oil price shocks, the US market looked to Canada for less expensive imports of hydropower. Since then, while trade volumes have undergone variations based on several factors—weather conditions, average rainfalls, changes in relative price of input fuels and emergency supply requirements—on average total trade between Canada and the US has increased steadily, and in both directions, between the two countries.

In 1980, the US exported roughly 3,560 GWh of electric power, the bulk to Canada. In 1999, that figure increased more than fourfold to approximately 16,020 GWh. Canada's exports in 1980 started from a higher base but, during the same period, they increased from approximately 30,000 GWh to almost 43,000 GWh.[130] Total Canadian electricity exports to the United States in 2000 were 50,000 GWh, an increase of 11 percent from 1999.[131] Electricity exports from the US to Canada declined but remain significant at 10,000 GWh. (Please refer to Figure 5 above.)

The electricity sectors of the US and Canada have been described as an exceptionally good fit, because of seasonal differences and asymmetric demand patterns: peak demand in Canada is highest during its winter months, while in the US peak demand is highest during summer. Based on price differences, market proximity and seasonal differences, trade has been climbing over the past 20 years.

Annual changes in Canada-US electricity trade underline the extent of growing market integration between the two countries. During the price volatility during the 1999–2000 period in the US, Canadian export revenues from electricity sales jumped 111 percent, or C$2.1 billion. Among the factors that had US buyers scrambling to purchase Canadian power were high natural gas prices compared to the lower cost of Canadian substitute power, low rainfall levels in the Pacific Northwest, and the supply crisis in California. In addition to a net export increase during this period, electricity spot prices for sale in the Pacific Northwest and California during this period fluctuated by more than 1000 percent.[132]

Mexico-US Electricity Trade

Trade in electricity between Mexico and the US, as noted, is considerably smaller than Canada-US trade. In the past decade, the electric energy balance of trade (exports – imports) of Mexico has declined steadily, from an export surplus of 1,300 GWh in 1989 to an export deficit of 0.36 thousand GWh in 1999. (Please see Figure 6.) More Mexican electricity exports went to Belize

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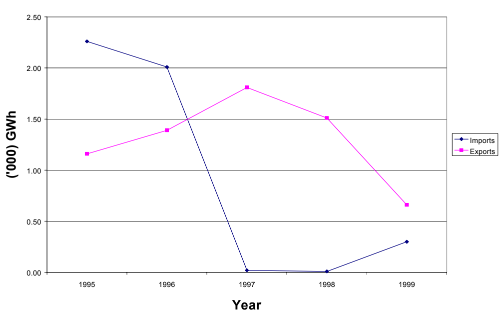
[130] International Energy Agency. 2001. *Electricity Information, 2001*, Paris.
[131] International Energy Agency, May 2001, Monthly Electricity Survey, Paris.
[132] National Energy Board (2000), *Annual Report*. Spot prices are the prices charged on the spot market; they may be representative of prices during an interval as short as a few hours.

than northwards, to the US. In 2000, approximately 110 GWh of Mexican electricity were exported to Belize. By contrast, total exports from Baja California to the US were roughly 30 GWh in 2000.[133]

There are many reasons why the trade volumes are so different between Canada and Mexico. An important one is transmission connections. Roughly 100 power grid connections link Canada and the US, of which approximately one-third have the capacity to handle bulk electricity exports. Those connections will expand in the coming years, particularly plans to improve transmission connections between Alberta and the US market (all exports from Alberta are wheeled through BC Hydro, and exported from the BC-Washington State grid link).

Figure 4 - United States Electricity Trade with Mexico - Source IEA 2001



By contrast, transmission infrastructure and grid links between Mexico and the US remain very limited. Two main power exchange systems exist between the two countries: the first, comprising two 230 kV grid connections (from Mexicali to the Imperial Valley and from Tijuana 1), links Baja-California and California. In January 2001, Mexico commenced exporting 50 megawatts (MW) of electricity through this grid. The other main grid connection involves two 115 kV connections, in Diablo and Azcarate. Smaller grid capacity connections—approximately seven—exist between Mexico and the US.[134] Transmission capacity is also slated to expand between the US and Mexico in this decade. (Transmission issues and transmission policies are extremely important to the future of trade patterns in North America, and are discussed below.)

Export Authorizations from Canada's National Energy Board

In Canada, the Federal Minister of Natural Resources recently underlined the importance of expanding and improving the North American energy market, a market in which Canada should "expect important new electricity marketing opportunities in the US."[135] During the same speech, the minister was reported as saying that there "are tremendous opportunities there as the United States goes through what it self-describes as an energy crisis."

Recent applications to the National Energy Board (NEB), seeking authorization to export electricity or expand or construct new power lines connecting the US and Canadian grids, provides a glimpse into where markets are heading with respect to market integration:

- An application by Aquila Canada Capital and Trade of 7 June 2001, to seek authorization to export up to 10,000 GWh of interruptible energy annually, and 1,142 MW/10 000 GWh of short-term firm capacity, annually for 10 years;

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[133] It should be noted, however that these numbers should be seen in light of the fact that total Mexican consumption is around 5 percent of that of the United States. As such, this number is not as small as it may first seem.

[134] These interconnections are normally open and are used only for emergency assistance and short term capacity and energy sales.

[135] Speech to the Toronto Board of Trade, 6 September 2001.

- An application by Energy Encore Solutions of 4 June 2001, seeking authorization to export up to 10,541 GWh of interruptible energy annually and 750 MW/6,588 GWh of short-term energy;
- An application by Morgan Stanley Capital Group, dated 1 May 2001, seeking a 20-year authorization to export up to 2,336 000 MW/1,557 GWh of firm power and energy annually, and up to 779 GWh of interruptible energy annually;
- An application by Nexen Marketing, dated 24 May, 2001, seeking authorization to export up to 5,000 GWh of interruptible energy annually and 1,000 MW/5,000 GWh of short-term firm capacity and energy annually;
- An application by Sumas Energy, dated 7 July 1999, to construct and operate a 230 kV international power line from the Clayburn Substation in Abbotsford, British Columbia to Sumas, Washington;
- An application by the Manitoba Hydro Power Board, to construct a 230 kV international power line (IPL) from Manitoba Hydro's Glenboro Station located in southwestern Manitoba to the international boundary near Killarney, Manitoba.

In October, Hydro Quebec announced plans to build a natural gas plant south of Montreal, with a generation capacity of approximately 800 MW.

Export Authorizations from CRE

In the past year, a number of important export authorizations have been granted by the *Comisión Reguladora de Energía* (CRE). These appear to comprise exports to, and imports, from the US. For example,

- In March 2000, the CRE granted its first permit to export electricity to *Energía de Mexicali,* a subsidiary of the American Electric Power Co. The company will build and operate a power station in the municipality of Mexicali, Baja California, with a 257.60 MW net generating capacity. Exports from the natural gas power plant will be exported and marketed in Southern California by Integral Energy Sources, Inc. The CRE notes that this project marks a "*further step toward the integration of a North American energy market*."[136]
- In the same vicinity of Baja California—adjacent to southern California—in August 2001, the CRE approved the application by Termoeléctrica de Mexicali to export to the US, through US-based Sempra Energy Resources, 5,835 GWh of electricity. The plant, to be located in the municipality of Mexicali, will have a total estimated generating capacity of 679.7 MW. The CRE approval notes that the plant, to be powered by natural gas, will require US$279 million in private capital investment, and will begin operations in May 2003.
- In May 2001, the CRE granted permission to DeAcero S.A., in association with Enron Power Marketing, to import an estimated 932 GWh to its location in Saltillo. A 16 km, double circuit, 230 KV power line will be used to connect the US system to the Mexican grid. The CFE will provide wheeling from the border to Saltillo;
- In December 2000, the CRE issued the first authorization to an Independent Power Producer—Energía Azteca X, a subsidiary of InterGen, to operate and export electricity from two power stations. The stations, Rosarito 10 and 11, will have a combined maximum gross capacity of 895.9 MW. In its approval of the CFE bidding process to build and operate this station, US-owned Energía Azteca X also gained approval to export.

[136] InfoCRE, Marzo-Abril 2000, Ano 3, No. 2, 4/4

In addition to export permits, approvals of foreign direct investments in Mexico's electricity sector have increased in the past two years. These involve not only US companies seeking direct access to Mexico, but investors from France (Électricité de France International), Belgium (Tractebel), Spain (Iberdrola and Unión Fenosa), Japan (Mitsubishi) and Canada (Transalta). For example, in April 2000, Transalta—Alberta's largest electricity generator—won approval from the CRE to build a 275 MW gas-fired combined cycle plant in the state of Campeche. Under this project, the CRE granted a total of eight Independent Power Producer permits, representing a combined generating capacity of 3,528 MW of new capacity, and an investment of US$1.8 billion.[137]

Recent business reports also indicate interest by US-based EnviroPower in building two coal-fired plants in the cities of Manzanillo and Lazaro Cardenas. Under the reported terms of the contract, a proportion of total electricity generated in the Mexicali plant will be for domestic use, and the remainder destined for California.[138]

Factors Affecting the Evolution of Trade

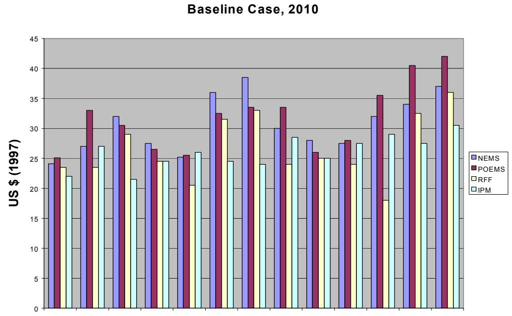
The above information, which provides individual examples but hardly a comprehensive overview of likely changes in trade, is complemented by the findings of models and other work, which suggests that trade will increase in North America . Although there are many variables that condition this expectation, two are particularly noteworthy: (a) differences in prices between regions; and (b) the evolution of a seamless transmission grid linking regions.

(a) Price Differences Between Fuel Sources

First, most models suggest that, on the aggregate level, price changes affected by restructuring will be modest. However, price differences are expected to be much higher between regions. The Energy Modeling Forum paper cited earlier finds that, in the Baseline Scenario for restructuring, average wholesale generation electricity prices in the near term will be between US$24–34 per MWh (1997 dollars). Prices then fall marginally over time, to $25–$30. In both the Baseline and Alternative Competition scenarios, there appears to be important divergence in price effects between NERC regions as restructuring proceeds.

Differences in relative prices between regions, and trade, cannot be explained by restructuring alone. For example, since 1993, electricity imports to New England have increased steadily, so that imports now comprise over 11 percent of total electricity in that region. However, some modeling estimates suggest that the ratio of imports to local production may become even higher. For example, under the Alternative Competition case, the EMF study suggests that the largest price increase relative to the baseline assumption is a 27 percent price increase in the midwestern MAIN region (in the NEMS model). The largest reduction, of 22 percent, takes place in the New York region (in

Figure 5 - Regional Competitive Wholesale Electricity Price in Baseline Case, 2010



[137] Ibid.

[138] "Energy firms get a foothold in Mexico"; "Power: With demand for electricity soaring, the Mexican government is becoming receptive to foreign proposals." *The Los Angeles Times*; Los Angeles, Calif.; 19 August 2001.

the RFF model). Some estimates suggest that the highest imports are likely to be in the ECAR and eastern MAAC regions, and less trade intensity in the MAIN and CNV regions. Figure 7[139] summarizes the regional differences in costs of electricity, from the EMF summary work, in 2010.[140]

While space does not allow them to be summarized, there are important differences among the findings of the modeling results presented by EMF:

> In general, the lowest prices are experienced in regions which have existing low cost coal and nuclear generation sources. Regions more reliant on oil- and gas-fired generation and those with higher delivered fuel costs have higher prices.[141]

Some predicted that coal consumption by utilities would increase by as much as 30 percent directly because of price-based competition related to restructuring.

(b) Transmission Expansion and Policy Integration

As noted, numerous constraints exist within and between the transmission networks of Canada, Mexico and the US. The system was not conceived or built to provide a superhighway for interregional trade, but to allow individual utilities to serve their local customers. As a result, there are considerable constraints, both physical and behavioral, which continue to act as bottlenecks within the system. At the same time, interregional transmission has expanded rapidly in recent years. This indicates the growing importance of trade between NERC regions, as well as some infrastructure improvements in grid linkages. For example, in 1995, approximately 25,000 interregional transmission transactions occurred in North America. By 1999, that single year figure increased to over 2 million.[142]

Energy planners do not think on the large scale only with respect to planning increases in supply, they also think very big when considering transmission capacity needs. For example, the US National Energy Policy estimates that 255,000 miles of new transmission infrastructure will be required by 2020, to meet increased demand.

Estimates by NERC show a small increase in planned infrastructure between 1999 and 2009 in the US, from 137,300 GW-miles to 143,500 GW-miles. However, when planned new transmission capacity is measured against total new generating capacity until 2009, measured in summer-peak demand, NERC data suggests a decline in total transmission capacity from 201 to 176 MW-miles/MW demand from 1999 to 2009.[143]

According to the Edison Electric Institute, a Washington based industry association, a constant decline in US transmission capacity has taken place since 1982 in relation to rising demand. One estimate suggests a contraction of 1.4 percent per year in transmission capacity per MW of summer peak demand from that year to 1999. The EEI estimates that to maintain transmission

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[139] Reproduced from *EMF Report* 17.
[140] Note that the regions in the figure and the EMF study do not correspond exactly with the major NERC regions.
[141] Energy Modeling Forum (May 2001), "Prices and emissions in a restructured electricity market," *EMF Report* 17.
[142] Hirst and Kirby (2001), *Transmission Planning for a Restructuring US Electricity Industry,* Edison Electric Institute.
[143] Ibid.

capacity at its current level relative to summer peak demand, a net increase of 54,000 GW-miles would be needed during the next ten years. (This includes a 2 percent rate of retirement for older lines.) The same EEI report estimates that transmission investments (1999 dollars) have declined over a 25-year period by an average rate of US$120 million a year. The total investment to meet new transmission capacity needs is approximately $56 billion over the ten-year period, roughly one-half of the total costs to meet new generating capacity in the US.[144]

Transmission Policy

Transmission policy will have dramatic impacts on trade patterns in North America. The foundations of these policy changes are being laid now.

In the US, FERC Order 2000—introduced in late 1999— aims at reducing barriers to an open market that persisted after FERC Orders 888 and 889 had been issued. Those orders required utilities to provide "open access" to their transmission systems, a key step in the creation of an open, price-based competitive electricity marketplace. However, the rules created by these first orders nevertheless made it possible for utilities to manage their transmission systems in ways which discriminate against competing generators. Order 2000 was meant to remedy this situation, by requiring a much greater degree of separation between marketing and transmission than was previously allowed.

The specific objective of Order 2000 is for utilities to cede control over their transmission assets to independent Regional Transmission Organizations (RTOs).[145] These RTOs may be either for-profit or not-for-profit entities. In subsequent orders, FERC made clear that it hopes to see the US divided into four very large RTOs, though it has since acknowledged arguments to the effect that California and the Pacific Northwest not be obliged to participate in a single RTO.

One of the important roles of RTOs will be to coordinate transmission planning in the US:

> [T]he RTO must have ultimate responsibility for both transmission planning and expansion within its region that will enable it to provide efficient, reliable and non-discriminatory service...In the absence of a single entity performing these functions, there is a danger that separate transmission investments will work at cross-purposes and possibly even hurt reliability.[146]

RTOs are also expected to address reliability issues as grid use expands, by lowering information barriers between different operators and financial intermediaries. Rules are being elaborated now to reduce dual tariff regimes within regions—for instance, pancaked rates—to lower administrative or other barriers to market entry and exit, and to increase competition with wholesale power markets.

This represents a dramatic change from the way the transmission system has worked in the past. Traditionally, exports came from transmitting electric utility companies. Exports were arranged through long-term sales contracts or were intended for emergency back-up. However, restructuring has brought an explosion of power marketers and brokers, who can arrange deals for power generators along the border—even for those who are adjacent to it. Now, exporters no

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[144] Ibid.
[145] While RTO membership is not technically mandatory, there are very strong incentives to comply.
[146] FERC Order 2000.

longer have to be adjacent to the border to export, and can transmit electricity, at a fee, through a border operator to the buyer.

These developments are particularly welcome to smaller power producers, including Independent Power Producers such as providers of renewable energy or distributed generation. Of course, open access does not mean ensured access, and the ability of all producers to access the grid will be a function of their ability to afford the uniform tariff rates likely to prevail within regions.

As RTOs become a reality they will have major effects on international trade.[147] This is especially true in the case of US-Canada trade. Several Canadian entities have already been granted wholesale marketer status by FERC, through reciprocity requirements for open access under FERC Orders 888 and 889.

There is considerable interest among several Canadian utilities to continue this arrangement with FERC, and most importantly to be inside rather than outside the seamless network. In the wake of the California energy crisis, FERC has undertaken to revise its approach to evaluating market power, a key issue in awarding marketer status. This initiative, together with its RTO policy, could have considerable impact on Canada's electricity exporters.

In its 2000 Annual Report, BC Hydro characterized continued access to export markets as one of its most important business risks.[148] At a recent FERC meeting on RTOs, a representative of BC Hydro noted that "extensive efforts have been made by BC Hydro to design a structure that would accommodate Canadian participation [in the US market] and create a seamless market that includes the western provinces and states."[149]

Policy Integration and Market Integration

When looking at the North American market, the US market not only provides the hub for exports and imports, but US domestic competition policy reform appears to be the benchmark of market integration policies. For example, in its recent review of Canada, the International Energy Agency of the OECD notes that the views of FERC "have had a major impact on the development of policy in Canada. It is likely that competitive markets will continue to develop in some provinces to bring about domestic competition and in order to gain broader access to US markets. This may require provincial market structures to conform, in part, with US FERC policies." This conformity, the report adds, is likely despite objections from the province of Alberta regarding the extraterritorial application of FERC rules.[150]

Similarly, the National Energy Board recently noted that the creation of RTOs will further the ability of Canadian utilities not only to access the US transmission system, but to accelerate the "integration of the US and Canadian electricity markets." The NEB notes:

> "Canadian entities are not subject to FERC regulations, but due to the integrated nature of the North American transmission system, it appears that Canadian involvement in RTO

[147] The notion that a seamless transmission network will increase trade is partly intuitive, and partly based on counter-factual evidence that congestion in transmission ties between New England and Canada has led to losses in less expensive imports of hydropower from Canada.
[148] BC Hydro, *Annual Report 2000,* page 51.
[149] Submission by Tokout Mansour, BC Hydro to FERC in the Matter of RTO Interregional Coordination, Docket Number PL01-5-001, 19 June 2001
[150] IEA (2000), *Canada*, 2000, OECD, Paris.

> formation could be potentially beneficial to all market participants, provided proper approaches for joint overseeing of cross-border RTOs are adopted."

The above drives home a simple fact: if you are a foreign exporter watching the emergence of a seamless transmission market, then you want to be inside the seam. Put another way, you don't want seams to be determined by national borders.

The Role of NAFTA in North American Electricity Trade

The North American Free Trade Agreement (NAFTA) represents an additional factor in understanding liberalization and integration of the North American electricity market. For example, the objective of FERC Order 2000 to ensure a non-discriminatory and open access closely parallels similar commitments under NAFTA.

A series of legal commitments are contained in the NAFTA which set out disciplines covering trade in goods, services as well as the investment of liberalization. These rules are examined in detail in a stand-alone paper, released by the CEC in early November 2001, and available at the CEC web site at <www.cec.org/electricity>. Among the key provisions of NAFTA are national treatment and non-discrimination, rules covering technical barriers to trade, trade in services, specific commitments by the Parties to market access, tariff reduction—including the reduction of some tariffs for electric generating machinery and other capital goods—liberalization of procurement, and commitments covering liberalization of trade-related investments in the sector. These provisions are described in Horlick and Schuchardt in some detail.[151]

NAFTA Chapter Six

In addition to these commitments, NAFTA Chapter Six sets out more specific liberalization commitments for the energy sector, including commitments covering the trade in electricity. Electricity is categorized as a good in NAFTA—Chapter Six is included under NAFTA Part Two: Trade in Goods—while electricity is covered under the Harmonized System 2716.00.00.[152]

The Scope and Coverage of Chapter Six applies both to trade in energy goods as well as to "measures relating to investment and the cross-border trade in services associated with such goods." Among the main provisions of NAFTA Chapter Six include disciplines prohibiting or constraining (a) import and export restrictions; (b) the use of export taxes; and (c) other export measures.

There are numerous and important exceptions to these and other NAFTA disciplines. Most importantly, there are reservations and special provisions for Mexico, in particular exemptions for activities and investment in Electricity Generation Facilities covering CFE, cogeneration and Independent Power Production covered in NAFTA Chapter Six, Annex 602.3 (5) (a), (b) and (c).

Other exceptions in Chapter Six, of particular interest to environmental policy, is included in Article 605: Other Export Measures reference to GATT Article XX(g) with respect to the export

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[151] Horlick, Gary and Christiane Schuchhardt. 2001. *NAFTA Provisions and Electricity Sector.* Background Paper for the Article 13 Working Paper. Commission for Environmental Cooperation, Montreal. (Printed elsewhere in this volume.)

[152] The staging category of HS 2716.00.00 for Canada and the US is "D" (shall continue to receive duty-free treatment), with a free base rate. Mexico's schedule for 2716.00.00 is staging category B, with a 10 percent duty phased-out by 1998.

of energy to the territory of another Party. Article XX: General Exceptions of the General Agreement on Tariffs and Trade (GATT), which is incorporated in the Uruguay Round of the World Trade Organization (WTO), has been the subject of an intense and ongoing debate related to trade and the environment. The Chapeau of Article XX and subparagraph (g) are:

> Subject to the requirement that such measures are not applied in a manner which would constitute a means of arbitrary or unjustifiable discrimination between countries where the same conditions prevail, or a disguised restriction on international trade, nothing in this Agreement shall be construed to prevent the adoption or enforcement by any contracting party of measures…
>
> …(g) relating to the conservation of exhaustible natural resources if such measures are made effective in conjunction with restrictions on domestic production or consumption…

In all likelihood, NAFTA has had a marginal impact on the increase in electricity trade in North America. Canada and the US agreed upon the rules of bilateral energy liberalization six years before NAFTA, under the Canada-United States Free Trade Agreement. Numerous bilateral agreements exist between Canada and the US over the years setting out rules for trade in electricity.[153] Mexico has maintained substantive exceptions to Chapter Six provisions.

However, NAFTA would have important consequences in the event of a dispute between Parties over NAFTA provisions covering trade in electricity, trade in electricity-related capital goods and services, or liberalization of electricity-related investment.

Among the possible areas in which NAFTA provisions could be important, in the context of this discussion, is in the area of trade-environment issues. To date, it is important to note that no trade-environment disputes have occurred under NAFTA Chapter Six or other provisions related to the electricity sector. However, given the expansion of trade and market access, coupled with the number of environment-related regulations, standards, financial transfers, incentives, product standards and other measures, it is not inconceivable that such a dispute could arise. Indeed, as noted earlier, the government of Canada has alluded to the possibility of such an action on behalf of Canada's hydro exporters, with respect to Renewable Portfolio Standards.

Renewable Portfolio Standards and Market Access

Renewable Portfolio Standards (RPS) present an interesting example of potential issues that could be raised under NAFTA. In the US, some 23 states have either introduced, or have pending, mandatory RPS requirements. These requirements call for a certain percentage of the state's total electricity portfolio be based on renewable electricity. These RPS measures are not based on a uniform definition of what constitutes renewable electricity, but rather differ between jurisdictions.

A longstanding concern from some exporters revolves around the potential market access effects of electricity trade that falls outside of specific criteria contained in individual RPS measures. For example, some RPS criteria either exclude hydropower altogether, or specify that electricity can only be considered renewable if it comes from smaller scale hydropower projects. Other RPS standards appear to favor renewable electricity sources generated within

[153] These include the Energy Banking Agreement, the Interconnection Use Agreement, various energy contracts and firm energy contracts, such as those governing exports from Hydro-Québec to New England.

state boundaries. Similarly, criteria regarding performance standards, fuel sources or implied generation technologies may exclude some electricity imports from Mexico or Canada.

Under international trade rules (NAFTA and the WTO) such measures could raise questions about the potentially discriminatory nature of non-uniform environmental criteria, which could be in violation of the national treatment requirements, unless protected by an exception.[154]

Among the tentative conclusions of the Horlick and Schuchhardt paper are the following points.

As a general observation, GATT Article XX has not been read expansively so as to permit one WTO Member to act extra jurisdictionally to force another Member's nationals to change their practices *within* their own national territory, when the impact of these practices is *limited to* their national territory, when the practices are regulated under the jurisdiction of their own governments and when the practices comply with these regulations. Such a reading would not only strongly interfere with basic principles of national sovereignty.[155] it would also deny rights to Members based on differences in levels of regulatory protection. It should also be noted that panels have interpreted Article XX narrowly, in order to preserve the basic objectives and principles of the GATT.[156] A trade measure would be easier to justify under Article XX(g) if it had one clearly recognizable objective instead of targeting a sweeping array of aims of environmental protection.

Also as a general observation, RPS requirements in a number of state laws may be challenged as *de facto* discrimination against hydropower providers.[157] Those portfolio requirements establish the permissible maximum size of a hydropower plant, (e.g., through flooding of territory, building of a dam, etc.). Although the precise environmental justification of RPS criteria are not explained in detail in RPS criteria, one may assume that concerns center on the adverse environmental impacts of large-scale hydropower.

Whatever the aims and objectives of the specific criteria are, it is arguable whether they would be considered a justifiable objective for conservation of exhaustive resources under Article XX(g). Construction of a large-scale hydropower plant, dam building, flooding, undoubtedly may have negative environmental impacts. In some cases, it is clear that these impacts extend outside of the jurisdiction in which they are built and operated (e.g., effects on migratory birds or on international waterways). However, it is difficult to determine the extent to which this is the case, or whether such impacts are preferred to imports from alternative power sources.

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[154] However, it would appear that GATT Article XX exceptions provided for in Article 605 of NAFTA Chapter Six are intended to be applied only to exports. Moreover, NAFTA does not include any reference to GATT Article XX (b), "necessary to protect human, animal or plant life or health…"

[155] This is recognized both as an international legal principle and under US law. *See, e.g.,* Ian Brownlie, *Principles of Public International Law* 287 (4th ed. 1990) (The sovereignty and equality of states represent the basic constitutional doctrine of the law of nations, which governs a community consisting primarily of states having a uniform legal personality. * * * The principle corollaries of the sovereignty and equality of states are (1) a jurisdiction, prima facie exclusive, over a territory and the permanent population living there; (2) a duty of non-intervention in the area of exclusive jurisdiction of other states."); *The Schooner Exchange v. McFaddon*, 11 US (7 Cranch) 116, 136 (1812) ("The jurisdiction of the nation within its own territory is necessarily exclusive and absolute. * * * Any restriction upon it, deriving validity from an external source, would imply a diminution of its sovereignty to the extent of the restriction."); *Pennoyer v. Neff,* 95 US 714, 722 (1877) ("One of these [well-established] principles is, that every State possesses exclusive jurisdiction and sovereignty over persons and property within its territory.")

[156] *United States—Section 337 of the Tariff Act of 1930*, 1989, BISD 36S/345, 393, paragraph 5.27; see also *FIRA*, paragraph 5.20, *Gasoline*, at pp. 22-23.

[157] See Section V.2.a.

Harmonizing the Definition of Renewable Electricity

A key conclusion Horlick and Schuchhardt's discussion of non-uniform criteria is that the lack of a harmonized definition of what constitutes renewable electricity in RPS measures may create legal disparities for market participants involved in the trade of electricity. Lack of harmonization exists at the domestic level. Lack of harmonization also exists on the international level, since neither NAFTA nor any other international organization currently provides for binding or even non-binding guidelines as to what constitutes a renewable resource.

It is clear that a trade dispute bringing into question the ability of states to pursue high levels of environmental protection through RPS measures would be disruptive to both trade and environmental policies. Moreover, while trade rules may set out specific obligations, a profound concern of the public and civil society about free trade centers precisely on trade rules striking down domestic environmental policies.

A first step to anticipate and avoid this potential collision is by working towards a non-binding international or regional definition of renewable electricity. A second would see the adoption of international standards themselves.[158] Clearly, international trade rules have indicated a preference for international standards because of examples like non-uniform RPS measures at the state/provincial level. Moreover, environmental policies have long recognized the importance of international, regional and bilateral cooperation.

In support of increasing the transparency and comparability of both mandatory RPS measures, and voluntary environmental product and services labeling, the CEC has compiled and updated two on-line databases. The first compiles RPS measures currently in place in the US, while the second compiles information on product-related energy efficiency labeling and certification standards. These databases can be found at <www.cec.org/databases>.[159]

NAFTA Chapter Eleven: Investment

A second area of potential concern from a trade-environment perspective involves NAFTA Chapter Eleven: Investment. The scope of Coverage of NAFTA Chapter Six: Energy and Basic Petrochemicals applies both "to measures relating to energy and basic petrochemicals goods originating in the territories of the Parties, *and to measures relating to investment*…" (NAFTA Article 602.1, emphasis added.) The definition of investment contained in Chapter Six, Article 609, refers to the definition of investment contained in NAFTA Chapter Eleven, Article 1139 (Section C, Definitions).

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[158] Rowlands and Patterson identify four options for a North American standard for renewable energy: (a) continetal standard with no local variation; (b) continental standard with 'objective' local variations; (c) continetnal standard with local interpretations; and (d) continental norms with local priorities. Among the advantages of adoption one or more variations on these options is that scale economies from a consistent definition would be created; private sector interest in renewable energy would increase with a clear standard; and the kind of "vicious spiral" of definitions between brown and green sources would be avoided. I. H. Rowlands and M.J. Patterson (August 2001), "A North American definition for green electricity: Implications for sustainability," draft paper presented at the Fourth Biennial Conference of the Canadian Society for Ecological Economics, Montreal.

[159] An analysis of these standards shows that areas of greatest similarity among these standards are found with respect to the amount of electricity that need come from renewable sources, as well as in the definition of what is considered to be renewable. Nine of the 12 states have renewable requirements of less than 5% and non-hydro, noncombustable renewables are the most likely to be considered as renewable.

The author of the second part of Background Paper III notes that behind the simple Chapter Eleven heading of "Investment" lies a broad range of rights designed to protect foreign investors from certain types of government actions and provide remedies to the foreign investors if those actions occur. Historically, investor protection was developed to prevent governments from nationalizing or expropriating the assets of a foreign owned company without paying proper compensation. Over time, investor protections have been expanded to include other concepts such as requiring a foreign company to be treated the same as a domestic company, establishing a concept of minimum international standards of treatment for all foreign owned companies, and prohibitions against requiring companies to manage their business based on operating parameters or economic benefits determined by governments.

The investor protections are accomplished by placing obligations on governments where the investment takes place (the host state) not to breach the obligations set out in Chapter Eleven. Government actions that breach these obligations can include legislative or regulatory measures, administrative decisions, policy enactments, or other acts in relation to the investor. All levels of government are covered by these obligations (national, state/provincial, municipal), as well as all branches of government (legislative, executive and judicial). In the context of electricity, for example, electricity regulating boards at federal, state, provincial or local levels would likely all be included, unless excluded by specific provisions of NAFTA.

Expropriation

Of the main provisions contained in Chapter Eleven—rights of establishment, national treatment, minimum standard of treatment and performance requirements—it is Article 1110 on Expropriation that has been the most controversial. International law on the expropriation of foreign property originally developed in response to wholesale expropriation or nationalization of such property. In time, it was expanded to include notions of creeping or gradual expropriation—measures that effectively strip an owner of the ability to manage or determine the fate of one's property but without actually changing the ownership or title.

Today, a critical issue is the scope of "tantamount to expropriation" language, as well as evolving concepts of what constitutes "fair and equitable treatment." There is considerable debate within the three NAFTA governments today as to the appropriate scope and interpretation of these provisions, including discussion on a recently agreed upon interpretative statement, initiated by the Free Trade Commission in July 2001, which may soon lead to further clarifications.[160]

A different issue that may also have some relevance to the expropriation provision is whether the imposition of export quotas or controls may lead to claims of expropriation of a property right. One case at least has defined export markets as a property interest subject to protection under Chapter Eleven.[161] A quota that restricts this may, therefore, amount to an expropriation of that interest. It is not immediately clear whether export restrictions that meet the quotas and circumstances in Chapter 6, as outlined previously, could still be subject to challenge under Chapter Eleven by a foreign investor. If so, this could create a further constraint on the ability of governments to limit exports under conditions expressly applied in other parts of NAFTA.

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[160] The interpretative statement defines "fair and equitable" to mean "minimum standards" under international law and partially addresses some of the transparency concerns of Chapter 11 proceedings.
[161] *S.D. Myers v. Canada*, op. cit.

CONCLUSION: ENVIRONMENTAL QUALITY AND ENVIRONMENTAL POLICY IMPLICATIONS

Determining the extent to which increased trade in electricity will affect both environmental quality and environmental policy remains complex and unclear. However, experience thus far in assessing the environmental effects of free trade provide some important insights into some likely impacts.

The first, and most immediate impact on environmental quality is closely linked to scale effects from accessing larger markets. Clearly, trade in electricity has come in part because smaller markets- notably Canadian hydropower producers in the 1970s and 1980s—exploited their comparative advantage to expand production to meet significantly larger US markets. However, seen more broadly, this is really a locational effect, as generation expands in one region to serve demand in another. Free trade in electricity opens new markets that otherwise would have been served by a domestic utility. Market creation, driven both by free trade and the unbundling of power services, will offer new opportunities both for larger scale generators as well as smaller production units. The objective of FERC Order 2000 is to ensure that all generators—regardless of market size or generating scale—have access to transmission grids on an equal and non-discriminatory basis. It is worth noting once again that large-scale trade in electricity in North America began in earnest in the mid-1970s, when US buyers turned away from imported oil to cheaper Canadian hydropower.

The environmental quality impacts of free trade can therefore be seen as a shift in the location of electricity generation from what would have occurred under closed markets. Changes in the location of electricity generation, coupled with an expansion in the scale of markets accessed by those generating facilities, clearly brings about a change in the spatial distribution, and intensity of emissions and environmental impacts from those plants. In essence, imported electricity displaces local environmental impacts that otherwise would have occurred.

> [T]he importation of power results in the exportation of its environmental burden, and the exportation of power results in the importation of an environmental burden.[162]

Insofar as locational effects also involve a shift in the *type* of generation (e.g., from fossil fuel to hydropower), they also result in a shift in the type of impacts. The extent of that emission and environmental impact displacement is difficult not only to forecast, but also to assess. Based on an analysis of current levels of exports from Canada to the US—approximately 9 percent of total generation—further broken down by provinces, fuel sources and emission factors, a back-of-the-envelope estimate suggests that emissions in 1999 related to total Canadian exports were the equivalent of 3.6 million tonnes of CO_2 emissions, 28,300 tonnes of SO_2 and 9,700 tonnes of NO_x.[163] At the same time, net exports and imports by definition lead to the avoidance of pollution in the importing country. Hydro-Quebec estimates that its total exports to the US in 1998 was equivalent to the avoidance of 14.4 million tonnes of CO_2, 60,400 tonnes of SO_2 and 23,500 tonnes of NO_x that would otherwise have been emitted by US-based power producers.[164]

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[162] Arturo Gándara, "United States-Mexico electricity transfers: of alien electrons and the migration of undocumented environmental burdens," *Energy Law Journal* 16:1 (1995).

[163] These calculations used export data from Electric Power in Canada 1998–1999 as well as from analysis conducted in Miller et al. 2002, relating to provincial emissions from the electricity sector.

[164] Communication by Hydro-Quebec to the CEC, 10 January 2002.

The question is not whether there will be a change with free trade in the spatial distribution and in the type of environmental impacts resulting from the generation of electricity. Clearly, there has been and will continue to be. But several important questions remain. First, in changing the location and type of those impacts, does free trade also change their magnitude? This assumes, of course, a methodology for comparing environmental impacts as diverse as SO_x emissions and biodiversity losses. Second, it raises the issue of to what extent a local population should be asked to shoulder the environmental impacts related to the generation of power consumed elsewhere?

These in turn raise questions as to the extent to which differences in environmental regulations and standards between regions and countries as well as between different fuel sources factor in locational changes related to free trade, given that regulatory compliance in the energy sector can involve significant costs. Considerable attention during the 1990s was focused on whether environmental regulations affect competitiveness at the firm level. Comparing the costs of environmental standards and regulations between Canada, Mexico and the US in the electricity sector is an important issue that warrants more attention.

As a resource and pollution intensive sector, drawing heavily on environmental resources, electricity generation and its related activities are subject to extensive environmental regulations. The most recent estimates show that US electricity companies spent US$4.34 billion on pollution abatement costs in 1994. Expenditures for air capital equipment increased 7 percent from 1993, while water capital expenditures decreased by 2 percent from 1993.[165] As for hydropower, it has been estimated that the environmental improvements required by regulators in recent years in the US have resulted in a production constraint of between 1 to 8 percent, over and above direct costs related to impact mitigation. A surrogate estimate of the costs to US industry in meeting SO_2 emissions requirements is US$175 per ton, and for NO_x between US$600 to $1,000 per ton. The equivalent constraint on output or profit is hard to estimate, but is in the range of one-tenth of a cent per kWh to one cent per kWh.

In addition to operating and capital costs for existing plants—including the costs of retrofitting older plants with end-of-pipe capital equipment—new generating facilities face numerous (and often onerous) environmental impact assessment requirements. Meeting EIA obligations is costly, both in expense and time: an EIA can take anywhere from 12 to 24 months. FERC notes that the single most important provision in attaining a Presidential Permit for export or import of electricity revolves around EIA permitting.

Given the fact that price and technological constraints are less flexible between producers, the question arises as to whether differences in environmental regulations can affect locational decisions in North America. That is, to what extent will free trade lead to the cancellation or deferral of planned generation in some regions and expansion in others, and to what extent can such deferrals, expansion and overall locational changes be linked back to differences in environmental regulations? There is some empirical evidence that countries with lax environmental regulations in free trade areas tend to increase their comparative advantage in pollution-intensive industries. There is also limited evidence of a shift of toxic intensive industries away from countries with high environmental standards to countries with lower standards.[166]

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[165] US Department of Commerce (1996), "Pollution abatement costs and expenditures: 1994," MA2000 (94)—1.
[166] World Bank. 1992. *Trade and Environment*. Edited by Patrick Low. Washington, DC.

Less clear is to what extent regulatory differentials have been the *cause* of those shifts in pollution intensive sectors.

Analysis of the trade effects of air quality regulations suggests that regulatory differentials between countries in pollution-intensive sectors in general have had a small but measurable impact on patterns of trade. However, there are other and more important factors that can largely explain these locational decisions, over and above environmental regulations. such as market proximity, cost of labor, cost of capital, country risk, infrastructure and other factors. For example, the largest number of new plants up to 2007 in the NEWGen data are located in California and New York, two states with among the highest environmental regulations in the United States. Hence, proximity to markets, driven in part because of the considerable constraints that persist in interregional transmission, appear to be more important than differences in environmental regulations on average.

Nevertheless, there is evidence that some companies *may* use environmental regulatory differences strategically, to lower operating costs. Although the pollution haven argument thus far has not found robust empirical backing, there are instances within the United States where new generating facilities have been built immediately outside of non-attainment areas, with a large proportion of total generation bound for areas within the non-attainment area. Similarly, it seems clear that the lower emission standards for criteria pollutants in Alberta compared to the US will almost certainly be a contributing factor in the construction of new coal-fired generating plants in that province expected in coming years.

A similar regulatory differential appears to exist with respect to hydropower. As noted earlier, hydropower licensing in the US has evolved greatly since the passage in 1986 of the *Electric Consumer Protection Act*, which requires FERC to give equal consideration to environmental concerns. However, important differences remain between the US and Canada on licensing procedures. Since licenses are generally not time-limited, there is no equivalent to the relicensing process in the US.[167] As a result, flow regimes for Canadian hydropower facilities may be far less demanding than those for similar projects in the US.

Unlike air quality, however, there has been little study of the regulatory differentials between NAFTA jurisdictions with respect to hydropower, or of their consequences for generation siting. Without a careful assessment of the way similar projects are or would be treated in these very different regulatory environments, it is impossible to reach firm conclusions with respect to the extent to which regulatory differentials create a pollution haven effect.

There is limited and unsatisfactory evidence thus far regarding the aggregate environmental effects of free trade in North America. One study[168] found that over the near term, as Mexican exports to the US increased, a net decline in SO_2 and NO_x emissions would occur, together with an increase in $C0_2$ emissions. As for Canada-US electricity trade, significant growth is expected, with new coal and hydro facilities under development to serve the US market. While a number of estimates have been made of the avoided air emissions resulting from the export of hydropower, no satisfactory estimates have been developed of its net environmental effect, taking into account the direct effects of dams and reservoirs on ecosystems and societies. It would thus be premature to draw conclusions as to the net environmental effects of free trade in electricity North America.

[167] However, both British Columbia and Ontario have recently embarked on water use planning processes in order to review the operating regimes for existing hydro facilities.
[168] Hoyt, Edward A., John Paul Moscarella and Joel N. Swisher. 1998. “Environmental Implications of Increased US-Mexico Electricity Trade.” *Environmental Science and Policy*, pp. 99–113.

ANNEX I

Imports and Exports of Electricity Generating Machinery in North America					
Source - Trade Data Online, Industry Canada					
Exports to Canada - Current US Dollars					
	1996	1997	1998	1999	2000
US	651,872,345	819,572,614	999,040,437	987,884,541	1,107,021,771
Mexico	34,562,989	59,309,481	57,450,551	93,338,758	89,074,549
Total	686,435,334	878,882,095	1,056,490,988	1,081,223,299	1,196,096,320
Exports to US - Current US Dollars					
	1996	1997	1998	1999	2000
Canada	796,389,004	671,627,288	734,163,231	821,760,218	949,992,682
Mexico	1,140,690,945	1,562,411,906	1,665,796,600	1,751,619,423	2,104,040,835
Total	1,937,079,949	2,234,039,194	2,399,959,831	2,573,379,641	3,054,033,517
Exports to Mexico - Current US Dollars					
	1996	1997	1998	1999	2000
Canada	2,186,134	1,990,441	4,752,176	9,019,026	3,111,307
United States	1,059,092,342	1,447,041,384	1,333,417,831	1,618,674,681	1,961,503,103
	1,061,278,476	1,449,031,825	1,338,170,007	1,627,693,707	1,964,614,410
IMPORTS					
Canadian Imports - Current US Dollars					
	1996	1997	1998	1999	2000
US	556,952,156	697,972,089	841,244,785	814,967,875	859,559,033
Mexico	34,562,989	59,309,481	57,450,551	93,338,758	89,074,549
Total	591,515,145	757,281,570	898,695,336	908,306,633	948,633,582
United States Imports - Current US Dollars					
	1996	1997	1998	1999	2000
Canada	748,185,054	628,286,913	675,778,690	738,724,281	861,164,666
Mexico	1,140,690,945	1,562,411,906	1,665,796,600	1,751,619,423	2,104,040,835
Total	1,888,875,999	2,190,698,819	2,341,575,290	2,490,343,704	2,965,205,501
Mexican Imports - Current US Dollars					
	1996	1997	1998	1999	2000
Canada	2,186,134	1,990,441	4,752,176	9,019,026	3,111,307
United States	1,059,092,342	1,447,041,384	1,333,417,831	1,618,674,681	1,961,503,103
Total	1,061,278,476	1,449,031,825	1,338,170,007	1,627,693,707	1,964,614,410
Mexican data are derived from US and Canadian data, e.g., Mexican exports to Canada will be the same as Canadian imports from Mexico.					

ANNEX II

HS Codes used to Calculate Electrical Industry Equipment Imports and Exports for Canada and the US - Not electricity itself

HS 840110 - nuclear reactors
HS 840120 - machinery and apparatus for isotopic separation and parts thereof
HS 840130 - fuel elements (cartridges) non-irradiated.
HS 840140 - parts of nuclear reactors
HS 840211 - watertube boilers - steam production exceeding 45 tons per hour
HS 840212 - watertube boilers - steam production not exceeding 45 tons per hour
HS 840219 - other vapor generating boilers nes (including hybrid boilers)
HS 840220 - super-heated water boilers
HS 840290 - parts of steam or vapor generating boilers nes
HS 840410 - auxiliary plants for use with central heating, steam or vapor generating boilers
HS 840420 - condensers for steam or vapor power units
HS 840490 - parts for auxiliary plants and condenser for steam or vapor generating unit
HS 840510 - producer gas or water gas generators, acetylene gas generators and the like
HS 840590 - parts of producer gas or water gas generators, acetylene gas generators and the like
HS 840619 - steam and other vapor turbines (other than for marine propulsion)
HS 840681 - steam and other vapor turbines (other than for marine propulsion) - output 40MW or more
HS 840682 - steam and other vapor turbines (other than for marine propulsion) - output less than 40MW
HS 840690 - parts of steam and vapor turbines
HS 840810 - diesel engines for marine propulsion engines
HS 841011 - hydraulic turbines and water wheels - power not exceeding 1,000 kW
HS 841012 - hydraulic turbines and water wheels - power 1,000-10,000 kW
HS 841013 - hydraulic turbines and water wheels - power exceeding 10,000 kW
HS 841090 - parts of hydraulic turbines and water wheels including speed regulators
HS 850211 - generating sets with diesel/semi-diesel engines - output not exceeding 75 kVa
HS 850212 - generating sets with diesel/semi-diesel engines - output 76-375 kVa
HS 850213 - generating sets with diesel/semi-diesel engines - output exceeding 375 kVa
HS 850230 - electric generating sets nes
HS 850231 - electric generating sets - wind-powered
HS 850239 - electric generating sets - other than wind-powered
HS 850240 - electric rotary converters
HS 850300 - parts for electric motors, generators, generating sets and rotary converters
HS 850421 - liquid dielectric transformers - power handling capacity not exceeding 650 kVa
HS 850422 - liquid dielectric transformers - power handling capacity 651-10,000 kVa
HS 850423 - liquid dielectric transformers - power handling capacity exceeding 10,000 kVa
HS 850431 - electric transformers nes - power handling capacity not exceeding 1 kVa
HS 850432 - electric transformers nes - power handling capacity 2-16 kVa
HS 850433 - electric transformers nes - power handling capacity 17-500 kVa
HS 850434 - electric transformers nes - power handling capacity exceeding 500 kVa
HS 850440 - electric static converters (including power supplies, rectifiers and inverters)
HS 850450 - electric inductors
HS 850490 - parts of electrical transformers, static converters and inductors

GLOSSARY

Acid Rain: Also called acid precipitation or acid deposition, acid rain is precipitation containing harmful amounts of nitric and sulfuric acids formed primarily by the release of nitrogen oxides and sulfur oxides into the atmosphere when fossil fuels are burned. It can be wet precipitation (rain, snow, or fog) or dry precipitation (absorbed gaseous and particulate matter, aerosol particles or dust). Acid rain has a pH below 5.6. Normal rain has a pH of about 5.6, which is slightly acidic. The term pH is a measure of acidity or alkalinity and ranges from 0 to 14. A pH measurement of 7 is regarded as neutral. Measurements below 7 indicate increased acidity, while those above indicate increased alkalinity.

Ancillary Services: Necessary services that must be provided in the generation and delivery of electricity. As defined by the Federal Energy Regulatory Commission, they include: coordination and scheduling services (load following, energy imbalance service, control of transmission congestion); automatic generation control (load frequency control and the economic dispatch of plants); contractual agreements (loss compensation service); and support of system integrity and security (reactive power, or spinning and operating reserves).

Barrel: A volumetric unit of measure for crude oil and petroleum products equivalent to 42 US gallons.

Baseload: The minimum amount of electric power delivered or required over a given period of time at a steady rate.

Baseload Capacity: The generating equipment normally operated to serve loads on an around-the-clock basis.

Baseload Plant: A plant, usually housing high-efficiency steam-electric units, which is normally operated to take all or part of the minimum load of a system, and which consequently produces electricity at an essentially constant rate and runs continuously. These units are operated to maximize system mechanical and thermal efficiency and minimize system operating costs.

Boiler: A device for generating steam for power, processing, or heating purposes or for producing hot water for heating purposes or hot water supply. Heat from an external combustion source is transmitted to a fluid contained within the tubes in the boiler shell. This fluid is delivered to an end-use at a desired pressure, temperature, and quality.

Broker: An entity that arranges the sale and purchase of electric energy, transmission, and other services between buyers and sellers, but does not take title to any of the power sold.

Btu (British Thermal Unit): A standard unit for measuring the quantity of heat energy equal to the quantity of heat required to raise the temperature of 1 pound of water by 1 degree Fahrenheit.

Bundled Utility Service: All generation, transmission, and distribution services provided by one entity for a single charge. This would include ancillary services and retail services.

Capability: The maximum load that a generating unit, generating station, or other electrical apparatus can carry under specified conditions for a given period of time without exceeding approved limits of temperature and stress.

Capacity: The amount of electric power delivered or required for which a generator, turbine, transformer, transmission circuit, station, or system is rated by the manufacturer.

Capacity (Purchased): The amount of energy and capacity available for purchase from outside the system.

Capacity Charge: An element in a two-part pricing method used in capacity transactions (energy charge is the other element). The capacity charge, sometimes called Demand Charge, is assessed on the amount of capacity being purchased.

CFE: *Comisión Federal de Energía*—the state-owned enterprise that generates, transmits, distributes and sells electricity to 19 million clients, representing almost 80 million Mexicans.

Circuit: A conductor or a system of conductors through which electric current flows.

Coal: A readily combustible black or brownish-black rock whose composition, including inherent moisture, consists of more than 50 percent by weight and more than 70 percent by volume of carbonaceous material. It is formed from plant remains that have been compacted, hardened, chemically altered, and metamorphosed by heat and pressure over geologic time.

Cogenerator: A generating facility that produces electricity and another form of useful thermal energy (such as heat or steam), used for industrial, commercial, heating, or cooling purposes. To receive status as a qualifying facility (QF) under the Public Utility Regulatory Policies Act (PURPA), the facility must produce electric energy and "another form of useful thermal energy through the sequential use of energy," and meet certain ownership, operating, and efficiency criteria established by the Federal Energy Regulatory Commission (FERC). (See the Code of Federal Regulations, Title 18, Part 292.)

Coke (Petroleum): A residue high in carbon content and low in hydrogen that is the final product of thermal decomposition in the condensation process in cracking. This product is reported as marketable coke or catalyst coke. The conversion is 5 barrels (of 42 US gallons each) per short ton. Coke from petroleum has a heating value of 6.024 million Btu per barrel.

Combined Cycle: An electric generating technology in which electricity is produced from otherwise lost waste heat exiting from one or more gas (combustion) turbines. The exiting heat is routed to a conventional boiler or to a heat recovery steam generator for utilization by a steam turbine in the production of electricity. This process increases the efficiency of the electric generating unit.

Combined Cycle Unit: An electric generating unit that consists of one or more combustion turbines and one or more boilers with a portion of the required energy input to the boiler(s) provided by the exhaust gas of the combustion turbine(s).

Combined Pumped-Storage Plant: A pumped-storage hydroelectric power plant that uses both pumped water and natural streamflow to produce electricity.

Commercial Operation: Commercial operation begins when control of the loading of the generator is turned over to the system dispatcher.

Competitive Transition Charge: A non-bypassable charge levied on each customer of a distribution utility, including those who are served under contracts with nonutility suppliers, for recovery of a utility's transition costs.

Congestion: A condition that occurs when insufficient transfer capacity is available to implement all of the preferred schedules for electricity transmission simultaneously.

Contract Receipts: Purchases based on a negotiated agreement that generally covers a period of 1 or more years.

Cooperative Electric Utility: An electric utility legally established to be owned by and operated for the benefit of those using its service. The utility company will generate, transmit, and/or distribute supplies of electric energy to a specified area not being serviced by another utility. Such ventures are generally exempt from Federal income tax laws. Most electric cooperatives have been initially financed by the Rural Electrification Administration, US Department of Agriculture.

Cost-of-Service Regulation: Traditional electric utility regulation under which a utility is allowed to set rates based on the cost of providing service to customers and the right to earn a limited profit.

CRE: *Comisión Reguladora de Energía.* The Mexican regulatory commission whose mission is to foster investment and development in the gas and electricity industries.

Demand (Electric): The rate at which electric energy is delivered to or by a system, part of a system, or piece of equipment, at a given instant or averaged over any designated period of time.

Demand Bid: A bid into the power exchange indicating a quantity of energy or an ancillary service that an eligible customer is willing to purchase and, if relevant, the maximum price that the customer is willing to pay.

Demand-Side Management: The planning, implementation, and monitoring of utility activities designed to encourage consumers to modify patterns of electricity usage, including the timing and level of electricity demand. It refers only to energy and load-shape modifying activities that are undertaken in response to utility-administered programs. It does not refer to energy and load-shape changes arising from the normal operation of the marketplace or from government-mandated energy-efficiency standards. Demand-Side Management (DSM) covers the complete range of load-shape objectives, including strategic conservation and load management, as well as strategic load growth.

Deregulation: The elimination of regulation from a previously regulated industry or sector of an industry.

Direct Access: The ability of a retail customer to purchase commodity electricity directly from the wholesale market rather than through a local distribution utility.

Distribution: The delivery of electricity to retail customers (including homes, businesses, etc.).

Distribution System: The portion of an electric system that is dedicated to delivering electric energy to an end user.

Divestiture: The stripping off of one utility function from the others by selling (spinning-off) or in some other way changing the ownership of the assets related to that function. Stripping off is most commonly associated with spinning-off generation assets so they are no longer owned by the shareholders that own the transmission and distribution assets.

Electric Plant (Physical): A facility containing prime movers, electric generators, and auxiliary equipment for converting mechanical, chemical, and/or fission energy into electric energy.

Electric Utility: A corporation, person, agency, authority, or other legal entity or instrumentality that owns and/or operates facilities within the United States, its territories, or Puerto Rico for the generation, transmission, distribution, or sale of electric energy primarily for use by the public and files forms listed in the Code of Federal Regulations, Title 18, Part 141. Facilities that qualify as cogenerators or small power producers under the Public Utility Regulatory Policies Act (PURPA) are not considered electric utilities.

FERC: The Federal Energy Regulatory Commission.

Flue Gas Particulate Collectors: Equipment used to remove fly ash from the combustion gases of a boiler plant before discharge to the atmosphere. Particulate collectors include electrostatic precipitators, mechanical collectors (cyclones), fabric filters (baghouses), and wet scrubbers.

Forced Outage: The shutdown of a generating unit, transmission line or other facility, for emergency reasons or a condition in which the generating equipment is unavailable for load due to unanticipated breakdown.

Futures Market: Arrangement through a contract for the delivery of a commodity at a future time and at a price specified at the time of purchase. The price is based on an auction or market basis. This is a standardized, exchange-traded, and government regulated hedging mechanism.

Gas Turbine Plant: A plant in which the prime mover is a gas turbine. A gas turbine consists typically of an axial-flow air compressor, one or more combustion chambers, where liquid or gaseous fuel is burned and the hot gases are passed to the turbine and where the hot gases expand to drive the generator and are then used to run the compressor.

Generating Unit: Any combination of physically connected generator(s), reactor(s), boiler(s), combustion turbine(s), or other prime mover(s) operated together to produce electric power.

Generation (Electricity): The process of producing electric energy by transforming other forms of energy; also, the amount of electric energy produced, expressed in watthours (Wh).

Generation Company: A regulated or non-regulated entity (depending upon the industry structure) that operates and maintains existing generating plants. The generation company may own the generation plants or interact with the short-term market on behalf of plant owners. In the context of restructuring the market for electricity, the generation company is sometimes used to describe a specialized “marketer” for the generating plants formerly owned by a vertically-integrated utility.

Gross Generation: The total amount of electric energy produced by the generating units at a generating station or stations, measured at the generator terminals.

Net Generation: Gross generation less the electric energy consumed at the generating station for station use.
Geothermal Plant: A plant in which the prime mover is a steam turbine. The turbine is driven either by steam produced from hot water or by natural steam that derives its energy from heat found in rocks or fluids at various depths beneath the surface of the earth. The energy is extracted by drilling and/or pumping.
Gigawatt (GW): One billion watts.
Gigawatthour (GWh): One billion watthours.
Grid: The layout of an electrical distribution system.
Gross Generation: The total amount of electric energy produced by a generating facility, as measured at the generator terminals.
Hydroelectric Plant: A plant in which the turbine generators are driven by falling water.
Independent Power Producers: Entities that are also considered nonutility power producers in the United States. These facilities are wholesale electricity producers that operate within the franchised service territories of host utilities and are usually authorized to sell at market-based rates. Unlike traditional electric utilities, Independent Power Producers do not possess transmission facilities or sell electricity in the retail market.
Intermediate Load (Electric System): The range from base load to a point between base load and peak. This point may be the midpoint, a percent of the peakload, or the load over a specified time period.
Internal Combustion Plant: A plant in which the prime mover is an internal combustion engine. An internal combustion engine has one or more cylinders in which the process of combustion takes place, converting energy released from the rapid burning of a fuel-air mixture into mechanical energy. Diesel or gas-fired engines are the principal types used in electric plants. The plant is usually operated during periods of high demand for electricity.
Interruptible Gas: Gas sold to customers with a provision that permits curtailment or cessation of service at the discretion of the distributing company under certain circumstances, as specified in the service contract.
Interruptible Load: Refers to program activities that, in accordance with contractual arrangements, can interrupt consumer load at times of seasonal peak load by direct control of the utility system operator or by action of the consumer at the direct request of the system operator. It usually involves commercial and industrial consumers. In some instances the load reduction may be affected by direct action of the system operator (remote tripping) after notice to the consumer in accordance with contractual provisions. For example, loads that can be interrupted to fulfill planning or operation reserve requirements should be reported as Interruptible Load. Interruptible Load as defined here excludes Direct Load Control and Other Load Management. (Interruptible Load, as reported here, is synonymous with Interruptible Demand reported to the North American Electric Reliability Council on the voluntary Form EIA-411, "Coordinated Regional Bulk Power Supply Program Report," with the exception that annual peakload effects are reported on the Form EIA-861 and seasonal (i.e., summer and winter) peakload effects are reported on the EIA-411).
Investor-Owned Utility: A class of utility whose stock is publicly traded and which is organized as a tax-paying business, usually financed by the sale of securities in the capital market. It is regulated and authorized to achieve an allowed rate of return.
Kilowatt (kW): One thousand watts.
Kilowatthour (kWh): One thousand watthours.
Load (Electric): The amount of electric power delivered or required at any specific point or points on a system. The requirement originates at the energy-consuming equipment of the consumers.
Market-based Pricing: Electric service prices determined in an open market system of supply and demand under which the price is set solely by agreement as to what a buyer will pay and a

seller will accept. Such prices could recover less or more than full costs, depending upon what the buyer and seller see as their relevant opportunities and risks.

Market Clearing Price: The price at which supply equals demand for the Day Ahead and/or Hour Ahead Markets.

Maximum Demand: The greatest of all demands of the load that has occurred within a specified period of time.

Mcf: One thousand cubic feet.

Megawatt (MW): One million watts.

Megawatthour (MWh): One million watthours.

MMcf: One million cubic feet.

Monopoly: One seller of electricity with control over market sales.

NEB: National Energy Board.

Natural Gas: A naturally occurring mixture of hydrocarbon and nonhydrocarbon gases found in porous geological formations beneath the earth's surface, often in association with petroleum. The principal constituent is methane.

Net Generation: Gross generation minus plant use from all electric utility owned plants. The energy required for pumping at a pumped-storage plant is regarded as plant use and must be deducted from the gross generation.

Noncoincidental Peak Load: The sum of two or more peakloads on individual systems that do not occur in the same time interval. Meaningful only when considering loads within a limited period of time, such as a day, week, month, a heating or cooling season, and usually for not more than 1 year.

Nonutility Power Producer: A corporation, person, agency, authority, or other legal entity or instrumentality that owns electric generating capacity and is not an electric utility. Nonutility power producers include qualifying cogenerators, qualifying small power producers, and other nonutility generators (including independent power producers) without a designated franchised service area, and which do not file forms listed in the Code of Federal Regulations, Title 18, Part 141.

Nuclear Fuel: Fissionable materials that have been enriched to such a composition that, when placed in a nuclear reactor, will support a self-sustaining fission chain reaction, producing heat in a controlled manner for process use.

Nuclear Power Plant: A facility in which heat produced in a reactor by the fissioning of nuclear fuel is used to drive a steam turbine.

Off-peak Gas: Gas that is to be delivered and taken on demand when demand is not at its peak.

Open Access: A regulatory mandate to allow others to use a utility's transmission and distribution facilities to move bulk power from one point to another on a nondiscriminatory basis for a cost-based fee.

Outage: The period during which a generating unit, transmission line, or other facility is out of service.

Peak Demand: The maximum load during a specified period of time.

Peak Load Plant: A plant usually housing old, low-efficiency steam units; gas turbines; diesels; or pumped-storage hydroelectric equipment normally used during the peak-load periods.

Peaking Capacity: Capacity of generating equipment normally reserved for operation during the hours of highest daily, weekly, or seasonal loads. Some generating equipment may be operated at certain times as peaking capacity and at other times to serve loads on an around-the-clock basis.

Petroleum: A mixture of hydrocarbons existing in the liquid state found in natural underground reservoirs, often associated with gas. Petroleum includes fuel oil No. 2, No. 4, No. 5, No. 6; topped crude; Kerosene; and jet fuel.

Planned Generator: A proposal by a company to install electric generating equipment at an existing or planned facility or site. The proposal is based on the owner having obtained (1) all environmental and regulatory approvals, (2) a signed contract for the electric energy, or (3) financial closure for the facility.

Plant: A facility at which are located prime movers, electric generators, and auxiliary equipment for converting mechanical, chemical, and/or nuclear energy into electric energy. A plant may contain more than one type of prime mover. Electric utility plants exclude facilities that satisfy the definition of a qualifying facility under the Public Utility Regulatory Policies Act of 1978.

Plant-use Electricity: The electric energy used in the operation of a plant. This energy total is subtracted from the gross energy production of the plant; for reporting purposes the plant energy production is then reported as a net figure. The energy required for pumping at pumped-storage plants is, by definition, subtracted, and the energy production for these plants is then reported as a net figure.

Power Exchange: The entity that will establish a competitive spot market for electric power through day- and/or hour-ahead auction of generation and demand bids.

Power Exchange Generation: Generation being scheduled by the power exchange.

Power Exchange Load: Load that has been scheduled by the power exchange and which is received through the use of transmission or distribution facilities owned by participating transmission owners.

Power Marketers: Business entities engaged in buying, selling, and marketing electricity. Power marketers do not usually own generating or transmission facilities. Power marketers, as opposed to brokers, take ownership of the electricity and are involved in interstate trade. These entities file with the Federal Energy Regulatory Commission for status as a power marketer.

Power Pool: An association of two or more interconnected electric systems having an agreement to coordinate operations and planning for improved reliability and efficiencies.

Qualifying Facility (QF): A cogeneration or small power production facility that meets certain ownership, operating, and efficiency criteria established by the Federal Energy Regulatory Commission (FERC) pursuant to the Public Utility Regulatory Policies Act (PURPA).

Rate Base: The value of property upon which a utility is permitted to earn a specified rate of return as established by a regulatory authority. The rate base generally represents the value of property used by the utility in providing service and may be calculated by any one or a combination of the following accounting methods: fair value, prudent investment, reproduction cost, or original cost. Depending on which method is used, the rate base includes cash, working capital, materials and supplies, and deductions for accumulated provisions for depreciation, contributions in aid of construction, customer advances for construction, accumulated deferred income taxes, and accumulated deferred investment tax credits.

Ratemaking Authority: A utility commission's legal authority to fix, modify, approve, or disapprove rates, as determined by the powers given the commission by a State or Federal legislature.

Reliability: Electric system reliability has two components--adequacy and security. Adequacy is the ability of the electric system to supply to aggregate electrical demand and energy requirements of the customers at all times, taking into account scheduled and unscheduled outages of system facilities. Security is the ability of the electric system to withstand sudden disturbances, such as electric short circuits or unanticipated loss of system facilities. The degree of reliability may be measured by the frequency, duration, and magnitude of adverse effects on consumer services.

Renewable Resources: Naturally, but flow-limited resources that can be replenished. They are virtually inexhaustible in duration but limited in the amount of energy that is available per unit of time. Some (such as geothermal and biomass) may be stock-limited in that stocks are depleted by use, but on a time scale of decades, or perhaps centuries, they can probably be replenished. Renewable energy resources include: biomass, hydro, geothermal, solar and wind. In the future, they could also include the use of ocean thermal, wave, and tidal action technologies. Utility renewable resource applications include bulk electricity generation, on-site electricity generation, distributed electricity generation, non-grid-connected generation, and demand-reduction (energy efficiency) technologies.

Reregulation: The design and implementation of regulatory practices to be applied to the remaining regulated entities after restructuring of the vertically-integrated electric utility. The remaining regulated entities would be those that continue to exhibit characteristics of a natural monopoly, where imperfections in the market prevent the realization of more competitive results, and where, in light of other policy considerations, competitive results are unsatisfactory in one or more respects. Regulation could employ the same or different regulatory practices as those used before restructuring.

Reserve Margin (Operating): The amount of unused available capability of an electric power system at peakload for a utility system as a percentage of total capability.

Restructuring: The process of replacing a monopoly system of electric utilities with competing sellers, allowing individual retail customers to choose their electricity supplier but still receive delivery over the power lines of the local utility. It includes the reconfiguration of the vertically-integrated electric utility.

Retail Competition: The concept under which multiple sellers of electric power can sell directly to end-use customers and the process and responsibilities necessary to make it occur.

Retail Wheeling: The process of moving electric power from a point of generation across one or more utility-owned transmission and distribution systems to a retail customer.

Spinning Reserve: That reserve generating capacity running at a zero load and synchronized to the electric system.

Spot Purchases: A single shipment of fuel or volumes of fuel, purchased for delivery within 1 year. Spot purchases are often made by a user to fulfill a certain portion of energy requirements, to meet unanticipated energy needs, or to take advantage of low-fuel prices.

Stability: The property of a system or element by virtue of which its output will ultimately attain a steady state. The amount of power that can be transferred from one machine to another following a disturbance. The stability of a power system is its ability to develop restoring forces equal to or greater than the disturbing forces so as to maintain a state of equilibrium.

Steam-electric Plant (Conventional): A plant in which the prime mover is a steam turbine. The steam used to drive the turbine is produced in a boiler where fossil fuels are burned.

Stranded Benefits: Benefits associated with regulated retail electric service which may be at risk under open market retail competition. Examples are conservation programs, fuel diversity, reliability of supply, and tax revenues based on utility revenues.

Stranded Costs: Prudent costs incurred by a utility which may not be recoverable under market-based retail competition. Examples are undepreciated generating facilities, deferred costs, and long-term contract costs.

Substation: Facility equipment that switches, changes, or regulates electric voltage.

Transmission System (Electric): An interconnected group of electric transmission lines and associated equipment for moving or transferring electric energy in bulk between points of supply and points at which it is transformed for delivery over the distribution system lines to consumers, or is delivered to other electric systems.

Transmitting Utility: This is a regulated entity which owns, and may construct and maintain, wires used to transmit wholesale power. It may or may not handle the power dispatch and coordination functions. It is regulated to provide non-discriminatory connections, comparable service, and cost recovery. According to EPACT, this includes any electric utility, qualifying cogeneration facility, qualifying small power production facility, or Federal power marketing agency which owns or operates electric power transmission facilities which are used for the sale of electric energy at wholesale.

Turbine: A machine for generating rotary mechanical power from the energy of a stream of fluid (such as water, steam, or hot gas). Turbines convert the kinetic energy of fluids to mechanical energy through the principles of impulse and reaction, or a mixture of the two.

Unbundling: The separating of the total process of electric power service from generation to metering into its component parts for the purpose of separate pricing or service offerings.
Vertical Integration: An arrangement whereby the same company owns all the different aspects of making, selling, and delivering a product or service. In the electric industry, it refers to the historically common arrangement whereby a utility would own its own generating plants, transmission system, and distribution lines to provide all aspects of electric service.
Voltage Reduction: Any intentional reduction of system voltage by 3 percent or greater for reasons of maintaining the continuity of service of the bulk electric power supply system.
Watthour (Wh): An electrical energy unit of measure equal to 1 watt of power supplied to, or taken from, an electric circuit steadily for 1 hour.
Wheeling Service: The movement of electricity from one system to another over transmission facilities of intervening systems. Wheeling service contracts can be established between two or more systems.
Wholesale Competition: A system whereby a distributor of power would have the option to buy its power from a variety of power producers, and the power producers would be able to compete to sell their power to a variety of distribution companies.
Wholesale Transmission Services: The transmission of electric energy sold, or to be sold, at wholesale in interstate commerce (from EPACT).

Source EIA: <http://www.eia.doe.gov/cneaf/electricity/epav1/glossary.html>