



Electricity and the Environment

An Article 13 Initiative of the North American
Commission for Environmental Cooperation

1

Discussion Paper

Environmental Challenges and Opportunities of the Evolving North American Electricity Market

Author: Commission for Environmental Cooperation Secretariat

Date: 5 November 2001

This discussion paper was prepared by the CEC Secretariat in support of the “Electricity and Environment” initiative undertaken pursuant to Article 13 of the North American Agreement on Environmental Cooperation. These background materials are intended to stimulate discussion and elicit comments from the public, as well as the Electricity and Environment Advisory Board, in addition to providing information for the 29–30 November 2001 Symposium on the “Environmental Challenges and Opportunities of the Evolving North American Electricity Market.” The opinions, views or other information contained herein do not necessarily reflect the views of the CEC, Canada, Mexico or the United States. Following receipt of comments and observations on these materials, the Secretariat will prepare a report to Council, with recommendations, early in 2002.

Commission for Environmental Cooperation
393, rue Saint-Jacques Ouest, Bureau 200
Montréal (Québec) Canada H2Y 1N9
Tel: (514) 350-4300; Fax: (514) 350-4314
E-mail: info@ccemtl.org
<http://www.cec.org>

© Commission for Environmental Cooperation, 2001

Discussion Paper: *Environmental Challenges and Opportunities of the Evolving North American Electricity Market*

North American Commission for Environmental Cooperation (CEC)

This paper highlights key issues and identifies important policy questions raised by the CEC draft working paper of the same title.¹ The overview is intended to further stimulate discussion on the environmental dimensions of the integration of electricity markets on the continent. The CEC promotes environmental cooperation on matters of regional importance, including the effective enforcement of environmental law and the avoidance of environment-related trade disputes.

As the leaders of Canada, Mexico and the United States agree to explore a North American approach to important energy issues, the electricity sector in the region is in the midst of unprecedented change. Competitive electricity markets have been introduced, or remain under consideration, in Canada, Mexico and the United States. As can be seen from Table 1, trade and cross-border investment in electricity is growing on both borders, bolstered by the long-term stability conferred by the trade and investment rules adopted in NAFTA.

	1999	2000	2001	2002	2003	2004	2005	2006	2007
Imports from Canada and Mexico	47.6	46.5	48.6	62.0	66.9	66.0	68.7	67.1	61.9
Gross Exports	15.5	13.0	13.1	13.1	12.7	16.6	16.7	16.8	16.9

Source: IEA Monthly Electricity Survey, May 2001.

In the span of just a few decades, a complex array of cross-border transactions and relationships has become the fabric of North America’s growing regional connectivity.

Affordable and reliable electricity provides a foundation of economic stability upon which prosperity depends. Presently, concerns exist over the prospect of electricity shortages and their affect on economic development in affected regions. At the same time, electricity—its generation, distribution and usage—has significant impacts on human health and the environment. The CEC working paper, “Environmental Challenges and Opportunities of the Evolving North American Electricity Market,” examines some of the regional environmental

¹ Vaughan, Scott, Zachary Patterson and Paul Miller. 2001. CEC Secretariat working paper: *The Environmental Challenges and Opportunities of the Evolving North American Electricity Market*. Commission for Environmental Cooperation, Montreal. The CEC Secretariat welcomes comments on the working paper prior to submitting a final report to Council in early 2002. Kindly forward comments to Zachary Patterson, CEC, 393 St. Jacques St. Ouest, Suite 200, Montreal, Quebec, Canada, H2Y 1N9, or by e-mail at <zpatterson@ccemtl.org>.

dimensions arising out of the transformation of the electricity market, including the key features, trends and variables shaping events in this dynamic sector.

A new level of cooperation in meeting North America's electricity needs opens up possibilities for identifying ways in which affordable and reliable electricity can be provided while at the same time protecting human health and the environment in the region.

Choosing Our Future

Most experts agree that, over time, competitive forces will figure prominently in the design and operation of North American electricity markets. Yet, this does not mean that governments are devolving all responsibility for environmental and economic outcomes to the logic, or vicissitudes, of the marketplace. Electricity markets will continue to operate within the regulatory frameworks designed to deliver affordable and reliable electricity in the region, as well as to protect the health and environment of its citizens (and its neighbors).

The extent to which a more integrated North American electricity market captures the possible benefits of more efficient resource allocation, technology diffusion and consumer choice will depend on the complex interplay between many variables. Many of these variables, such as fuel choice, technology, pollution control strategies and subsidies, are directly influenced by rules and policy measures. Where and when these policy interventions occur, and the degree to which they are coordinated across borders, is likely to be a critical factor in achieving the twin goals of clean and abundant electricity. It is a matter of choice.

After years of experience, we have learned that proactive, preventative policies are almost always preferred to reactive, remedial measures. An overriding question facing policymakers today is what, if any, regional environmental policy responses are called for in the early stages of the accelerating convergence of electricity trade and competition policies in North America.

Key policy considerations emerging from the CEC Secretariat working paper and the other background documents include:

- While important differences remain in each country, a clear trend towards convergence in competitiveness and trade policy is underway in North America. What outcomes would result from a greater effort to coordinate or make compatible relevant federal, state or provincial environmental laws, standards and policies relevant to this sector? More specifically, how could more compatible environmental approaches help to make domestic environmental policies, such as air pollutant reduction strategies, more effective, decrease the likelihood of environment-related trade disputes, (especially those concerning restrictions on market access based on product or production standards) and address concerns about so-called “pollution havens.”
- Current and future uncertainties about many fundamental characteristics of the electricity sector—such as planned and future generation capacity and location, demand, fuel type and technology—lead policymakers to build-in a secure health and

environment safety net. Ambient air standards, already adopted in North America, represent a good common platform to build on. What additional environmental policies and management tools work well in restructured markets and how should these policies be adapted to ensure that they enhance competitiveness and benefit the entire region.

- In some instances, market-based mechanisms to avoid or reduce adverse environmental effects may prove efficient and effective at regional scale, even generating resources for environmental protection and conservation. What potential exists to regionalize these mechanisms and what steps must be taken to identify and explore the potential for cooperation in this area?
- Building a more supportive North American policy framework for energy efficiency and renewables represents a significant opportunity for achieving “win-win” outcomes. What concrete measures must be taken to ensure that domestic measures mesh well in the region?
- How can Canada, Mexico and the United States enhance their policies on access to information, environmental impact assessment and integrated resource planning to better reflect ecological, cultural and economic linkages in North America?

One of the most striking features of the evolving North American electricity market is the rapid pace of change occurring in a sector once characterized by its almost unchanging nature. While the rate of change varies from country-to-country, and in some cases, jurisdiction-to-jurisdiction, the ripple effects of major structural changes increasingly affect electricity generation and transmission throughout those portions of the region currently engaged in electricity trade. Key elements of this dynamic sector highlighted below include the environmental profile of electricity, how market integration links to health and environment and opportunities for great environmental cooperation in this field.

The Environmental Profile of the Electricity Sector

Notwithstanding the obvious benefits electricity provides, the generation and transmission of electricity has considerable impacts on human and ecosystem health. For example, at an aggregate level, in the US, the electricity sector emits approximately 25 percent of all NO_x emissions, roughly 35 percent of CO₂ emissions, one-quarter of total mercury emissions, and almost 70 percent of SO₂ emissions. The sector is the single largest source of nationally reported toxic emissions in the United States and Canada,² and represents a large source of toxic emissions in Mexico.

² CEC. 2001. *Taking Stock 98*. Commission for Environmental Cooperation, Montreal.

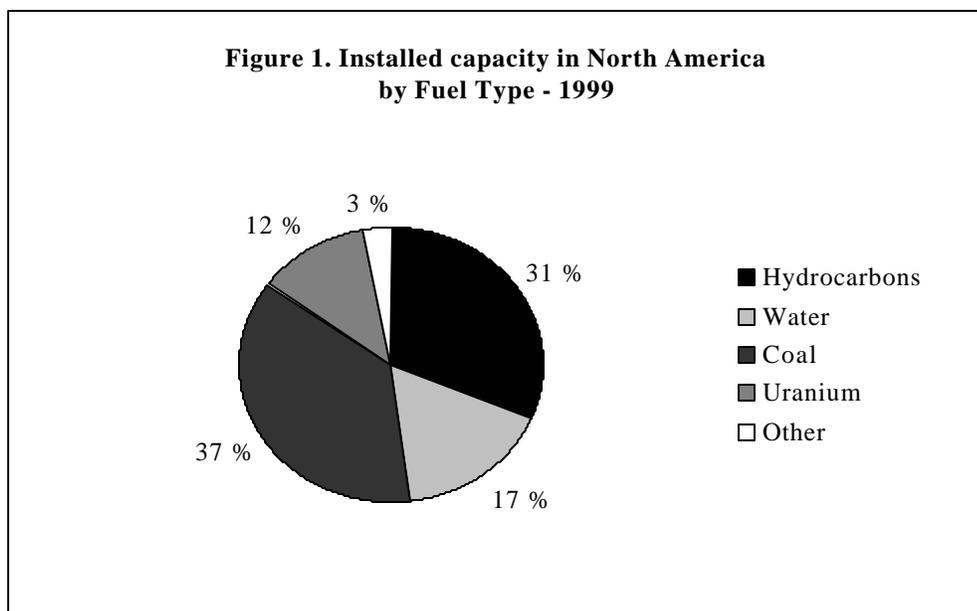
	CO₂ equivalent (tonnes)	Annual SO₂ (tonnes)	Annual NO_x (tonnes)	Annual Hg (kg)
Canada	122,000,000	648,411	289,137	1,774.8
Mexico	90,095,882	1,683,199	244,380	1,117.1
United States	2,331,958,813	12,291,107	5,825,982	29,241

*Some data are estimates, not all data come from 1998. See Section Three of Vaughan et al. 2001, for further discussion.

All forms of large-scale electricity generation affect one environmental medium or another. The majority of air pollution emissions come from coal- and oil-fired plants, though natural gas-fired plants emit a considerable amount of CO₂, a greenhouse gas. Major hydroelectric facilities can displace communities, destroy or degrade critical habitat such as streams and rivers and harm native fish populations. Nuclear power poses well-known health and safety risks. Even wind farms, depending on their location, may raise aesthetic issues and concerns for avian wildlife.

Long-range and Cross-border Environmental Impacts

The environmental impacts associated with most conventional forms of electricity generation often are not limited to the immediate vicinity in which they operate. The medium- and long-range transport properties of ozone precursors (SO_x, NO_x), acid rain, particulates and mercury, to name a few, are well documented.³ Persistent organic pollutants can travel thousands of miles from where they originated before entering the food chain of a distant community. Other emissions, such as CO₂ and ozone-depleting gases, are of global concern wherever they are emitted. Even impacts on biodiversity from pollutants or habitat destruction may affect species far from an activity site, especially for migratory species dependent on corridors and specialized ecosystems in multiple regions.



³ CEC. 1997. *Continental Pollutant Pathways: An Agenda for Cooperation to Address Long-range Transport of Air Pollution in North America*. Commission for Environmental Cooperation, Montreal.

Through our linked airsheds, watersheds and migratory species corridors, the cumulative effects of how we generate electricity are likely to influence the quality of life elsewhere on our continent.

New Generation Capacity

The need to attract policy attention sooner, rather than later, to the electricity sector is illustrated by the planned expansion in domestic electricity supply in all three countries. As of August 2001, utilities, investors and energy planners have announced plans to build more than 2,000 new power generating units in North America, to 2007 (roughly 50% over current installed capacity today). While only a fraction of these projects will likely go forward, it is impossible to determine which ones will move ahead or where they will be located. Based on planned new generation capacity in North America, the CEC estimated high boundary and low boundary values for selected air emissions.⁴

⁴ “High boundary” values include all planned new generation capacity; low boundary values represent a much smaller fraction (approximately 40%) of currently planned generation. For a complete explanation of the methodology employed in deriving these values, see Miller, Paul. 2001. *Summary of Air Quality Indicators Linked to Electric Power Generation*. Commission for Environmental Cooperation, Montreal.

Table 3 – Summary of national emission totals for the electricity generation sector in the reference inventory case and the high and low boundary future projections (percentage change from 1998* reference inventory case shown in parentheses).

Country scenario	Annual CO ₂ (tonnes)	Annual SO ₂ (tonnes)	Annual NO _x (tonnes)	Annual Hg (kg)
Canada reference inventory	122,000,000	648,411	289,137	---
Canada high boundary 2007	19,169,219 (+16%)	15,037 (+2%)	42,014 (+15%)	233 n/a
Canada low boundary 2007	5,118,299 (+4%)	-3,556 (-1%)	15,381 (+5%)	11 n/a
Mexico reference inventory	90,095,882	1,683,199	244,380	1,117
Mexico high boundary 2007	68,565,216 (+76%)	130,708 (+8%)	216,565 (+89%)	275 (+25%)
Mexico low boundary 2007	43,085,556 (+48%)	84,278 (+5%)	128,876 (+53%)	153 (+14%)
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%)	-77,433 (-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 equivalent to 16% of the 1998* reference inventory emissions. This provides a relative sense of the scale of potential emission changes.				
* Some data are estimates, not all data come from 1998. See Section Three of Vaughan et al. 2001, for further discussion.				

The boundaries reflect differing assumptions on the probability of listed projects going forward between 2001 and 2007. The aggregate numbers provide convincing indicators of the dramatically different outcomes possible in today's only partially integrated market. Such variation underscores the importance of carefully considering which environmental policy tools are best suited to operating effectively in a climate of uncertainty. Some of these approaches, such as national ambient air quality standards in Canada, Mexico and the US, enjoy a long record

of implementation and provide an excellent point of departure for less widely adopted measures such as domestic or regional cap and trade programs.

The analysis further identifies regions where generating capacity is likely to be located based on the same assumptions determined to apply to the upper and lower boundary scenarios. For example, consider Table 4, which shows for the high boundary case, changes in emissions of CO₂ and mercury for the top three states/provinces in the three countries.

Table 4 – Changes in Emissions of CO₂ and Mercury Associated with Planned Electricity Projects in 2007 – High Boundary Case, Top Three States/Provinces in the Three NAFTA Countries - numbers in parentheses represent percent contribution of the given jurisdiction of total estimated national increase (see Table 2) in emissions from new capacity in the year 2007.			
Province/Territory	Annual CO₂ (tonnes)	Province/Territory	Annual Hg (kg)
Canada			
Alberta	12,091,059 (63%)	Alberta	218 (94%)
Ontario	2,494,749 (13%)	Ontario	6 (3%)
Quebec	2,252,505 (12%)	Quebec	5 (2%)
Mexico			
Tamaulipas	14,870,794 (22%)	San Luis Potosí	35 (13%)
Veracruz	10,981,293 (16%)	Tamaulipas	34 (12%)
Nuevo Leon	7,314,836 (11%)	Veracruz	27 (10%)
United States			
Texas	59,705,611 (7%)	Kentucky	718 (12%)
Florida	46,201,965 (5%)	Utah	474 (8%)
Illinois	46,113,390 (5%)	Arkansas	403 (7%)

Again, these data merely provide insight into what actors in the sector are thinking *now*; time and time again we are reminded how unpredictable events can alter current paradigms. Nonetheless, the table draws attention to potential regional hotspots of interest for additional analysis on fuel types, pollution control technologies and other factors affecting potential impacts.

How Electricity Market Integration Can Affect the North American Environment

The “integration” of electricity markets refers generally to the operation of a more seamless market, characterized by cooperative regulatory approaches supportive of regional trade, investment and infrastructure development. While far from completely integrated, North American markets have evolved to the point where retail prices in regions of the US are affected by the level of snowfall in eastern Canada, natural gas pipelines cross thousands of miles from

western Canada to Chicago and a growing number of generation projects are designed for export. Recently, British Columbia hydropower even entered into a contract to deliver electricity to northern Mexico.

Integration of regional electricity markets potentially affects environmental quality in a number of ways, many of which are discussed in the draft working paper. For example, removing trade and investment barriers may accelerate capital turnover, allowing for more rapid diffusion of state-of-the-art technologies and pollution control equipment. A more transparent and open trading regime may also help to “get the price right,” helping to internalize environmental externalities—costs not often reflected in electricity prices.⁵

The discussion below introduces a few factors likely to influence what affect market integration may have on the environment. It is critical to note that fuller market integration remains hindered by often severe limitations and constraints in the functioning of the so-called “grid,” or linked supply and transmission infrastructure in the three countries. Many of the considerations discussed below are influenced greatly by the success of efforts to improve the reach and capacity of the grid.

The Fuel of Choice in North America

Related to prices, a key consideration for environmental policymakers will be how market integration affects, in larger areas or regions, the competitiveness of particular fuels such as coal, natural gas or renewables. The fuel, of course, along with pollution control technologies, performance standards, and related regulations largely determine environmental impacts from a specific facility. In 1996, this potential was examined extensively by the US Federal Energy Regulatory Commission (“FERC”) in an environmental impact assessment prior to introducing competition in US wholesale electricity markets by promoting open access to transmission lines.

So far, actual experience in the period of time since the policy took effect suggests that FERC’s “Competition favors Coal” scenario seems to have come the closest to the various scenarios FERC evaluated, although even this scenario underestimated actual CO₂ emissions by a considerable margin.⁶ Importantly, the historic difficulty of accurately forecasting electricity demand continues to plague planners of all types, especially those attempting to assess the potential environmental impacts of different scenarios.

Data including the fuel choice for proposed new generation facilities across North America suggests, for the moment, that prevailing conditions favor natural gas—currently the cleanest of the fossil fuels. Relative fuel prices can shift rapidly, however, and a number of experts already are projecting increased natural gas prices as low-cost, accessible reserves are aggressively exploited. Over time, whether and where “cleaner” electricity generation fuels can compete favorably with “dirtier” ones (considering their full lifecycle) will help answer many of the

⁵ Through, for example, the removal of price distorting subsidies which decrease the relative price of dirtier fuels.

⁶ Woolf, Tim, Geoff Keith and David White. 2001. *A Retrospective Review of FERC’s Environmental Impact Statement on Open Transmission Access*. Synapse Energy Economics, Inc. Cambridge, Massachusetts. The authors attribute the underestimation of emissions in FERC’s analysis mainly to underestimating demand projections throughout the relevant period.

questions being asked today. A longer time frame would consider the still more uncertain pace of technological change and the advent of “breakthrough” technologies, such as hydrogen fuel cells.

Regional Impacts, Pollution Havens, Halos and Generation Clusters

Currently, key determinants for the siting of new electricity generators include the availability and cost of fuel sources along with access to profitable markets (limited, for example, by deficiencies in the operation of the grid). As international markets become more closely integrated, markets favoring the least cost producer may lead to some locational shifts in production. A shift in where production takes place will be accompanied by a change in the location of certain environmental impacts, such as air emissions. Put another way, imported electricity displaces emissions that would have taken place in the domestic market. The relative economic and environmental costs and benefits of these shifts will depend on how a particular region is affected by these changes.

One factor affecting production costs, and hence location, is the relative and absolute cost of environmental regulations. In tight, highly competitive markets, concerns persist in the region that widely divergent regulatory standards could accelerate such locational shifts (so-called “pollution havens”), to the detriment of those living in adversely affected air or watersheds. Renewed concerns about pollution havens have been expressed by some citizens in all three countries.⁷ Conversely, jurisdictions with strong standards or which attract “clean” electricity may see associated health and environment benefits (“pollution halos”).

Even with high environmental standards, the sheer scale effects of new electricity generation in preferred generation regions (often near lucrative export markets) pose significant challenges for environmental managers charged with meeting air quality standards and other environmental goals. Absent near-term technological breakthroughs, regions likely to attract concentrated “clusters” of conventional generation facilities will require robust environmental policies to deliver the benefits of affordable energy and environmental protection. Jurisdictions downwind of new generation facilities will be interested in assuring that adequate measures are in place to protect their environmental and health interests as well.

The Need for Greater Environmental Cooperation, Coordination and Compatibility

There can be no doubt that NAFTA is but the latest evidence of a trend towards convergence of trade, investment and competition policies in the electricity sector in North America. To be sure, Canadian and US competition, trade, investment and transmission policies are converging faster than Mexico, which carved out significant areas from the NAFTA electricity chapter. Still, the

⁷See, for example: Pembina Institute press release: “New standards position Alberta as a pollution haven for coal-fired plants: Standards that affect health and environment set with no public input”. (18 June 2001) at <http://pembina.piad.ab.ca/news/press/2001/2001-06-18.php>; letter from The Border Power Plant Working Group to the Secretaries of State and Energy of the United States and Mexico, *et al.*, entitled “Urgent Need for Bilateral Agreement between the United States and Mexico regarding Sustainable Environmental Requirements for New Power Plants in the Border Region” (22 August 2001). Available on file at CEC. See also Michael Janofsky, “In the race to produce more power, states are faced with environmental tradeoffs.” *New York Times*, 26 March 2001.

trend toward greater trade and deeper integration is clear, reinforced and reinvigorated by the April 2001 leaders' statement on advancing a North American approach to energy. Under the circumstances, it seems fair to ask what might happen if trade and competition policies continue to move in sync without a parallel effort towards more compatible environmental policies, regulations and standards.

As CEC analysis has demonstrated, despite notable advances in modeling and forecasting tools, accurate predictions of demand, supply or other market factors in this area represent a historical exception rather than rule. Nor have futurists fared much better with the wildcard of technology. In fact, one might be inclined at this point to conclude that the picture is too complex and fluid to identify concrete steps to address the environmental dimensions of the changing electricity market.

On the other hand, applying the notion of precaution in the face of uncertainty, there appear to be a number of fairly compelling reasons why early action is indicated. First, failure to at least ensure compatible (not identical) environmental laws, policies and programs in this sector could render less effective carefully considered domestic strategies for striking the right balance between health, environment and abundant electricity. For example, in an increasingly integrated grid, generators could locate power facilities in neighboring jurisdictions without caps, offset requirements or mitigation rules even though emissions from those facilities will enter the airshed of the neighboring jurisdiction maintaining such policies.

Moreover, failure to coordinate regional environmental responses to electricity markets may invite unwelcome environment-related trade disputes as local jurisdictions scramble to enact policies to promote clean energy and/or protect their environment. Examining early policy initiatives from a growing number of US states and Canadian provinces provide a glimpse of some potentially larger scale responses, as well as illustrating how some environmental policy options may be shaped, or constrained, by trade and commerce rules.⁸ Trade experts point out that a number of the environmental policy responses either in place or currently under consideration may be problematic under rules established by the WTO and in NAFTA's Chapter Six and elsewhere.⁹ While such disputes are not inevitable, nor are they insulated from attack and lawmakers need to be cognizant of how trade rules can shape, or in some cases constrain, environmental policy responses.

Opportunities for Environmental Cooperation

Compatible, mutually reinforcing regional policies could provide the long-term stability and predictability conducive to private sector ventures. More compatible regulatory approaches may also establish a foundation for employing innovative market mechanisms on a regional scale. These mechanisms, such as cap and trade schemes, may achieve environmental goals while generating substantial resources that could be made available to help finance technology

⁸ Some twelve US states have enacted renewable portfolio standards. A significantly higher number of states and provinces have introduced consumer choice for "green electricity," or provide incentives for renewable energy.

⁹ Please see background paper III - NAFTA Provisions and the Electricity Sector

upgrades in poorer regions.¹⁰ And development of national, regional and international guidelines, definitions and criteria for areas such as “renewables” could reduce the possibility of environmental policies clashing with trade rules.

Indeed, closer policy collaboration on national, state and provincial policies to promote energy efficiency and renewable energy represent outstanding areas for building a more balanced and sustainable long-term policy framework. In addition to promoting energy security through a more distributed and diverse energy portfolio, greater attention to these areas could help cushion the region from the impacts of more conventional electricity sources.

Finally, there are a number of opportunities to enhance public access to environmental information as well as to improve mechanisms for transboundary integrated resource planning and assessment. A more informed and active citizenry can help ensure that the integration of the North American electricity market benefits our shared economic and environment goals.

¹⁰ CEC. 2001. *Mexico and Emerging Carbon Markets: Investment Opportunities for Small and Medium-sized Companies and the Global Climate Agenda*. Commission for Environmental Cooperation, Montreal.