Green Power Programs in Canada — 2002

Overview of Government Green Power Policies, Utility Green Power Development Programs, Green Power and Certificate Marketing Initiatives, and Their Benefits

By Matthew Bramley, Sylvie Boustie, Jaisel Vadgama, Carissa Wieler and Andrew Pape-Salmon

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for Appropriate Development

About the Pembina Institute

The Pembina Institute is an independent non-profit research, education and advocacy organization that promotes environmental, social and economic sustainability through the development of practical solutions for businesses, governments, individuals and communities. The Pembina Institute provides policy research leadership on climate change, energy policy, green economics, renewable energy, and environmental governance, as well as extensive formal and public education programs. More information about the Pembina Institute is available at http://www.pembina.org.

The Pembina Institute is committed to the development of low-impact renewable energy in Canada. As a practical contribution to this development, and to support the organization's work, in November 2003 the Pembina Institute began selling green power certificates representing the environmental attributes of wind power generated by Vision Quest Windelectric.

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1.1 What is green power?

"Green power" generally refers to electricity with two key characteristics:

- it is produced from renewable sources, and
- its production has low adverse impacts on the environment, human health and communities.

Electricity production from fossil fuels, especially coal, is a major source of greenhouse gases (GHGs) that cause climate change, as well as the regional air pollutants that contribute to acid deposition and smog. Electricity production was responsible for 19% of Canada's GHG emissions in 2001,[1] and for 20% of Canada's sulphur dioxide emissions in 1995.[2] Coal-fired electricity production is also a major source of the toxic metal mercury, accounting for 16% of Canada's air emissions of mercury in 1995.[3]

Green power, on the other hand, has zero or near-zero GHG emissions, and green power sources like wind, hydro and solar power also have zero emissions of regional air pollutants. Green power therefore has an important role to play in Canada's efforts to address climate change and air pollution. Green power can also avoid the adverse impacts on watersheds and landscapes associated with conventional electricity generation, and prevent the pollution and other environmental impacts resulting from the production, distribution (and, where applicable, disposal) of fossil and nuclear fuels.

In addition to its environmental benefits, green power has important benefits for energy security, regional development, economic diversification and creation of skilled jobs:

- Most green power production has no need for supplies of fuel that can be subject to major price fluctuations and international disputes.
- Unlike conventional electricity generation, which involves a small number of very large, centralized facilities, green power development results in a network of numerous small-scale plants with a wide geographic distribution and the promise of economic stimulus in multiple, mainly rural locations.
- A broad review of studies of the relative employment impacts of conventional and alternative energy investment showed that low-impact renewable energy supply provides over 50% more jobs per dollar invested than conventional energy supply.[4]
- A recent study found that wind and solar power both provide about 43% more person-years of employment per dollar invested than coal-fired electricity production.[5]

Precise definitions of green power vary as a result of different views on which levels of adverse environmental, health and social impacts are considered to be sufficiently low and on which sources are considered to be renewable. The important issue of certifying green power generation facilities or

1 Environment Canada. 2003. *1990–2001 National and Provincial GHG Emissions*; http://www.ec.gc.ca/pdb/ghg/ghg_tables_2001_e.cfm.
[2] Environment Canada. 1999. *1995 Criteria Air Contaminant Emissions for Canada*; http://www.ec.gc.ca/pdb/ape/ape_tables/canada95_e.cfm.
[3] Environment Canada. Undated. *Sources of Mercury*; http://www.ec.gc.ca/mercury/bf-s-e.html.
[4] Campbell, B., L. Dufay and R. Macintosh. 1997. *Comparative Analysis of Employment from Air Emission Reduction Measures*. Report for Environment Canada, Global Air Issues Branch. Drayton Valley: Pembina Institute, p. 10.
[5] Singh, V. and J. Fehrs. 2001. *The Work That Goes Into Renewable Energy*, Renewable Energy Policy Project Research Report No. 13. Washington, DC: REPP, p. 20; http://www.repp.org.

products, which depends on adopting particular definitions, is discussed further in Section 4.[6] However, there is broad agreement that green power sources include wind, solar, sustainably produced biomass, small-scale hydro, earth, tidal and waste energy. The following paragraphs provide brief summaries of the three technologies that currently dominate Canada's green power capacity: wind, hydro and biomass.

Wind: Wind energy is one of the fastest-growing sources of energy in the world. To date, however, Canada has made little use of wind power compared to other industrialized countries. At the end of 2002, Canada's installed capacity was about 237 megawatts (MW),[7] compared, for example, to 12,000 MW in Germany.[8] Canada's geographical characteristics result in a considerable wind resource. A very large untapped potential exists in the northern remote regions, along the west and east coasts, in lakefront areas in the Great Lakes region and in site-specific locations in the Prairies. Small wind turbines can be used for remote small-scale applications, and larger wind farms can used for grid-connected applications.

Small-scale hydro: Canada's current small-scale hydroelectric capacity is about 2000 MW.[9] Natural Resources Canada has completed an inventory of Canadian small hydroelectric sites, identifying over 3600 sites with a technically feasible potential of about 9000 MW. Only about 1300 MW of this would be economically feasible currently, but an additional 1800 MW of economically exploitable capacity would become available if capital costs could be reduced by 10–15%.[10] Given the need to conduct site-specific assessments, it is difficult to estimate what proportion of existing or potential future projects have sufficiently low adverse impacts to qualify as green power.

Sustainable biomass: Canada's largest biomass resource is wood. Many facilities in Canada's forest products industry now use bark, sawdust, shavings and/or other wood residues for large-scale production of electricity and heat for their own needs. Canada also has a few grid-connected wood waste-fired power plants operational or under construction, with a maximum capacity of 60 MW.[11] It is projected that Canada will produce surplus wood residues in 2010 with an energy content of 57.6 petajoules (16,000,000 megawatt-hours (MWh)) under a business-as-usual scenario.[12] Others sources of biomass are municipal solid wastes and livestock wastes, all of which can be used to produce "biogas" for electricity generation. By 1997, Canada was generating 82.5 MW of electricity from captured municipal landfill gas, and there are significant opportunities for increasing this amount.[13] Whether a given biomass-fired electricity generation facility can be considered to be producing green power depends on issues including sustainability of harvesting, appropriateness of waste management and emissions of air pollutants.

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[6] For the Pembina Institute's views on what constitutes green power, see Raynolds, M. and A. Pape-Salmon. 2002. *Pembina Institute Green Power Guidelines for Canada*. Drayton Valley: Pembina Institute; http://www.pembina.org/publications_item.asp?id=23.

[7] Canadian Wind Energy Association. Undated. *Canadian Wind Production*; http://www.canwea.org/CanadianProduction.html.

[8] European Wind Energy Association. 2003. *Wind Energy in Europe*; http://www.ewea.org/src/europe.htm.

[9] Natural Resources Canada. 2000. *Hydroelectric Energy Resource Assessment*; http://www.canren.gc.ca/resou_asse/index.asp?CaId=54&PgId=274.

[10] Natural Resources Canada. 2000. *Hydroelectric Energy Resource Assessment*; http://www.canren.gc.ca/resou_asse/index.asp?CaId=54&PgId=274.

[11] Pape-Salmon, A., J. Dogterom, C. Wieler and M. Anielski. 2003. *Low-Impact Renewable Energy Policy in Canada: Strengths, Gaps and a Path Forward*. Drayton Valley: Pembina Institute, p. 22–23; http://www.pembina.org/publications_item.asp?id=150.

[12] National Climate Change Process Forest Sector Table. 1999. *Options Report: Options for the Forest Sector to Contribute to Canada's National Implementation Strategy for the Kyoto Protocol*, p. 24; http://www.nccp.ca/html/tables/pdf/options/Final_Options_Report_English.pdf.

[13] National Climate Change Process. 1998. *Municipalities Issue Table Foundation Paper*, p. 75–76; http://www.nccp.ca/NCCP/pdf/mun_found.pdf.

It is also worth noting that **solar power** is now finding niche applications in Canada, despite the fact that its cost remains relatively high (although falling). For example, in the northern Yukon solar power systems are being used to power telecommunication sites, highway maintenance camps and park facilities. Even though northern countries have a poor solar resource relative to tropical countries, Canada's potential solar resource for heating and electricity is enormous. A solar power assessment conducted in the United Kingdom (located at a similar latitude to Canada) showed that solar photovoltaic (PV) cells could produce an output equivalent to current national electricity generation from 2% of the land area. It was calculated that this output could be achieved by integrating PV modules into roofs and walls, without any additional demand for land.[14]

1.2 Categories of green power programs

A certain amount of green power capacity has developed autonomously in Canada with no specific intervention by governments or major electric utilities. But in the absence of such intervention, green power remains, in most cases, more costly in purely monetary terms than conventional power. A broadening of the concept of cost to include damage to the environment and human health could lead to green power being seen as generally less costly than conventional power. Indeed, to guide its purchases of green power the federal government uses a comparison of its price with the "full" price of conventional power, where the latter is calculated using a full environmental net cost accounting model.[15] However, in the absence of broad market instruments[16] to incorporate adequately environmental and health impacts into all energy prices, specific policies and programs are required to stimulate green power development.

The following four sections describe the four categories of programs responsible for most of the green power development currently occurring in Canada.

1.2.1 Government green power policies

Key government policies used in various countries to directly stimulate significant green power development include the following:

- "renewable portfolio standards" that require a minimum percentage of electricity to be green power
- financial incentives (e.g. tax credits) paid to green power producers per kilowatt-hour (kWh) generated
- other tax benefits such as accelerated depreciation of green power generating equipment for tax purposes
- guaranteed prices per kWh for green power producers
- energy or carbon taxes providing a relative advantage to green power over conventional power
- allocations of emissions allowances or credits to green power facilities in emissions trading schemes
- "public benefits funds" to fund green power projects from charges levied on electricity purchases
- grants, loans or loan guarantees to green power project developers or green power marketers
- construction of green power generation facilities by government agencies
- directives to electric utilities by electricity sector regulatory authorities

[14] Royal Commission on Environmental Pollution. 2000. *Energy — The Changing Climate*. London: Royal Commission, p. 132; http://www.rcep.org.uk/newenergy.html.
[15] Welsh, L. 2003. *The Government of Canada's Incentive Programs*. Presentation to the Conference "How to Profit from the Business of Renewable Energy," Toronto, 20–21 October.
[16] For example, renewable energy portfolio standards, emissions trading systems, or environmental taxes.

- procurement of green power by governments.

Procurement of green power by governments has been a key factor in stimulating green power marketing programs in Canada. The federal government's purchases of green power from ENMAX, SaskPower and Maritime Electric (with provincial government participation in the latter two cases) — in part fulfillment of the government's commitment to meet 20% of its electricity requirements with green power[17, 18] — are an important pioneering example of this. Another major forthcoming initiative is the government of Alberta's commitment to meet more than 90% of its electricity requirements from green power sources, beginning in 2005.[19] Government green power procurement is not explicitly included among the government green power policies described in Section 2.1, but this is only because it is included implicitly in the categories of utility green power development programs (Sections 1.2.2 and 2.2) and green power marketing initiatives (Sections 1.2.3 and 2.3).

Apart from government procurement, relatively few examples of the policies listed above have been implemented to date in Canada. For example, no governments in Canada have yet implemented mandatory renewable portfolio standards or public benefits charges levied on electricity purchases, in contrast to 13 and 14 US state governments respectively that have done so.[20] However, governments in Canada do now seem to have begun a trend towards implementing major green power policies. Perhaps most notably, the federal government recently implemented a major financial incentive for green power in the form of the Wind Power Production Incentive. Other important emerging government green power policies are briefly listed at the beginning of Section 2.

There are currently four key drivers for the implementation of government green power policies in Canada:

- the need to comply with Canada's Kyoto Protocol target to reduce net national GHG emissions to 6% below the 1990 level during 2008–2012
- reduction of the electricity sector's contribution to regional air pollution (smog), which is a subject of major public concern, especially in Ontario
- governments' desire to secure additional, publicly acceptable electricity supplies to forestall shortages (again, especially in Ontario)
- governments' interests in energy security, regional development, economic diversification and creation of skilled jobs (see Section 1.1).

1.2.2 Utility green power development programs

Several large Canadian electric utilities (mostly crown corporations) have begun voluntarily establishing green power generation facilities and/or purchasing green power from independent producers. Terms used to refer to these initiatives include "voluntary portfolio standard," "set aside" or "quota." In some cases the green power is blended with conventional power in the electricity product offered to all consumers, with any cost premiums being recovered from the entire consumer base. While these initiatives are not primarily driven by green power marketing, in other cases the utilities seek to sell the green power at a

[17] Government of Canada. 2000. *Government of Canada Action Plan 2000 on Climate Change*, p. 8; http://www.climatechange.gc.ca/english/whats_new/action_plan.shtml.
[18] Government of Canada. 2002. *Climate Change Plan for Canada*, p. 33; http://www.climatechange.gc.ca/plan_for_canada/plan/index.html.
[19] Government of Alberta. 2003. *Alberta Leads Country In Purchase Of Green Power*. News release, 12 March; http://www.gov.ab.ca/acn/200303/14035.html.
[20] See http://www.ucsusa.org/clean_energy/renewable_energy/page.cfm?pageID=96.

premium through green power marketing (Section 1.2.3) or certificate marketing (Section 1.2.4) initiatives.

For those utilities that are crown corporations, it can be difficult to distinguish utility green power development programs from government green power policies (Section 1.2.1), as provincial governments often use their wholly owned electric utilities as arms of policy. There is therefore some arbitrariness in Section 2 in classifying such programs. There is also some arbitrariness in judging which programs are not primarily driven by green power marketing.

Key drivers for utility green power development programs include

- the desire by the provincial governments that own utilities to develop green power, for reasons outlined in Section 1.2.1;
- companies' desire to be seen as environmentally responsible and proactive;
- companies' desire to gain experience with green power technologies, in the expectation that they will become increasingly important in future;
- customers' desire for utilities to develop green power, revealed through market research;
- government procurement of green power.

1.2.3 Green power marketing initiatives

Several electricity providers in Canada now offer a specific green power product as an alternative to conventional electricity. These products are offered at a higher price than conventional supplies to cover the cost premium associated with generating green power, with the advantage for utilities that the premium does not have to be borne by the entire consumer base. This type of offering is commonly referred to as "green power marketing" or "green pricing." Some green power marketing programs target residential customers, some target business customers, and some both. Governments are also important customers in green power marketing programs.

Experience is showing that a significant number of consumers are willing to pay a green power premium in exchange for receiving a product of higher environmental quality, with the primary motivation being reductions in air emissions from fossil-fuelled electricity generation. Residential customers are interested in taking actions to enhance their personal level of environmental responsibility; business customers may want to be seen as environmentally responsible and proactive and, in some cases, meet voluntary targets for the proportion of their electricity consumption supplied by green power. Governments, as noted above, are also setting targets for meeting a proportion of their electricity requirements from green power sources. These are all important drivers for green power marketing initiatives.

In some cases, the power sold under green power marketing initiatives comes from generation facilities that were established many years ago, either for economic reasons or as a result of a previous government policy. Utilities are now having such facilities certified as green power facilities and selling the product through new green power marketing programs. This is the case, notably, with Ontario Power Generation's Evergreen Green Power program, which depends at present almost entirely on small hydro facilities dating back as far as 1900; and with EPCOR's Green Power ECO-PACKs, which depends in part on a green power facility established as a result of Alberta's Small Power Research and Development Act (1988). In these cases, it can be said that a driver for utilities for establishing green power marketing initiatives is the opportunity to secure a higher price than was previously paid for electricity produced by these facilities. In such instances, the part of the price premium corresponding to pre-existing facilities does not contribute to the development of new green power facilities, create any new displacement of conventional power, or produce any new reductions in adverse environmental impacts.

1.2.4 Green power certificate marketing initiatives

Green power can be considered a combination of two distinct products: electricity plus a bundle of "environmental attributes." Some companies are using this concept to market certificates that represent the environmental attributes of green power, but without the electricity itself. The various programs that currently exist in Canada refer to the certificates as "renewable energy certificates," "green power certificates," "green tags," or "green energy tags." Green power certificates are a new paper commodity representing the reductions that green power generation brings about in emissions of GHGs and regional air pollutants, impacts on watersheds and landscapes, and impacts resulting from the life cycle of fuels.

The reasons for purchasing green power certificates are the same as the reasons for purchasing green power. A distinguishing feature, however, is that although green power certificates can only be created if there is a corresponding amount of actual green power production, certificates recognize the lack of any necessity for the two products inherent in green power — the electricity and the environmental attributes — to be sold together. A purchase of green power and a purchase of green power certificates both guarantee to the buyer that a corresponding amount of green power has been generated. But, unlike the buyer of green power, the buyer of certificates can choose to purchase the environmental attributes separately and apart from the electricity itself.

This creates both advantages and disadvantages. An electricity consumer wishing to support green power is at liberty to purchase certificates from any certificate marketer, rather than needing to have access to an electricity provider offering a green power product. Indeed, many electricity consumers in Canada do not yet have access to electricity providers offering a green power product. It is also generally easier for small companies to market certificates than it is for them to market green power. In addition, green power certificates are more flexible than green power in that they can be purchased by anyone, not just electricity consumers. A business may, for example, want to buy green power certificates to offset corporate GHG emissions, irrespective of their electricity needs.

On the other hand, the offset concept, and the separation of the electricity and the environmental attributes, may be unattractive or too abstract to customers whose primary concern is simply to satisfy their electricity needs with green power. But when green power certificates are sold to a customer who is buying at least an equivalent amount of power on a grid interconnected with the originating green power generation facility, green power certificate marketing becomes indistinguishable from green power marketing.

A risk associated with both green power and certificate marketing is that environmental attributes of the green power that is generated could be sold to multiple consumers, paid for more than once, and/or claimed by multiple parties as evidence of their environmental performance. This risk needs to be eliminated through product auditing programs that track the source and destination of each unit of green power or green power certificate.

1.3 The scope of this report

The scope of this report is green power activities related to the four categories of programs outlined above in Sections 1.2.1–1.2.4. As stated above, those categories of programs are responsible for most of the green power development currently occurring in Canada.

Some green power activities are not covered by this report because of difficulties in quantifying them:

- **Generation of green power not certified or identified by the generator as green power**. As mentioned in Section 1.2.3, some electric utilities have recently been seeking green power

certification for generation facilities that predate the concept of "green power." A considerable number of mainly small hydro facilities in British Columbia, Manitoba, Newfoundland and Labrador, Québec and the Yukon remain uncertified and unidentified as green power facilities. There may also be a few more recent green power facilities not identified by utilities as part of a specific green power program that are not covered by this report.

- **Industry or residential self-generation**. Some industrial facilities in Canada, especially in the forest products and mining sectors, generate electricity for their own needs from biomass or small hydro facilities. Some individuals also use small wind turbines or PV arrays to generate electricity for their own use. Many of these examples could probably qualify for green power certification.
- **Net metering**. By supplying surplus power into the grid at certain seasons or times of day, some small wind, solar and hydro power generators can offset their costs of purchasing grid electricity. This is referred to as "net metering," whereby the consumer is only charged for the net amount of electricity consumed, with the amount supplied back into the grid subtracted from the total. The only utilities allowing net metering in 2002 were Hydro One, Toronto Hydro and Manitoba Hydro. Utilities in other provinces and territories are currently developing net metering programs. The amounts of power involved are very small compared to green power programs covered in this report.
- **Small government programs**. There are a number of government programs that provide some support for green power technologies but that are not covered in this report. However, Section 2 does cover all government programs of which the authors are aware that have had a significant impact on the establishment of existing green power generation facilities.

2. Canadian Green Power Programs Active in 2002: Descriptions

In this section descriptions are provided of all Canadian green power programs that were active in 2002 (i.e., resulting in actual power generation during that year), and that fall into one of the four categories outlined in Section 1.2. Information in the following sections is based on surveys sent to each program proponent, augmented by follow-up communications and other publicly available information.[21]

Green power programs are developing rapidly in Canada. While the scope of this section and Section 3 is limited to programs active in 2002, a listing of new programs operating in 2003 or currently under development is provided in Appendix A.

In Section 2.1 below, procurement of green power by governments is not explicitly included because, as noted in Section 1.2.1, it is included implicitly in the categories of utility green power development programs and green power marketing initiatives (Sections 2.2 and 2.3). In Sections 2.2, 2.3 and 2.4, green power development initiatives by small independent power producers are not explicitly listed except where small producers are selling their product directly to consumers. Otherwise, green power development by small independent producers is captured implicitly under large utilities' green power purchases (Section 2.2), green power marketing initiatives (Section 2.3) or green power certificate marketing initiatives (Section 2.4).

2.1 Government green power policies

A summary of the programs described in this section is provided in Table 1.

2.1.1 Federal: Class 43.1 accelerated capital cost allowance rate and Canadian Renewable and Conservation Expenses (Income Tax Act and Regulations)[22]

The Class 43.1 accelerated capital cost allowance rate and Canadian Renewable and Conservation Expenses (CRCE) were introduced in the 1996 federal budget to promote energy efficiency and low-impact renewable energy through the income tax system. Class 43.1 in Schedule II of the Income Tax Act allows taxpayers an accelerated write-off at up to 30% per year of equipment generating electricity from wind, hydro (less than 15 MW), biomass (municipal waste, wood waste, landfill gas and anaerobic digester biogas), solar PV (over 3 kW), geothermal and certain cogeneration systems.

CRCE is a category of 100% tax-deductible expenditures associated with the start-up of projects for which at least 50% of the capital costs of the property would be described in Class 43.1. Expenses eligible under CRCE include: the cost of pre-feasibility and feasibility studies of suitable sites and potential markets; costs related to determining the extent, location and quality of energy resources; negotiation and site approval costs; certain site preparation costs; service connection costs incurred to transmit power from the project to the electric utility; and wind turbines used to test energy production at the site.

It is questionable whether the installation of specific green power generation facilities can be attributed solely to these measures, and this report does not attempt to quantify their impact in terms of installed

[21] More details on information sources are available from the authors upon request.
[22] Government of Canada. 1998. *Tax incentives For Business Investments In Energy Conservation And Renewable Energy*. Brochure. Cat. no. M92-159/1998; http://www.canren.gc.ca/app/filerepository/General-tax_incentives.pdf.

green power capacity. However, these measures have undoubtedly assisted in the installation of green power capacity that is accounted for in this report under other programs.

2.1.2 Federal: Wind Power Production Incentive[23]

The Wind Power Production Incentive (WPPI), announced in the December 2001 federal budget, provides incentive payments for ten years to wind power generation facilities over 500 kW (20 kW for remote and/or Northern projects) commissioned between April 1, 2002 and March 31, 2007. Payments begin at 1.2 cents per kWh, declining to 0.8 cents per kWh by 2007. Projects are receiving the incentive on a "first in construction, first served" basis up to a total cumulative capacity of 1,000 MW.

This program is likely to have a major future impact, especially if it is expanded, judging by the fact that the government has received letters of interest from proponents of eligible projects adding up to 4,000 MW.

Two wind power generation facilities benefiting from the WPPI entered into service in 2002: SaskPower's 6 MW Cypress Wind Power Project and Huron Wind's 9 MW facility in Ontario. The Cypress facility is covered under SaskPower's GreenPower program (Section 2.3.7), and the Huron Wind facility under Ontario Power Generation's green power target (Section 2.2.4).

Additional new wind power generation facilities benefiting from the WPPI entered into service in 2003, including Canada's largest (75 MW) wind farm at McBride Lake, Alberta.

2.1.3 Alberta: Small Power Research and Development Act[24]

Alberta's Small Power Research and Development Act, enacted in 1988, allowed small-scale or larger pilot solar, wind, hydro, geothermal or biomass power projects to sell power to electric utilities at a regulated price for a period of ten years or more. The Act established a maximum total cumulative capacity of 125 MW, but in reality it resulted in a total of about 108 MW[25] of biomass, wind, hydro and solar power projects built in the early 1990s, with the power being bought by ATCO, EPCOR and TransAlta. Among these projects was Canada's first large-scale wind farm, the 20 MW Cowley Ridge facility, as well as the 23 MW Whitecourt waste wood-fired facility.

Some of the electricity produced by the facilities established as a result of the Act has recently been certified as green power and is now being sold through green power marketing, notably EPCOR's Green Power program (Section 2.3.2).

2.1.4 British Columbia: BC Utilities Commission Integrated Resource Planning Guidelines

In 1993, the British Columbia Utilities Commission issued guidelines for "integrated resource planning," which it defined to include consideration of "not just costs and benefits as they appear in the market but also other monetizable and non-monetizable social and environmental effects."[26] To the authors'

[23] See http://www.canren.gc.ca/programs/index.asp?CaId=107&PgId=622.
[24] See http://www.canlii.org/ab/sta/csa/20030217/r.s.a.2000c.s-9/.
[25] Government of Canada. 1995. *National Action Program on Climate Change*; http://www.ec.gc.ca/climate/resource/cnapcc/c3part09.html.
[26] British Columbia Utilities Commission. 1993. *Integrated Resource Planning ("IRP") Guidelines*. Vancouver: British Columbia Utilities Commission, p. 1; ftp://ftp.bcuc.com/Web%20Folder/PUB/MiscDocs/IRPGuidelines.pdf.

knowledge, the only new low-impact renewable electricity facility of significant size that resulted from the guidelines was the 66 MW Williams Lake biomass power plant, now operated by TransCanada.

2.1.5 Ontario: "set aside" of tradable emissions allowances for renewable energy projects[27]

Under Ontario's regulated emissions trading system for sulphur dioxide (SO_2) and nitrogen oxides (NO_x), which has been operating since the beginning of 2002, a pool of emissions allowances of one kilotonne (kt) per year of NO_x and 4 kt per year of SO_2 is reserved for approved new conservation and renewable energy projects that displace electricity produced from coal- or oil-fired plants. Eligible renewable energy projects are wind power, solar PV and run-of-river hydro power generation facilities, as well as projects to increase production from existing hydro reservoirs (with no change in reservoir size). This represents a limited financial incentive to such projects, depending on the market value of the allowances.

By the end of 2002, one green power project had received "set aside" allowances: the 660 kW Port Albert wind turbine.[28] This facility is covered under the Green Tags Ontario program (Section 2.4.3).

2.1.6 Prince Edward Island: PEI Energy Corporation wind power development

The government of Prince Edward Island, acting through the PEI Energy Corporation, owns and finances, in partnership with the federal government, the Atlantic Wind Test Site at North Cape, established in 1980. In 2001, the PEI Energy Corporation installed a 5 MW EcoLogo-certified wind farm at the site in response to commitments by the provincial and federal governments to purchase most of the farm's output for use in government buildings on the island.

Up to 20% of the wind farm's output is being marketed through Maritime Electric's Green Power Program (Section 2.3.6), with the premiums passed on to PEI Energy Corporation.

2.1.7 Québec: Fonds pour l'accroissement de l'investissement privé et la relance de l'emploi[29]

Québec's November 2001 provincial budget made wind power projects eligible for funding by the Fonds pour l'accroissement de l'investissement privé et la relance de l'emploi (FAIRE; Private Investment and Job Creation Promotion Fund), which provides grants, loans and loan guarantees to new projects that, over a two-year period, involve an investment of at least $2 million and create at least 50 jobs. It has not been possible to assess the impact to date of this program on wind power development in Québec. However, all of Québec's existing wind power capacity is already covered under Hydro Québec's wind power development (Section 2.2.5).

2.1.8 Yukon: Green Power Initiative

In December 1999 the Yukon Development Corporation (a crown corporation controlled by the territorial government) published the *Yukon Green Power Initiative Implementation Strategy*, described by the

[27] See http://www.ene.gov.on.ca/envision/air/etr/index.htm.
[28] See http://www.ene.gov.on.ca/envision/air/etr/credits/saraccounts.htm.
[29] See http://www.formulaire.gouv.qc.ca/cgi/affiche_doc.cgi?dossier=5260&table=0&.

responsible minister as "an important component of the Yukon government's comprehensive energy program."[30] The initiative has four implementation components:

- green power information and training
- green power research and development
- tendering and constructing green power projects
- green power marketing and consumer choice.

Table 1. Summary of Government Green Power Policies Active in 2002

Program	Program Type	Program Lifetime	Resources Installed by the End of 2002 as a Result of the Program
Federal: Class 43.1 accelerated capital cost allowance rate and Canadian Renewable Energy and Conservation Expense	Tax write-off	1996–indefinite	*Assumed to be accounted for under other programs*
Federal: Wind Power Production Incentive	Subsidy per kWh	2002–2017	Wind: 15 MW *(also accounted for under SaskPower's GreenPower program (Table 3), and Ontario Power Generation's green power target (Table 2))*
Alberta: Small Power Research and Development Act	Guaranteed price per kWh	1988–various	Wind: 20 MW Biomass, hydro: 88 MW *(23 MW of this is also accounted for under EPCOR's Green Power ECO-PACKs (Table 3))*
British Columbia: BC Utilities Commission Integrated Resource Planning Guidelines	Directive by regulatory authority	1993–?	Biomass: 66 MW
Ontario: "set aside" of tradable emissions allowances for renewable energy projects	Allocation of emissions allowances	2002–indefinite	Wind: 0.66 MW *(also accounted for under the Green Tags Ontario program (Table 4))*
Prince Edward Island: PEI Energy Corporation wind power development	Construction of facility by government agency	2001–indefinite	Wind: 5 MW *(also accounted for under Maritime Electric's Green Power Program (Table 3))*
Québec: Fonds pour l'accroissement de l'investissement privé et la relance de l'emploi	Grants, loans and loan guarantees	2001–indefinite	*Accounted for under Hydro-Québec's wind power development (Table 2)*
Yukon: Green Power Initiative	Construction of facility by government agency	1999–indefinite	Wind: 0.66 MW

[30] Yukon Development Corporation. 1999. *The Yukon Green Power Initiative: Implementation Strategy*. Whitehorse: Yukon Development Corporation; http://www.yec.yk.ca/literature/gpower.pdf.

To date, the third of these four components has resulted in the installation of a 660 kW wind turbine in Whitehorse in September 2000. The green power marketing component received seed funding in February 2000 but has not yet been implemented.

2.2 Utility green power development programs

A summary of the programs described in this section is provided in Table 2.

2.2.1 British Columbia: BC Hydro voluntary portfolio standard

In 2000, BC Hydro adopted a voluntary portfolio standard under which it committed to meet 10% of increased demand for electricity up to 2010 through green power sources. By the end of 2002, 7.75 MW of hydro power had been installed (May 2002) in fulfillment of the standard, and BC Hydro plans to purchase power generated from biomass and potentially other technologies in the future. All green power is currently purchased from independent power producers. Green power purchases are screened according to BC Hydro's own "green criteria," although the company is considering future adoption of EcoLogo certification.

BC Hydro is now seeking to recover the costs associated with its voluntary portfolio standard through its green power certificate marketing initiative (Section 2.4.2).

In November 2002, the government of British Columbia set a voluntary goal for electricity distributors to acquire 50% of new supply from "BC Clean Electricity" between 2002 and 2012 (see Appendix A). This goal has now been adopted as a commitment by BC Hydro.

2.2.2 Nova Scotia: Nova Scotia Power Green Power Program

In the context of considerable support in the province for a mandatory renewable portfolio standard that would apply to green power facilities installed post-2001 (see Appendix A), Nova Scotia Power has begun voluntarily developing green power capacity. In fall 2002 the company installed two wind turbines (EcoLogo-certified) with a combined capacity of 1.2 MW. In addition, the company is now negotiating for an additional 100,000 MWh per year (approximately 30 MW) of wind energy from independent power producers.

Nova Scotia Power is seeking to recover the costs associated with these initiatives through green power marketing (Section 2.3.4).

2.2.3 Nunavut: Nunavut Power Corporation wind power generation

Nunavut Power Corporation has made a voluntary commitment to produce wind power to gain experience with the technology, in anticipation that capital costs will decline. In 2000, the company installed a 66 kW wind turbine in Rankin Inlet. Costs are recovered through territory-wide electricity sales.

2.2.4 Ontario: Ontario Power Generation green power target

Ontario Power Generation has adopted a goal to increase its supply of green power to 500 MW by 2005.[31] At the end of 2002, the company's green power portfolio was about 144 MW, dominated by hydro (29 facilities installed since 1900), but with 11.4 MW of wind power (comprising the 9 MW Huron wind farm installed in November 2002 and turbines at Pickering and Tiverton), 4.4 MW of landfill gas combustion (Waterloo, installed in 1999), 1.4 MW from an anaerobic digester for commercial organic waste (Newmarket, installed in 2002) and a small amount of solar power. Six per cent of this portfolio is currently purchased from independent producers, and all facilities are EcoLogo-certified.

Ontario Power Generation is seeking to recover the costs associated with meeting its green power target through its Evergreen Green Power marketing program (Section 2.3.5).

2.2.5 Québec: Hydro-Québec wind power development[32]

Hydro-Québec began exploring wind power in 1975, and installed a number of experimental wind turbines beginning in 1977. The projects currently operating are all in the Gaspésie region: a 2.25 MW farm installed in 1998, and the two phases of the Le Nordais project, with respective capacities of 57 MW and 43 MW, installed in 1998–99. Until July 2003 these were Canada's two largest wind farms. The Le Nordais project is independently owned but its entire output is purchased by Hydro-Québec.

Table 2. Summary of Utility Green Power Development Programs Active in 2002

Program	Cost Recovery Mechanism	Facility Certification	Resources Installed by the End of 2002 Under the Program
BC Hydro voluntary portfolio standard	Green power certificate marketing	No, but screened with BC Hydro "green criteria"	Hydro: 7.75 MW *(also accounted for under BC Hydro's Power Smart Green Power Certificates program (Table 4))*
Nova Scotia Power Green Power Program	Green power marketing	EcoLogo	Wind: 1.2 MW *(also accounted for under Nova Scotia Power's Green Power Program (Table 3))*
Nunavut Power Corporation wind power generation	General electricity sales	No	Wind: 0.066 MW
Ontario Power Generation green power target	Green power marketing	EcoLogo	Hydro: 126.6 MW Wind: 11.4 MW *(9 MW of this is also accounted for under the Wind Power Production Incentive (Table 1))* Landfill/biogas: 5.8 MW *(all of the above are also accounted for under Ontario Power Generation's Evergreen Green Power program (Table 3))*
Hydro-Québec wind power development	General electricity sales	No	Wind: 102 MW

[31] Ontario Power Generation. 2002. *Ontario Power Generation Greenhouse Gas Action Plan — 2001*, p. 8; http://www.opg.com/envcomm/GreenhouseActionPlan_2001.pdf.
[32] See http://www.hydro.qc.ca/production/eolien/historique.html.

In 2003 the Québec government adopted a regulation requiring the installation of a further 1000 MW of wind power capacity by the end of 2012, and announced aid to facilitate the creation of an additional 108 MW of capacity (see Appendix A).

2.3 Green power marketing initiatives

A summary of the programs described in this section is provided in Table 3. The "marketing strategy" quotes below are edited extracts of the surveys completed by program proponents.

2.3.1 Alberta: ENMAX Greenmax program

ENMAX is a City of Calgary-owned utility with 340,000 residential and 22,000 commercial customers in Southern Alberta. ENMAX's Greenmax program, established in 1998, was the first green power marketing program in Canada. Over 4000 residential and 200 commercial customers were participating in the program at the end of 2002, buying electricity produced from 40 MW of EcoLogo-certified wind power capacity installed between 1997 and 2001 and owned by Vision Quest Windelectric and Canadian Hydro Developers. ENMAX has now partnered with Vision Quest to build Canada's largest (75 MW) wind farm at McBride Lake (supported by the federal Wind Power Production Incentive — see Section 2.1.2), completed in July 2003.

In 2002, residential participants had the option of paying a premium of $5, $10 or $15 per month on their electricity bill to purchase 75, 160 or 250 kWh respectively of green power. Premiums have since fallen dramatically; premiums have varied according to changing market conditions since the program's inception. In addition to the source facilities, the green power product is EcoLogo-certified.

Natural Resources Canada, Environment Canada and Calgary Transit are all examples of commercial customers that participate in the program. Calgary Transit's C-Train light rail system is 100% powered by wind power supplied through Greenmax.

Marketing strategy: "Aggressive marketing, publicity and communications tactics."

2.3.2 Alberta: EPCOR Green Power ECO-PACKs

EPCOR is Alberta's largest electric utility, with 500,000 residential customers alone. EPCOR's Green Power program was launched in 1999, and by the end of 2002, 4,985 residential customers and one small commercial customer were participating. Two-thirds of the electricity supplied to the program in 2002 came from the 900 kW Weather Dancer wind turbine on the Peigan Nation Reserve, with the remainder supplied by the 23 MW Whitecourt waste wood-fired facility (built in the early 1990s as a result of the Small Power Research and Development Act (Section 2.1.3), with a plant refurbishment in 1997 resulting in expanded production) and the 13 MW Taylor hydro plant (commissioned in 2000), plus 13.4 kW of solar roof panels installed in 1996 at the EPCOR Centre. All facilities are EcoLogo-certified.

The Green Power program offers "ECO-PACKs" for a premium of $5, $10, $20 and $40 per month, corresponding to 55, 110, 275 or 550 kWh of green power respectively. The ECO-PACKs are marketed as 10%, 20%, 50% and 100% green power use, based on an average residential customer's monthly electricity consumption of 550 kWh. In addition to the source facilities, ECO-PACKs are EcoLogo-certified.

Marketing strategy: "Web site, commercials."

2.3.3 Alberta: Vision Quest Windelectric Green Energy program

Vision Quest Windelectric is a formerly independent wind power producer (owned since October 2002 by TransAlta) that began operations in 1997 and had a total installed capacity of 44 MW (all EcoLogo-certified) by the end of 2002. Most of the power is marketed through the ENMAX Greenmax program (Section 2.3.1), but 4 MW of capacity was used in 2002 for direct sales to 100 residential customers and two commercial/industrial customers (as of the end of the year) through Vision Quest's Green Energy marketing program.

The price premium for residential customers in 2002 was $9.50 for 100 kWh of green power; the price for commercial/industrial customers is customized. In addition to the source facilities, the green power product is EcoLogo-certified. In 2003, residential customers are being targeted exclusively by Vision Quest's new green power certificate product (Green Energy Tags, see Appendix A), with a dramatically lower price.

Marketing strategy: "Web site, grass roots marketing, speaking, etc."

2.3.4 Nova Scotia: Nova Scotia Power Green Power Program

Nova Scotia Power is seeking to recover the costs associated with its voluntary wind power development (Section 2.2.2) through a green power marketing program launched in late 2002. By the end of the year, 161 of the company's 400,000 residential customers were participating in the program, following an initial marketing effort limited to employees and residents living close to the turbine sites. The Green Power Program offers 125 kWh blocks of EcoLogo-certified green power at a price of $5 over and above the standard electricity price.

Nova Scotia Power is not currently planning to offer green power to commercial customers, but in 2002 the company was in negotiation with the federal government regarding the sale of green power for use by federal facilities located in the province.

Marketing strategy: "Limited marketing to employees and residents around turbine sites. More widespread promotional efforts to start again in second quarter of 2003."

2.3.5 Ontario: Ontario Power Generation Evergreen Green Power program

Ontario Power Generation (OPG) is seeking to recover the costs associated with meeting its green power target (Section 2.2.4) through its Evergreen Green Power marketing program for large commercial, industrial and re-seller customers (the company does not serve residential customers directly). The program was launched in 2001 with the creation of OPG Evergreen Energy, a new division of the company. The company is not willing to reveal the size of its total customer base or the number of customers participating in the Green Power program.

Three products are offered through the Evergreen Green Power Program.

- "Evergreen Friendly Power," generated entirely from facilities built prior to 1991;
- "Evergreen Clean Green Power," a 50/50 blend of power generated from facilities built both prior to 1991 and after 1990; and
- "Evergreen Pure Green Power," generated entirely from facilities built after 1990.

The first of these is offered only to re-sellers who sell on the power to consumers. OPG implies that all facilities and products are EcoLogo-certified, but this cannot be the case for "Evergreen Friendly Power" as the certification criteria require green power products to incorporate a minimum of 50% of power from

facilities that began operations in 1991 or later (see Section 4.2.1). OPG has stated that Evergreen Green Power is offered at a premium of $35/MWh (with no change since the program's inception), but there is presumably some price differentiation between the three products.

Marketing strategy: "Launch of substantial marketing program aimed currently at large commercial and industrial customers."

2.3.6 Prince Edward Island: Maritime Electric Green Power Program

Maritime Electric agreed to develop and administer a green power marketing program for its customers in conjunction with the government of Prince Edward Island's development of its 5 MW North Cape wind farm (Section 2.1.6). Maritime Electric can purchase up to 20% of the wind farm's output for sale through its Green Power Program, which was launched in December 2001. By the end of 2002, 389 of the company's 56,300 residential customers and 32 of the company's 11,200 small business customers were participating in the program.

Under the program, EcoLogo-certified green power is sold at a premium of $1.75 per block of 50 kWh over and above the standard electricity price. A federal government Green Power Incentive of 1 cent per kWh was credited towards this premium until March 31, 2003. Premiums are passed on to the PEI Energy Corporation, which owns and operates the wind farm.

Marketing strategy: "TV, radio, ads, interviews."

2.3.7 Saskatchewan: SaskPower GreenPower program

SaskPower's GreenPower program, launched in 2002, offers green power from the 11 MW SunBridge wind power project (installed in 2001 and owned and operated by Suncor Energy and Enbridge) and SaskPower's own 6 MW Cypress Wind Power Project (installed in October 2002). Both facilities are EcoLogo-certified. In early 2002, the program had 230 commercial/industrial participants out of the 86,000 that the utility serves.[33] The program was launched for the utility's 312,000 residential customers in April 2002, with the City of Saskatoon as a partner in marketing the program. SaskPower is not willing to reveal the extent of participation in the program at the end of 2002, but it states that the Cypress facility was built "due to the positive response to GreenPower." The federal and provincial governments are major purchasers.

In 2002, the program offered green power at a premium of $3.50 per 100 kWh block. The price has been reduced to $2.50 in 2003. Purchases over $100,000 are negotiated on a case-by-case basis. In addition to the source facilities, the green power product is EcoLogo-certified.

Initially, unlike any of the other Canadian green power marketing programs active in 2002, SaskPower was planning to retain the ownership of the GHG reductions resulting from its green power sales (except for sales to the federal government), and to count them towards its voluntary GHG reduction targets.[34] This meant that consumers would be purchasing only a portion of the environmental attributes of the product, something that is at odds with the EcoLogo certification criteria, which require that all

[33] Dogterom, J., M. McCulloch and A. Pape-Salmon. 2002. *Green Power Marketing in Canada: The State of the Industry*. Drayton Valley: Pembina Institute; http://www.pembina.org/publications_item.asp?id=147.
[34] SaskPower. 2002. *Climate Change Action Plan Progress Report 2001*, Table 10.1; http://challenge.vcr-mvr.ca/cha_client_e.cfm?No=26.

environmental attributes be transferred to the customer or retired (see Section 4.2.1). SaskPower now no longer counts GHG reductions from its green power sales towards its voluntary GHG targets.[35]

Marketing strategy: "Awareness through television, bill inserts, newspaper inserts, trade shows and media."

Table 3. Summary of Green Power Marketing Initiatives Active in 2002

Program	Number of Customers at Year End	Price Premium in 2002 ($/MWh)	Resources Installed by the End of 2002 that Contribute to the Program
ENMAX Greenmax program	Residential: over 4,000 Commercial: 200	Residential: $60–66.67	Wind: 40 MW
EPCOR Green Power ECO-PACKs	Residential: 4,985 Commercial: 1	$72.73–90.91	Biomass: 23 MW *(also accounted for under the Small Power Research and Development Act (Table 1))* Hydro: 13 MW Wind: 0.9 MW Solar: 0.0134 MW
Vision Quest Windelectric Green Energy program	Residential: 100 Commercial/ industrial: 2	Residential: $95 Commercial/ industrial: customized	Wind: 4 MW
Nova Scotia Power Green Power Program	Residential: 161 Commercial/ industrial: 0	$40	Wind: 1.2 MW *(also accounted for under Nova Scotia Power's Green Power Program (Table 2))*
Ontario Power Generation Evergreen Green Power program	Commercial/ industrial/ re-seller*: confidential* Residential: 0	$35	Hydro: 126.6 MW Wind: 11.4 MW *(9 MW of this is also accounted for under the Wind Power Production Incentive (Table 1))* Landfill/biogas: 5.8 MW *(all of the above are also accounted for under Ontario Power Generation's green power target (Table 2))*
Maritime Electric Green Power Program	Residential: 389 Small business: 32	$35	Wind: 5 MW *(also accounted for under PEI Energy Corporation's wind power development (Table 1))*
SaskPower GreenPower program	Residential/ commercial/ industrial: *confidential*	$35 (negotiable for purchases over $100,000)	Wind: 17 MW *(6 MW of this is also accounted for under the Wind Power Production Incentive (Table 1))*

Certification: All facilities and products in the table, except for Ontario Power Generation's Evergreen Friendly Power (generated entirely from facilities built prior to 1991), sold under the company's Evergreen Green Power program, are EcoLogo-certified.

[35] SaskPower. 2003. *Climate Change Action Plan Progress Report 2002*, p. 12, Table 10.1; http://challenge.vcr-mvr.ca/cha_client_e.cfm?No=26.

2.4 Green power certificate marketing initiatives

A summary of the programs described in this section is provided in Table 4. The "marketing strategy" quotes below are edited extracts of the surveys completed by program proponents.

2.4.1 Alberta: Canadian Hydro Developers Renewable Energy Certificates

Canadian Hydro Developers has created a Renewable Energy Certificates program to sell the environmental attributes of the green power produced by its EcoLogo-certified Cowley Ridge North (19.5 MW) and Sinnot (6.5 MW) wind farms installed in September 2001. At the end of 2002 the program had three commercial customers. The Renewable Energy Certificates are sold in a minimum amount of 1 MWh at a price of $30 per MWh, and are self-certified.

Marketing strategy: "Advertising."

2.4.2 British Columbia: BC Hydro Power Smart Green Power Certificates

BC Hydro is seeking to recover the costs associated with its voluntary portfolio standard (Section 2.2.1) through its Power Smart Green Power Certificate marketing initiative, launched in 2002. Only one sale of certificates was made (to a wholesale customer) as a result of power generated in 2002. However, in September 2002, BC Hydro announced that 20 business and institutional buyers had agreed to purchase 2003 vintage certificates. In 2003 the program is being targeted (on a pilot basis) at business customers, who are charged $20 per certificate representing the environmental attributes of 1 MWh of green power. Certificates also continue to be offered to wholesale customers. Certificates of 2002 and 2003 vintages are self-certified and audited by KPMG, but BC Hydro is considering future adoption of EcoLogo certification.

Marketing strategy: "We are promoting the product through a dedicated key account sales manager who is making face-to-face sales calls. We are building awareness through some advertising in targeted vertical publications and attendance at key trade shows."

2.4.3 Ontario: Green Tags Ontario

Green Tags Ontario is a pure retailer of green power certificates representing the environmental attributes of green power purchased from the EcoLogo-certified Sky Generation (1.8 MW, installed in November 2002) and Port Albert (660 kW, installed in December 2001) wind turbines. The Green Tags Ontario program, launched in early 2002 by the Grey Bruce Renewable Energy Co-op, had 300 residential and 10 small business customers by the end of the year. The certificates are sold for $75 per MWh. The product itself is not certified but audits are permitted in the purchase agreements.

Marketing strategy: "PR, public speaking, brochure distribution in the turbine area, floats in parades, newsletter, community meetings, networking with other groups, Web site."

Table 4. Summary of Green Power Certificate Marketing Initiatives Active in 2002

Program	Number of Customers at Year End	Price Premium in 2002 ($/MWh)	Certification	Resources Installed by the End of 2002 that Contribute to the Program
Canadian Hydro Developers Renewable Energy Certificates	Residential: 0 Commercial: 3	$30	Facilities: EcoLogo Product: self-certified	Wind: 26 MW
BC Hydro Power Smart Green Power Certificates	Residential/ commercial/ industrial: 0 Wholesale: 1	$20 *(price offered to business customers in 2003)*	Facilities: no, but screened with BC Hydro "green criteria" Product: self-certified and independently audited	Hydro: 7.75 MW *(also accounted for under BC Hydro's voluntary portfolio standard (Table 2))*
Green Tags Ontario	Residential: 300 Small business: 10	$75	Facilities: EcoLogo Product: self-certified, audits permitted	Wind: 2.46 MW

3. Canadian Green Power Programs Active in 2002: Quantification and Benefits

Electricity production from fossil fuels, especially coal, is a major source of GHGs and regional air pollutants. Green power, on the other hand, has zero or near-zero GHG emissions,[36] and green power sources like wind, hydro and solar power also have zero emissions of regional air pollutants. Emissions of carbon dioxide (the most important long-lived GHG) from the combustion of biomass can be considered to be zero if the biomass is produced in a sustainable manner, because the carbon dioxide will be reabsorbed by new plant growth.[37] Biomass combustion can, however, have significant emissions of regional air pollutants.

Sections 3.1–3.3 provide brief background information on the environmental issues that green power can help to address. Section 3.4 then presents a quantitative analysis of the green power programs described in Section 2, in terms of their contribution in 2002 to each province or territory's electricity production, and to reductions of emissions of GHGs and regional air pollutants. Section 3.5 briefly outlines some non-environmental benefits of green power.

3.1 Climate change

Long-lived GHGs emitted from human activities, especially carbon dioxide, methane and nitrous oxide, are accumulating in the atmosphere and have now become the dominant influence on global climate change. The global average temperature rose by about 0.6 ºC during the twentieth century, and, unless emissions soon begin to fall quite quickly, it is projected to rise by a further 1.4 to 5.8 ºC by 2100.[38] A wide range of adverse environmental, social and economic impacts are associated with global average temperature increases in this range, some of them severe and extensive.[39]

As a small first step towards stabilizing GHG concentrations in the atmosphere, governments adopted the Kyoto Protocol in 1997. Canada ratified the protocol in December 2002, thereby agreeing to a legally binding target of reducing national GHG emissions to 6% below the 1990 level during 2008–2012 (net of credits for carbon sinks and purchases of international emissions units). In November 2002, the federal government published the *Climate Change Plan for Canada*,[40] outlining the approach it wishes to take to comply with the Kyoto Protocol. Renewable electricity, including green power, is a prominent feature of the plan (additional information is provided in Appendix A).

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[36] For national and international GHG emissions accounting purposes, hydro power is currently deemed to have zero GHG emissions. However, it is known that large hydro reservoirs can result in significant emissions of methane, a powerful GHG. These emissions can expected eventually to be accounted for in official GHG emissions inventories. This will not apply to small hydro power projects that avoid the flooding of land.

[37] For national and international GHG emissions accounting purposes, carbon dioxide emissions from all biomass combustion is currently deemed to be zero, regardless of how the biomass is produced. This may change in future. Currently, only the (relatively small) methane and nitrous oxide emissions from biomass combustion need be accounted for.

[38] Intergovernmental Panel on Climate Change (2001), *Summary for Policymakers.* A Report of Working Group I of the Intergovernmental Panel on Climate Change. Geneva: IPCC; http://www.ipcc.ch.

[39] Intergovernmental Panel on Climate Change (2001), *Summary for Policymakers — Climate Change 2001: Impacts, Adaptation and Vulnerability*. A Report of Working Group II of the Intergovernmental Panel on Climate Change. Geneva: IPCC; http://www.ipcc.ch.

[40] Government of Canada. 2002. *Climate Change Plan for Canada*; http://www.climatechange.gc.ca/plan_for_canada/plan/index.html.

3.2 Air pollution[41]

Perhaps the two most prominent aspects of regional air pollution are smog and acid rain. Smog has major adverse impacts on human health and acid rain has major environmental effects. Federal studies show that several thousand of premature deaths per year can be attributed to air pollution, and, according to the Ontario Medical Association, air pollution costs more than $1 billion a year in hospital admissions, emergency room visits and absenteeism in Ontario alone.

The two main ingredients in smog that affect human health are ground-level ozone and fine airborne particles (particulate matter, or PM). Ground-level ozone is produced when NO_x and volatile organic compounds (VOCs) react in sunlight and stagnant air. About 95% of NO_x emissions from human activity come from the burning of fossil fuels in vehicles, homes, industry and power plants. VOCs come mainly from gasoline combustion and the evaporation of liquid fuels and solvents. Human activities are responsible for the increases in ground-level ozone in recent years.

PM directly emitted to the atmosphere but a large proportion is also formed through chemical reactions involving NO_x, SO_2, VOCs and ammonia. The main sources of airborne SO_2 are coal-fired power generating stations and non-ferrous metal smelters.

SO_2 and NO_x are also the main contributors to acid rain, which can damage crops, forests and whole ecosystems. Models predict that in 2010, even after significant past and future planned emission reductions in both Canada and the US, up to one quarter of the lakes in eastern Canada will remain chemically damaged. Forests in eastern Canada receive roughly twice the level of acid they can tolerate without long-term damage.

Mercury is a highly toxic metal that can volatilize and be carried in the atmosphere all over the world. Airborne mercury in Canada comes mainly from coal-fired power plants in the US and base metal smelters and incinerators in Canada, although in 1995 coal-fired electricity production also accounted for 16% of Canada's air emissions of mercury.[42]

Key drivers for action in Canada to reduce emissions of air pollutants are the Canada-US Air Quality Agreement and its amendments, and the Canada Wide Standards (CWS)[43] agreed to by federal, provincial and territorial governments for PM, ground-level ozone and other pollutants. CWS for mercury from electricity generation are under development.

3.3 Other environmental issues

Other environmental issues that green power can help address are the impacts on watersheds and landscapes associated with conventional electricity generation, and the pollution and other environmental impacts resulting from the production and distribution (and, where applicable, disposal) of fossil and nuclear fuels.

[41] Except where noted, all information in this section has been taken from Environment Canada's Clean Air Web site; http://www.ec.gc.ca/air/introduction_e.html.
[42] Environment Canada. Undated. *Sources of Mercury*; http://www.ec.gc.ca/mercury/bf-s-e.html.
[43] See http://www.ccme.ca/initiatives/standards.html.

3.4 Quantitative analysis

This section presents a quantitative analysis of the green power programs described in Section 2, in terms of their contribution in 2002 to (i) each province or territory's electricity production, and (ii) estimated reductions of emissions of GHGs and regional air pollutants. The analysis presented here used the following assumptions, approaches and sources:[44]

1. Electricity production attributed to a particular green power program is the total production during 2002 from the green power generation facilities installed as a result of the program, under the program, or that contribute to the program.[45]
2. Electricity production data for facilities installed during 2002 has been adjusted in proportion to the number of months of full operation to ensure that only those months are counted.[46]
3. Care has been taken to avoid any double counting of electricity production or, as a consequence, emission reductions. In all cases but one, avoidance of double counting is made explicit in Tables 5 and 6 below by statements that the impacts of certain programs are already fully accounted for under other programs. The one case where avoidance of double counting is not explicit is that of the 23 MW Whitecourt waste wood-fired facility, which is accounted for here under the Small Power Research and Development Act rather than the EPCOR Green Power ECO-PACKs program (to which it contributed 700 MWh in 2002).
4. Since a full listing of facilities established as a result of the Small Power Research and Development Act was not available, it was assumed that the 88 MW of capacity not accounted for by the Cowley Ridge wind farm is evenly divided as 44 MW biomass and 44 MW hydro. It was further assumed that all the facilities established as a result of the Act are still operating at normal capacity.
5. The contribution of green power programs in 2002 to each province/territory's total electricity production (Table 8) had to be calculated using total electricity production data for 1999 (as more recent data could not be obtained), taken from the Canadian Electricity Association's publication *Electric Power in Canada 1998–1999*.

Additional assumptions, approaches and sources used are listed in Appendix C.

Table 5 presents the combined capacities of green power generation facilities installed as a result of the programs, under the programs, or that contribute to the programs described in Section 2.

Tables 6 and 7 show the electricity production in 2002 and the corresponding estimated net reductions of emissions of GHGs and regional air pollutants attributable to each of the green power programs described in Section 2. In each case, net emission reductions have been calculated as the difference between (i) the estimated emissions from green power generation and (ii) the estimated emissions from a "business-as-usual" scenario of generation of the same quantity of electricity. Generation of the green power is considered to avoid or displace generation of the electricity in the business-as-usual scenario.

[44] Further information on the way these assumptions and sources were applied or used is available from the authors upon request.

[45] Under a green power marketing or green power certificate marketing program not all power (or its environmental attributes) produced by green power facilities contributing to the program may actually be sold as green power (or as green power certificates). However, it can legitimately be argued that the facilities exist because of the program, and that therefore all power produced by the facilities can be attributed to the program.

[46] Installation dates were only available to the nearest month.

Table 5. Combined Capacities (MW) of Generation Facilities Associated with Green Power Programs Active in 2002

Jurisdiction	Wind	Hydro	Biomass	Landfill/ digester gas	Solar	Total
Alberta	91	57	44		0.013	192
British Columbia		7.8	66			74
Nova Scotia	1.3					1.3
Nunavut	0.066					0.066
Ontario	14	127		5.8	< 1	147
Prince Edward Island	5.2					5.2
Québec	102					102
Saskatchewan	17					17
Yukon	0.66					0.66
Canada	231	192	110	5.8	< 1	539

Note: The relative balance between (but not the total of) hydro and biomass in Alberta is guesswork given a lack of information about facilities established as a result of the Small Power Research and Development Act.

As the business-as-usual scenario is "counterfactual,"[47] there can be no single correct one. In addition, business-as-usual scenarios that might be considered highly realistic will in general be very complex. We have therefore used two simple but commonly used business-as-usual scenarios with the aim of obtaining two sets of reasonable estimates for net emission reductions. In Table 6, net emission reductions have been calculated assuming that green power production is causing the avoidance of *grid-average electricity generation* in each province or territory. This is a reasonable assumption if green power production is displacing output from existing facilities, as opposed to preventing the building of new facilities.

If, however, green power production is preventing the building of new conventional power generation facilities, it is causing the avoidance of "*build-marginal" electricity generation* (i.e., the conventional electricity capacity that would normally be built in response to increased demand). Natural gas-fired combined cycle gas turbine (CCGT) systems are widely regarded as the current build-marginal power supply throughout Canada. In Table 7, net emission reductions have been calculated assuming that green power production is causing the avoidance of *natural gas-fired CCGT electricity generation* in all jurisdictions.

As noted in Section 1.2.3, in some cases the power sold under green power marketing initiatives comes from generation facilities that were established many years ago. In these cases, the corresponding emission reductions shown in Tables 6 and 7 are likewise "old."

Explicative notes to Tables 6 and 7 are provided on the page following Table 7.

[47] By definition, it does not exist in reality.

Table 6	Category of program*	Electricity produced (MWh)	Net emission reductions if grid electricity displaced**				
Program			**GHGs (t)**	**ADPs (kg)**	**GLOPs (kg)**	**CO (kg)**	**PM (kg)**
Federal							
Class 43.1 CCA, Can. Renewable Energy and Conservation Expense	1	assumed to be accounted for under other programs					
Wind Power Production Incentive	1	accounted for under other programs					
Alberta							
Small Power Research and Development Act	1	620,208	547,879	1,795,702	426,761	-14,552,459	-2,265,812
ENMAX Greenmax program	3	120,000	106,080	443,791	210,097	18,238	22,111
EPCOR Green Power ECO-PACKs	3	58,135	51,392	214,999	101,783	8,836	10,712
Vision Quest Windelectric Green Energy program	3	9,000	7,956	33,284	15,757	1,368	1,658
Canadian Hydro Developers Renewable Energy Certificates	4	70,000	61,880	258,878	122,556	10,639	12,898
Totals for Alberta		877,343	775,187	2,746,654	876,955	-14,513,378	-2,218,433
British Columbia							
BC Utilities Commission Integrated Resource Planning Guidelines	1	549,252	19,032	-716,545	-944,747	-21,906,685	-3,565,252
BC Hydro voluntary portfolio standard	2	21,700	775	1,203	1,735	2,505	193
BC Hydro Power Smart Green Power Certificates	4	accounted for under BC Hydro's voluntary portfolio standard					
Totals for British Columbia		570,952	19,806	-715,342	-943,012	-21,904,181	-3,565,059
Nova Scotia							
Nova Scotia Power Green Power Program	2, 3	767	586	12,181	1,961	75	153
Nunavut							
Nunavut Power Corporation wind power generation	2	152	60	1,016	1,349	340	30
Ontario							
"Set aside" of emissions allowances for renewable energy projects	1	accounted for under Green Tags Ontario					
Ontario Power Generation green power target	2	750,100	225,742	574,928	294,332	13,318	24,965
Ontario Power Generation Evergreen Green Power program	3	accounted for under Ontario Power Generation's green power target					
Green Tags Ontario	4	2,217	667	1,699	872	44	85
Totals for Ontario		752,317	226,410	576,627	295,205	13,362	25,050
Prince Edward Island							
PEI Energy Corporation wind power development	1	19,000	8,473	117,259	24,848	1,667	1,168
Maritime Electric Green Power Program	3	accounted for under PEI Energy Corporation wind power development					
Québec							
Fonds pour l'accroissement de l'invest. privé et la relance de l'emploi	1	accounted for under Hydro-Québec's wind power development					
Hydro-Québec wind power development	2	312,732	657	2,138	2,401	589	79
Saskatchewan							
SaskPower GreenPower program	3	37,354	31,303	323,038	109,078	6,698	131,067
Yukon							
Green Power Initiative	1	865	79	1,590	2,678	540	45

Table 7	Category of program*	Electricity produced (MWh)	Net emission reductions if natural gas-fired CCGT electricity displaced**				
Program			**GHGs (t)**	**ADPs (kg)**	**GLOPs (kg)**	**CO (kg)**	**PM (kg)**
Federal							
Class 43.1 CCA, Can. Renewable Energy and Conservation Expense	1	assumed to be accounted for under other programs					
Wind Power Production Incentive	1	accounted for under other programs					
Alberta							
Small Power Research and Development Act	1	620,208	230,410	-454,574	-590,880	-14,628,114	-2,342,880
ENMAX Greenmax program	3	120,000	44,655	8,400	13,200	3,600	7,200
EPCOR Green Power ECO-PACKs	3	58,135	21,634	4,069	6,395	1,744	3,488
Vision Quest Windelectric Green Energy program	3	9,000	3,349	630	990	270	540
Canadian Hydro Developers Renewable Energy Certificates	4	70,000	26,049	4,900	7,700	2,100	4,200
Totals for Alberta		877,343	326,096	-436,574	-562,595	-14,620,400	-2,327,451
British Columbia							
BC Utilities Commission Integrated Resource Planning Guidelines	1	549,252	203,813	-708,535	-928,236	-21,953,602	-3,537,183
BC Hydro voluntary portfolio standard	2	21,700	8,075	1,519	2,387	651	1,302
BC Hydro Power Smart Green Power Certificates	4	accounted for under BC Hydro's voluntary portfolio standard					
Totals for British Columbia		570,952	211,888	-707,016	-925,849	-21,952,951	-3,535,881
Nova Scotia							
Nova Scotia Power Green Power Program	2, 3	767	286	54	84	23	46
Nunavut							
Nunavut Power Corporation wind power generation	2	152	57	11	17	5	9
Ontario							
"Set aside" of emissions allowances for renewable energy projects	1	accounted for under Green Tags Ontario					
Ontario Power Generation green power target	2	750,100	279,092	52,507	81,691	20,863	41,316
Ontario Power Generation Evergreen Green Power program	3	accounted for under Ontario Power Generation's green power target					
Green Tags Ontario	4	2,217	825	155	244	67	133
Totals for Ontario		752,317	279,917	52,662	81,935	20,930	41,449
Prince Edward Island							
PEI Energy Corporation wind power development	1	19,000	7,070	1,330	2,090	570	1,140
Maritime Electric Green Power Program	3	accounted for under PEI Energy Corporation wind power development					
Québec							
Fonds pour l'accroissement de l'invest. privé et la relance de l'emploi	1	accounted for under Hydro-Québec's wind power development					
Hydro-Québec wind power development	2	312,732	116,375	21,891	34,401	9,382	18,764
Saskatchewan							
SaskPower GreenPower program	3	37,354	13,900	2,615	4,109	1,121	2,241
Yukon							
Green Power Initiative	1	865	322	61	95	26	52

* 1. Government green power policies
2. Utility green power development programs
3. Green power marketing initiatives
4. Green power certificate marketing initiatives

** "ADP" = acid deposition precursors. ADP emissions are calculated as NO_x emissions plus 0.7 × SO_2 emissions
"GLOP" = ground-level ozone precursors. GLOP emissions are calculated as NO_x emissions plus VOC emissions
CO = carbon monoxide
PM = total particulate matter
"t" = tonnes of carbon dioxide equivalent
"kg" = kilograms

Table 8 summarizes the contribution made by the green power programs described in Section 2 to each province or territory's electricity production, as calculated in Tables 6 and 7, as a proportion of total provincial/territorial green power production.

It must be stressed that there are some large uncertainties in the results presented in Tables 6–8, and the precision with which the numbers in Tables 6 and 7 are expressed should not be taken as an indicator of absolute accuracy. Most importantly:

- In several cases the actual electricity production by green power facilities has been estimated fairly crudely using assumed capacity factors and months of operation.
- Information relating to the Small Power Research and Development Act was particularly sketchy.
- Emission factors for regional air pollutants from biomass-, landfill gas- and biogas-fired facilities are provisional only. Ideally, actual emissions measurements should be made at such facilities.
- Total jurisdictional electricity production data for 1999 was used as a proxy for 2002 data.

Table 8. Green Power Programs Active in 2002 as a Proportion of Total Jurisdictional Electricity Production (In Energy Terms)

Jurisdiction	Proportion of electricity production attributable to green power programs in 2002
Alberta	1.6 %
British Columbia	0.9 %
Manitoba	nil
New Brunswick	nil
Newfoundland and Labrador	nil
Nova Scotia	0.01 %
Nunavut and Northwest Territories	0.02 %
Ontario	0.5 %
Prince Edward Island	large proportion*
Québec	0.2 %
Saskatchewan	0.2 %
Yukon	0.3 %
Canada	0.5 %

* a precise figure cannot be calculated as data for total provincial electricity production in 2002 are not available.

3.5 Other benefits of green power

As noted in Section 1.1., in addition to its environmental benefits, green power has important benefits for energy security, regional development, economic diversification and creation of skilled jobs:

- Most green power production has no need for supplies of fuel that can be subject to major price fluctuations and international disputes.
- Unlike conventional electricity generation, which involves a small number of very large, centralized facilities, green power development results in a network of numerous small-scale plants with a wide geographic distribution and the promise of economic stimulus in multiple, mainly rural locations.
- A broad review of studies of the relative employment impacts of conventional and alternative energy investment showed that low-impact renewable energy supply provides over 50% more jobs per dollar invested than conventional energy supply.[48]
- A recent study found that wind and solar power both provide about 43% more person-years of employment per dollar invested than coal-fired electricity production.[49]

[48] Campbell, B., L. Dufay and R. Macintosh. 1997. *Comparative Analysis of Employment from Air Emission Reduction Measures*. Report for Environment Canada, Global Air Issues Branch. Drayton Valley: Pembina Institute, p. 10.

[49] Singh, V. and J. Fehrs. 2001. *The Work That Goes Into Renewable Energy*, Renewable Energy Policy Project Research Report No. 13. Washington, DC: REPP, p. 20; http://www.repp.org.

4. Green Power Certification

4.1 Introduction

Demand for green power from Canadian electricity consumers and the emergence of green power programs offered by utilities has created a need for certification standards to validate and ensure public confidence in green power products, especially in deregulated electricity markets where there is competition between multiple providers of green power products. As a result, a number of organizations have begun to develop and/or implement guidelines and certification standards. Certification systems can apply both to green power facilities themselves ("generation certification") and green power products offered to consumers ("retail product certification").

Certification can ensure that green power products meet a clear definition of low-impact renewable energy. There are many instances where renewable energy technologies present undesirable environmental consequences that prevent them from meeting a reasonable definition of "low-impact." The low-impact characteristics of green power go beyond the conventional definition of renewable resources and imply a minimal adverse effect on the following:

- climate change
- air quality
- water quality
- watersheds, river systems and fisheries
- flora and fauna
- geophysical features
- noise
- visual aesthetics
- any build-up of hazardous or toxic waste.

One objective of green power certification is to *increase* the total installed capacity of green power generation facilities. Recent date of installation is therefore another desirable quality to capture in a green power label.

Further discussion of what should be included in or excluded from the definition of green power is beyond the scope of this report.[50]

The following sections briefly describe all the existing or emerging green power guidelines or certification systems that, to the authors' knowledge, are currently relevant to Canadian green power development.

[50] The Pembina Institute has published its views on the definition of green power in the *Pembina Institute Green Power Guidelines for Canada*; http://www.pembina.org/publications_item.asp?id=23.

4.2 Certification systems

4.2.1 Environmental Choice Program EcoLogo (generation and retail product certification)[51]

The Environmental Choice Program (ECP) is Environment Canada's eco-labelling program, established in 1988 and now managed and delivered by TerraChoice Environmental Services. It covers a large number of categories of products and services. The Program's official symbol of certification — the EcoLogo — is a registered mark of Environment Canada.

In 1996, the ECP developed interim criteria for and began certification of "alternative source or environmentally preferable" electricity generation. Following a national multistakeholder consultation process, these criteria were combined, along with other information pertaining to renewable electricity, into a guideline for "renewable low impact electricity," of which the first draft was released in November 1999. A draft version was released by Environment Canada for public comment in December 2001. When the government has completed any further modifications, the final guideline will be issued under the Canadian Environmental Protection Act through a notice in the *Canada Gazette*. Meanwhile, 30 electricity generating companies and five retail companies are already licensed to use the EcoLogo for green power as defined by ECP's *Certification Criteria Document CCD-003* issued in December 2002.

The EcoLogo certification criteria apply to "alternative-use electricity" (power generation from an existing facility not originally designed for power generation), biogas- and biomass-fired, and solar, hydro and wind power facilities. The criteria

- require that there be consultation with communities and stakeholders;
- require that land use and biodiversity loss issues be addressed;
- exclude pilot-scale demonstration projects;
- prohibit any adverse impacts on endangered or threatened species;
- limit, for biogas- and biomass-fired facilities, the total of "load points" corresponding to emissions of CO, PM, NO_x and SO_x;
- require that, for facilities fuelled by wood waste, agricultural waste or energy crops, fuel be sourced from operations that ensure the rate of harvest "does not exceed levels that can be sustained;"
- include, for hydro facilities, a series of requirements addressing habitat alteration or destruction, water flows and temperature and their effect on indigenous species, water quality and fish passage;
- require that, for wind facilities, facility structures do not harm birds and are not located in areas protected for endangered or threatened bird species;
- require that green power products incorporate a minimum of 50% of power from facilities that began operations in 1991 or later and a maximum of 50% from older facilities;[52] and
- provide for unannounced verification checks by ECP representatives.

The EcoLogo certification criteria also contain provisions for avoiding double counting of the environmental attributes of green power, requiring that all such attributes be transferred to the customer or retired. However, this does not provide complete assurance that all forms of double counting are

[51] All information in this section has been either taken from the Environmental Choice Web site — http://www.environmentalchoice.com — or provided by Leslie Welsh, Environment Canada, personal communication, November 2003.

[52] As noted in Section 1.2.3, marketing of green power from facilities that are not new does not produce any new reductions in adverse environmental impacts.

prohibited, since the word "retired" is not accompanied by the words "without use." For example, double counting would occur if GHG emission reductions associated with green power generation were used towards meeting the generating company's voluntary or mandatory corporate GHG target, while at the same time the power was sold in a manner that implied that its full environmental attributes were being transferred to the customer (which is the justification for the customer paying a premium). A company might claim it was conforming to the EcoLogo critera in "retiring" the reductions *by using them* to meet its GHG target. The December 2001 draft EcoLogo guideline contains no prohibition against double counting at all, saying only that "It is the intention of the Environmental Choice Program to monitor the developments regarding the ownership and transfer of environmental benefits, including emission reductions arising from the generation of renewable low-impact electricity."

4.2.2 TerraChoice Green Leaf Label (retail product certification)[53]

In September 2002, separately from the ECP, TerraChoice Environmental Services launched its own (non-government-endorsed) Green Leaf standard for "Tradable Renewable Electricity Certificates." To meet the Green Leaf standard, green power certificates must be associated with renewable low-impact electricity sources that are either EcoLogo-certified or meet identical standards specified in the Green Leaf *Technical Requirements for Electricity Generation Facilities*. One company is currently licensed to use the Green Leaf label, and TerraChoice is in contact with several others interested in using it.

Two levels of Green Leaf certification are available. Level B certificates are from facilities that began operations between January 1, 1991 and April 1, 2001, while level A certificates are from newer facilities.[54]

The Green Leaf standard:

- prohibits double counting of environmental attributes of green power, including prohibiting the issuance of green power certificates representing environmental attributes used to comply with any regulatory requirement or non-regulatory mandate, and assumes green power certificates to have been automatically retired when a party promotes itself in association with the certificates;
- limits creation of green power certificates to grid-connected generation facilities;
- requires that certificates be sold within a year of the generation of the green power in respect of which they are issued;
- requires that certificates be accompanied by information disclosing the location and type of facilities producing the green power in respect of which they are issued; and
- provides for unannounced verification checks by TerraChoice representatives.

In contrast to the uncertain provisions against double counting in the EcoLogo certification criteria (Section 4.2.1), the Green Leaf standard's prohibition of double counting is clear and absolute: "In no way can the environmental attributes associated with the Green Leaf [certificates] be counted more than one time."

[53] All information in this section has been taken from the TerraChoice Web site — http://www.terrachoice.ca/trcs.htm — except for the *Technical Requirements for Electricity Generation Facilities*, which were provided by TerraChoice personnel upon request.

[54] As noted in Section 1.2.3, marketing of green power from facilities that are not new does not produce any new reductions in adverse environmental impacts.

4.2.3 BC Hydro Green Criteria (generation and retail product)

In 2000, BC Hydro adopted a voluntary portfolio standard under which it committed to meet 10% of increased demand for electricity up to 2010 through green power sources (see Section 2.2.1). At the time, feeling that the EcoLogo certification system was not fully meeting the company's needs, BC Hydro prepared its own "Green Power Generation Green Criteria"[55] in order to define its compliance with its voluntary standard. BC Hydro states that meeting the criteria does not imply compliance to any certification process. However, the criteria are being used as a form of guarantee of quality for the company's new Power Smart Green Power Certificates (Section 2.4.2), hence their inclusion in this discussion of certification systems.

Key differences between the BC Hydro criteria and the EcoLogo certification criteria include the following:

- the BC Hydro criteria cover wave energy facilities, while the EcoLogo certification criteria do not;
- the BC Hydro criteria require that biomass- and biogas-fired facilities not cause a net decrease in regional air quality, while the EcoLogo certification criteria do not make such a requirement;
- the BC Hydro criteria require that biomass fuels are not diverted from a more productive or efficient use, while the EcoLogo certification criteria do not explicitly address this issue;
- the BC Hydro criteria contain considerably more elaborate provisions for ensuring that projects are developed in a socially responsible manner (especially respecting consultation and engagement of aboriginal communities), compared to the EcoLogo certification criteria;[56]
- the BC Hydro criteria require that facilities began operations on or after April 1, 2001, while the EcoLogo certification criteria allow green power products to incorporate up to 50% of power from facilities that began operations earlier than 1991.[57]

4.2.4 Low Impact Hydropower Institute (generation certification)[58]

The Low Impact Hydropower Institute, based in Portland, Maine, has established a Low Impact Hydropower Certification Program with the objective "to certify facilities with impacts that are low compared to other hydropower facilities based on objective environmental criteria." To date, five facilities in the US have been certified under the program.

Eight criteria must be met to achieve certification:

- the affected river must retain "healthy flows for fish, wildlife and water quality;"
- water quality must be protected (at present this criterion appears only to require compliance with existing regulatory requirements, but it is under consideration for revision);
- effective fish passage must be assured;
- sufficient action must have been taken to protect environmental conditions in the watershed (at present this criterion appears only to require compliance with existing regulatory requirements, but it is under consideration for revision);
- the facility must not negatively impact threatened or endangered species unless it complies with laws specifying adoption of mitigation measures if such species are affected;

[55] BC Hydro. 2003. *Green Criteria*; http://www.bchydro.com/info/ipp/ipp959.html.
[56] It should be noted, however, the ECP intentionally focuses on environmental criteria.
[57] As noted in Section 1.2.3, marketing of green power from facilities that are not new does not produce any new reductions in adverse environmental impacts.
[58] All information in this section has been taken from the Low Impact Hydropower Institute Web site; http://www.lowimpacthydro.org/.

- cultural resources must be protected;
- the facility must accommodate recreational activities on the river (without charge);
- a facility cannot be certified if a resource agency has recommended its removal.

The program appears to be designed mainly to certify hydro facilities that have dams, as opposed to run-of-river facilities. The program itself recognizes that certification under the program "should not be considered a benchmark for exemplary environmental operations at hydropower facilities," and that "not all environmental impacts associated with hydropower facilities are addressed by the criteria."

4.2.5 Canadian Electricity Association "Environmentally Preferable Electricity Portfolio" System (generation certification)

The Canadian Electricity Association (CEA) believes that the EcoLogo program does not adequately serve the needs of the Canadian electricity market,[59] and the association has therefore begun to develop an alternative certification system that it calls the "Environmentally Preferable Electricity Portfolio" (EPEP), assisted by Scientific Certification Systems (SCS), based in Oakland, California. The EPEP system seeks to achieve the "environmental optimization of power generation within each power production region. Optimization is accomplished through an integrated environmental accounting approach based on advanced life-cycle impact assessment. . . . Environmental performance and improvements are measured against the average performance of the regional power pool. The program does not pit one energy generation source against another, and does not artificially segment assets into 'green' and 'black' sources."[60]

In collaboration with Natural Resources Canada, the CEA has initiated five pilot projects for the EPEP system. The pilot projects cover nuclear, wind, and natural gas-, oil- and coal-fired generation facilities, and are expected to be complete by fall 2003.[61] Clearly, the EPEP system will differ from the EcoLogo and Green Leaf systems in that it will target lower cost, non-renewable resources including fossil-fuelled generation, whereas the EcoLogo and Green Leaf labels apply only to renewable resources with low environmental impacts.

[59] Tim Egan, Canadian Electricity Association, personal communication, 2002.
[60] See http://www.scs1.com/energy_electric.html.
[61] See http://www.canelect.ca/english/managing_issues_environment_epp_response.html.

5. Summary and Conclusions

This report has sought to provide a comprehensive review of all Canadian green power programs that were active in 2002 (i.e., resulting in actual power generation during that year). Eight are government green power policies, five are utility green power development programs, seven are green power marketing initiatives, and three are green power certificate marketing initiatives. Green power generation facilities associated with those programs amount to a total of 539 MW of capacity. This capacity is dominated by wind (43%), hydro (about 36%) and biomass (about 20%). Most of it is located in Alberta (36%), Ontario (27%), Québec (19%) and British Columbia (14%). Production of electricity by these facilities as a proportion of total jurisdictional electricity production (in energy terms) is at most 1.6% (in Alberta) and 0.5% for Canada as a whole.[62]

The eight government policies described cover a wide range of approaches: tax write-off, subsidy per kWh, guaranteed price per kWh, directive by regulatory authority, allocation of emissions allowances, construction of facilities by government agencies, grants/loans/loan guarantees. It appears that governments in Canada are still in a phase of experimenting with different types of policies for supporting green power. Some provincial governments have yet to provide any support at all. However, four of the seven policies were adopted since 2000, indicating that governments' interest in this area in increasing. The list of ten emerging government policies in Appendix A strongly confirms this.

Five utilities had green power development programs active in 2002 that did not appear to be primarily driven by green power marketing. In two cases, costs are recovered through general sales, while in three cases, companies are seeking to recover their costs through green power or green power certificate marketing initiatives. Unsurprisingly, it is only in these three latter cases that the associated green power facilities are certified or screened according to published criteria.

Of the ten green power or green power certificate marketing initiatives existing in 2002, only four were in place in 2001[63] — which illustrates the high pace of development of this market.[64] Four of the ten programs are in Alberta and two are in Ontario — an unsurprising result given that these are respectively the first and second jurisdictions in Canada to deregulate their electricity markets. As in 2001, the price premium relative to standard electricity varied widely between programs in 2002 — from $30 to $95 per MWh, with large variations within jurisdictions; clearly this is a very new market. By far the largest programs in 2002 in terms of participants were the ENMAX and EPCOR programs (established in 1998 and 1999 respectively), with 4,000–5,000 residential participants each at the year's end. All other programs are more recent and remained at a fledgling stage, with no more than a few hundred participants, at the end of 2002.[65] All the products offered through these ten initiatives, as well as the associated generation facilities, are EcoLogo-certified, except for the three green certificate products and the facilities associated with BC Hydro's green certificates, all of which lacked independent certification, and Ontario Power Generation's Evergreen Friendly Power (generated entirely from facilities built prior to 1991). The BC Hydro product and facilities are instead screened with BC Hydro "green criteria."

[62] It must be said, however, that these figures are subject to debate; there is no agreed upon definition as to what exactly constitutes a green power program or what qualifies as green power. For example, a considerable number of mainly small hydro facilities in British Columbia, Manitoba, Newfoundland and Labrador, Québec and the Yukon remain uncertified and are not associated with any green power program; therefore they have not been included in these figures. On the other hand, all of Canada's wind power capacity installed by the end of 2002 is included.
[63] Dogterom, J., M. McCulloch and A. Pape-Salmon. 2002. *Green Power Marketing in Canada: The State of the Industry*. Drayton Valley: Pembina Institute; http://www.pembina.org/publications_item.asp?id=147.
[64] Appendix A also lists four additional initiatives that have emerged in 2003.
[65] Ontario Power Generation and SaskPower were not willing to reveal the number of participants in their programs.

Green certificate marketing initiatives are at a very early stage of development, as the largest one had only 310 participants at the end of 2002.

Canadian green power programs had significant environmental benefits in 2002. For example, GHG emissions were estimated to have been reduced by some 775 kilotonnes of carbon dioxide equivalent (kt CO_2e) in Alberta and 226 kt CO_2e in Ontario compared to grid-average electricity (326 and 280 kt CO_2e respectively compared to natural gas-fired CCGT electricity). In British Columbia and Québec, the GHG benefits were small compared to grid-average electricity (which has a very low GHG intensity) but were estimated to have been 212 and 116 kt CO_2e respectively compared to natural gas-fired CCGT — which, in both provinces, is the "build-marginal" electricity technology that would conventionally be added in response to increased demand.

Where the capacity associated with green power programs does not contain biomass power, there are also significant reductions in emissions of regional air pollutants. However, when the capacity contains a significant biomass component, there may be significant increases in such emissions. Specifically, green power programs in Alberta and British Columbia, where biomass figures prominently, may be causing net increases in regional air pollutant emissions.[66] The results calculated in this report show increases in both provinces in emissions of acid deposition precursors, ground-level ozone precursors, CO and PM compared to natural gas-fired CCGT. (In Alberta, the increases in emissions of acid deposition precursors and ground-level ozone precursors become reductions when the comparison is made instead to grid-average electricity.) These results should not be considered definitive, as the emission factors used for biomass-fired facilities are provisional only. Ideally, actual emissions measurements should be made at such facilities. **Nonetheless, it is clear that close attention needs to be paid to regional air pollutant emissions from biomass power as the Canadian green power sector develops further.**

This report also reviewed all five existing or emerging guidelines or certification systems that, to the authors' knowledge, are currently relevant to Canadian green power development. Certification standards are needed to validate and ensure public confidence in green power products, and can ensure that green power products meet a clear definition of low-impact renewable energy.

EcoLogo certification (for which Environment Canada has not yet finalized a guideline) and BC Hydro's "green criteria" (which, strictly speaking, are used for screening, not certification) were the only systems used by green power and green power certificate marketing programs active in Canada in 2002. BC Hydro's green criteria are more environmentally stringent in a number of respects (although the EcoLogo criteria may be more stringent in others) and contain considerably more elaborate provisions for ensuring that projects are developed in a socially responsible manner. The new Green Leaf standard for green power certificates is a welcome innovation as it focuses on avoiding double counting and on tracing the environmental attributes of green power — a very important area for customer confidence not as clearly addressed by the EcoLogo certification criteria and not addressed at all by the December 2001 draft EcoLogo guideline.

The Low Impact Hydropower Institute's certification program appears to be designed mainly to certify hydro facilities that have dams, and does not appear well suited to certification of green power in Canada in the generally accepted sense of the term. The Canadian Electricity Association's Environmentally Preferable Electricity Portfolio, which is currently being piloted, does not appear to be a renewable electricity certification system at all, as it will cover nuclear and fossil-fuelled electricity generation.

[66] It is therefore of some importance that BC Hydro's Green Criteria (Section 4.2.3) require that *new* biomass-fired facilities that began operation on or after April 1, 2001 not cause a net decrease in regional air quality.

The green power sector is still very small in Canada compared to several other industrialized countries. This is primarily because governments in Canada have not yet adopted the policies that have been implemented in support of green power elsewhere. **In particular, Canada currently does not have financial incentives for green power as strong as those in place in the US,[67] and still lacks the renewable portfolio standards that have been widely implemented there.**[68] Proponents of green power programs surveyed for this report were vocal in their calls for governments to provide stronger financial incentives and a better regulatory environment for green power.[69]

Increased consumer awareness would facilitate both government action and increased success of the voluntary green power marketing approach. Proponents of green power programs surveyed for this report were almost unanimous in identifying a strong need to improve public awareness of green power and its benefits.[70] **While this is a task for all interested parties, the federal government in particular needs to be much more active in raising public awareness of green power, especially given the important role that green power can play in Canada's compliance with the Kyoto Protocol.** For example, the federal government's "One Tonne Challenge" to all Canadians to reduce their annual GHG emissions by an average of one tonne should be used to promote green power.

Finally, the following two calls for specific action by the federal government also featured prominently in the comments of green power program proponents surveyed for this report:[71]

- **The Market Incentive Program must be broadened to include pure retailers[72] of green power certificates, who are currently excluded, despite the important role that they could play in the green power market;**
- **The extended time that the federal government is taking to fulfil its commitment to purchase green power is an important factor in delaying further green power development in Canada.**

[67] For example, Canada's Wind Power Production Incentive (Section 2.1.2) has an after-tax value of less than one-third the value of the US Production Tax Credit. See Clean Air Renewable Energy Coalition. 2002. *Enhancing Sustainable Economic Development in Canada with Renewable Energy*, p. 8; http://cleanairrenewableenergycoalition.com/documents/Final%20Backgrounder%20-%20September%.
[68] Bramley, M. 2002. *A Comparison of Current Government Action on Climate Change in the US and Canada*. Pembina Institute and World Wildlife Fund Canada, p. 17–24; http://www.pembina.org/publications_item.asp?id=129.
[69] See Appendix B, especially question #2.
[70] See Appendix B, both questions #1 and #2.
[71] See Appendix B, question #2.
[72] That is, retailers selling green power certificates that are not accompanied by electricity.

Appendix A. Emerging Canadian Green Power Programs

The authors are aware of the following programs that were not active in 2002, in the sense of resulting in actual power generation during that year, but that can be expected to fall within the scope of future years' editions of this report:

- **Government green power policies**
  - Federal: the government's *Climate Change Plan for Canada* (November 2002) "sets the target of at least 10 percent of new electricity generating capacity in Canada to come from emerging renewable sources. This could be achieved in a number of ways, including expanded production incentives, renewable energy portfolio standards in provinces, increased efforts to develop market demand, as well as the stimulus provided by the proposed emissions trading system."[73]
  - Federal: the government is currently in the process of introducing its Market Incentive Program for Distributors of Emerging Renewable Electricity Sources.[74] The program will provide a short-term financial incentive up to 40% of the eligible costs of market-based programs undertaken by electricity distributors "to increase sales of green power in the residential and small business markets." The total budget is $25 million ending 2006. By October 2003, three contribution agreements had been signed, and four other proposals retained.[75]
  - Federal: under its Pilot Emission Reductions, Removals and Learnings (PERRL) Initiative, the federal government will spend $2.5 million on purchasing verifiable GHG emission reductions from renewable energy projects that begin after the date on which the purchase agreement is signed. An auction process to identify successful projects was launched in September 2003.[76]
  - Alberta: the government's change action plan (October 2002) set a goal for "increasing the renewable and alternative energy portion of total provincial energy capacity by 3.5 per cent by 2008. This equals about 560 Megawatts of new capacity." The specific framework for reaching the target is to be established by the Clean Air Strategic Alliance, a multistakeholder group.[77]
  - British Columbia: the government's energy plan (November 2002) sets a voluntary goal for electricity distributors to acquire 50% of new supply from "BC Clean Electricity" between 2002 and 2012. The plan states that "BC Clean Electricity . . . may include small/micro hydro, wind, solar, photovoltaic, geothermal, tidal, wave and biomass energy, as well as cogeneration of heat and power, fuel cells, and efficiency improvements at existing facilities."[78]
  - New Brunswick: the new Electricity Act (April 2003) gives the government power to implement a mandatory renewable portfolio standard.[79]

[73] Government of Canada. 2002. *Climate Change Plan for Canada*, p. 34; http://www.climatechange.gc.ca/plan_for_canada/plan/index.html.
[74] See http://www2.nrcan.gc.ca/es/erb/english/View.asp?x=457.
[75] Welsh, L. 2003. *The Government of Canada's Incentive Programs*. Presentation to the Conference "How to Profit from the Business of Renewable Energy," Toronto, 20–21 October.
[76] See http://www.ec.gc.ca/perrl/news_2003_09_25_e.html.
[77] Government of Alberta. 2002. *Albertans & Climate Change: Taking Action*, p. 34; http://www3.gov.ab.ca/env/climate/actionplan/docs/takingaction.pdf.
[78] Government of British Columbia. 2002. *Energy for Our Future: A Plan for BC*, p. 33; http://www.premier.gov.bc.ca/em/popt/energyplan.htm.
[79] See http://www.gnb.ca/cnb/Promos/NB-Power/electricity-e.asp.

- Nova Scotia: the key advisory body to government on electricity issues, the Electricity Marketplace Governance Committee (EMGC), recommended in its second interim report (April 2003) that the province should adopt a mandatory renewable portfolio standard to take effect in 2006. The EMGC recommended that the standard should require that, by 2010, green power from facilities installed post-2001 should represent 3.2% of electrical energy supplied.[80]
- Ontario: in July 2003, the government filed new regulations that provide a 100% corporate income tax write-off for facilities used to generate electricity from "clean, alternative or renewable energy sources;" a sales tax rebate on building materials incorporated into such facilities; and a ten-year property tax holiday on the same facilities. The regulations apply to facilities or materials acquired, purchased or that begin generating electricity between November 25, 2002 and January 1, 2008.[81]
- Ontario: the three major political parties in Ontario all promised, if elected in the October 2003 provincial elections, to implement a significant mandatory renewable portfolio standard.
- Québec: in March 2003, the government adopted a regulation requiring the installation of 1000 MW of wind power capacity by the end of 2012, linked to a requirement for the establishment of wind turbine assembly facilities in the province. The same regulation also requires the installation of 100 MW of biomass-fired electricity capacity by 2010.[82] In July 2003, the government announced aid to facilitate the creation of an additional 108 MW of capacity in Murdochville.[83]

- **Green power marketing initiatives**
  - Ontario: Toronto Hydro Energy Services plans soon to be offering green power to its customers. Power will be supplied from a 750 kW wind turbine at Exhibition Place in Toronto[84] (completed in January 2003) and the 1 MW (approximately) Thackeray landfill gas capture project.[85]
  - Yukon: the Yukon Green Power Initiative (see Section 2.1.7) involves a green power marketing component that remains to be developed.

- **Green power certificate marketing initiatives[86]**
  - Ontario: the Canadian Renewable Energy Corporation plans to initiate in 2003 the Ontario Clean Power green power certificate program, initially based on the new 3 MW Misema hydro facility, to be followed by wind power projects.
  - Alberta: in 2003, Vision Quest Windelectric launched its Green Energy Tags program as an alternative to its existing Green Energy green power marketing program (see Section 2.3.3).[87] Green Energy Tags are offered to both residential and commercial/wholesale customers.

[80] See http://www.gov.ns.ca/petro/energystrategy/emgc/newsdetails.asp?itemID=8.
[81] Ontario Ministry of Energy. 2003. *Eves Government Encourages Development of New Electricity Supply from Clean, Alternative and Renewable Energy Sources*. News release, 8 July; http://www.energy.gov.on.ca/index.cfm?fuseaction=english.news&body=yes&news_id=38.
[82] See http://www.regie-energie.qc.ca/regie/reglements.html.
[83] Chouinard, T. 2003. Un million de plus pour garder Murdochville ouverte. *Le Devoir*, July 17, On-line edition; http://www.ledevoir.com/2003/07/17/31997.html.
[84] The turbine was developed under a joint venture between Toronto Hydro and Windshare, a federally funded community co-operative.
[85] See http://www.torontohydro.com/energyservices/green_power/index.cfm.
[86] The information here is based on surveys sent to program proponents, augmented by other publicly available information.
[87] Green Leaf certification for Green Energy Tags was announced in September 2002, but the program was not launched until 2003.

Appendix B. Additional Information from Surveys Completed by Green Power Program Proponents

The surveys sent to green power program proponents that were used to gather information used in this report asked two questions focusing on barriers to the implementation of green power programs. All answers received are presented here (edited), grouped by theme.

Question #1: What have been the largest barriers encountered when implementing your green power program?

Answers:

- *Lack of public awareness*
  - "Building customer understanding and awareness of the product and its benefits."
  - "Lack of awareness and need for education."
  - "High marketing dollars required to raise awareness of program."
  - "Lack of understanding among consumers as to why they have to pay extra for this type of electricity."
  - "Education and awareness on current electricity generation sources."
  - "Awareness."
  - "Slowness in adopting the concept of buying green power by customers."
- *Financial constraints*
  - "Limited marketing budget."
  - "Capital cost."
  - "Obtaining a fixed price for power and/or a power sales contract to ensure the project financials can be fixed at least for a period of time."
  - "Lack of financial support from grants applied for have left the marketing efforts largely to volunteer efforts."
  - "Limited dollars for increasing awareness."
  - "Cost."
- *Regulatory environment*
  - "Regulatory uncertainty around GHGs and the valuation of them within a green power product."
  - "Ontario's Bill 210."
  - "Lack of supporting government regulation."
- *Nature of the market*
  - "Matching supply and demand, given the intermittent nature of green resources and changing online dates for independent power producers."
  - "Uncertainty in the Ontario electricity market."
  - "This market [Ontario] is very tiny at this time."
  - "Government programs such as the Market Incentive Program specifically excludes [the green tags] market, which is currently the only viable way to access the retail market [for green power] in Ontario."
- *Other*
  - "Developing the business case for a nascent product, then maintaining internal sponsorship and support as the product proves itself in an evolving marketplace."
  - "Developing appropriate verification and tracking mechanisms."
  - "Remote arctic climate."
  - "The slow pace of municipalities that control landfill gas sites to develop the sites."

Question #2: What could the federal government, NGOs and other industry stakeholders do to enhance the success of your green power marketing program?

Answers:

- *Adjust the Market Incentive Program*
  - "Access to the Market Incentive Program to enable recovery of front-end product development, promotion and set-up costs associated with launching a green product to the residential and small commercial mass markets is essential in the context of the provincial regulator's directive to keep rates low and increased regulatory scrutiny."
  - "The new Market Incentive Program has potential to help with high marketing costs."
  - "Federal programs such as the Market Incentive Program support only retailers or distributors of electricity. In Ontario, retailers have been effectively shut down by the 4.3 cent price cap, and distributors are not allowed to offer green power. So that leaves Green Tags as the sole marketer of green power in the province. But the Market Incentive Program rules forbid the support of the sole marketer of green power in Canada's largest province."
  - "Broaden the scope of the Market Incentive Program to include green tags sellers."
- *Step up government procurement of green power*
  - "The federal government could actually purchase green power on a long-term basis (current funding only for three years)."
  - "The Government of Canada has also made statements that they will buy green power, but we have not yet seen them buying, or trying to buy, green power [in Ontario]."
  - "Lead by example. The federal government has committed to buying 20% of their power from green sources. But so far, they have only made purchases in three provinces. The Ontario purchase has been stalled for 18 months due to funding problems."
- *Increase awareness*
  - "Help provide credibility and increase awareness on current electricity generation sources and the environmental problems associated with them."
  - "Provide consumer education about environmental impacts of energy consumption and individual responsibility to initiate change."
  - "Assist with education on current electricity generation plus continue top support green tag sales and education that the electron does not need to come from your utility."
  - "NGOs should buy local green power for their offices, and publicize that they did so, and why."
  - "Education of consumers about the current electricity mix, and the reasons to buy green should be done within the NGO's constituency (Web sites, newsletters etc.)."
- *Governments should provide additional funding / incentives / policy certainty / regulated standards*
  - "With respect to the emerging GHG regulatory regime, the sale of green power will benefit from clarity. The regime must make efforts on the fronts of renewable energy, energy efficiency and emissions trading in the electricity sector complementary and self-reinforcing. Issues of potential double counting and ownership of emission reductions need to be settled once and for all."
  - "A national renewable portfolio standard, with a national system of tradable renewable certificates, should be considered. This can co-exist with retail sales of green power."
  - "The federal government could provide financial assistance in the marketing of green power programs."
  - "Additional program funding."
  - "Governments must confirm green power is a tax-exempt product and GST/HST should not apply."
  - "Governments at all levels need to step up to their public commitments."

  - "The level of incentives for the producers of green energy are low compared to incentives to other electricity producers. The result is that the premium for green power is high, and this limits the sales opportunity."
  - "All parties should advocate for policies that will allow green marketing at the provincial level through Local Distribution Companies."
- *Other*
  - "The federal government could partner with others to create a national customer recognition program similar to the US EPA's Green Power Partnerships Program."
  - "The Environmental Choice Program could work with industry and stakeholders to enhance certification at a product level (versus facility level). More standardization of accounting, reconciliation, truing-up, verification and auditing methodology could set the stage for a national renewable portfolio standard / tradable renewable certificates system."
  - "Anything. There is no impact at present. We are all alone."
  - "There needs to be a liquid market — many buyers for green power — be it residential customers or others, so work needs to be done here."
  - "Many cities and municipalities have made commitments to use environmentally friendly power, but when it comes down to paying additional costs, or signing a more expensive contract for power, they become unwilling."
  - "Grant bodies do not seem to readily support the development of green tag marketing initiatives."
  - "Purchase green power for their own consumption; promote the purchase of green power to businesses and consumers; provide production, customer, or other incentives to reduce cost."

Appendix C. Additional Assumptions, Approaches and Sources

Section 3 presents a quantitative analysis of green power programs in terms of their contribution in 2002 to (i) each province or territory's electricity production, and (ii) estimated reductions of emissions of GHGs and regional air pollutants. The analysis presented there used the five assumptions/approaches/sources listed at the beginning of Section 3 as well as the following assumptions, approaches and sources:[88]

6. Where electricity production data (in MWh) was not available from surveys of program proponents, it was calculated from capacity data (in MW) using the following capacity factors: 95% for biomass, 50% for hydro, and 35% for wind.
7. GHG emission factors per MWh of grid-average electricity in each province and territory were those provided by Environment Canada[89] for 2000 except for the factors for New Brunswick, Northwest Territories plus Nunavut, and Yukon, which were calculated from GHG emissions data provided by Environment Canada[90] and electricity production data taken from the Canadian Electricity Association's publication *Electric Power in Canada 1998–1999* for 1999.
8. Emission factors for regional air pollutants per MWh of grid-average electricity in each province and territory were calculated from emissions data provided by Environment Canada[91] and electricity production data provided by Natural Resources Canada[92] for 1995.
9. Emissions factors for all emissions per MWh of grid-average electricity in Prince Edward Island were taken as equal to those for New Brunswick since more than 99% of electricity consumed on the Island is imported from the New Brunswick grid.
10. Emission factors for all emissions per MWh of electricity produced by a natural gas-fired combined cycle gas turbine system were taken from Spath, P. and M. Mann. 2000. *Life Cycle Analysis of a Natural Gas Combined Cycle Power Generation System*. Golden, CO: National Renewable Energy Laboratory.
11. Emission factors for all emissions per MWh of electricity produced by a biomass power facility were taken from US Environmental Protection Agency. 1996. *AP-42 Environmental Inventory Database*.
12. Emission factors per MWh of electricity produced by landfill gas- and anaerobic digester biogas-fired power facilities were derived as follows: GHG emissions were assumed to be identical to the methane emissions from a natural gas-fired combined cycle gas turbine system (see above); and using the simplification that landfill/digester gas is pure methane, emissions of NO_x and SO_2 were assumed to be zero while emissions of non-methane hydrocarbons, particulate matter and carbon monoxide were assumed to be equal to those of a "natural gas average" power plant, as taken from US Environmental Protection Agency. 1996. *AP-42 Environmental Inventory Database*.
13. Wind, hydro and solar power facilities were assumed to have zero emissions.
14. For the purpose of calculating emissions of ground level ozone precursors, volatile organic compound emissions were assumed to be equal to non-methane hydrocarbon emissions.

[88] Further information on the way these assumptions, approaches and sources were applied or used is available from the authors upon request.
[89] Pierre Boileau, Environment Canada, personal communication, 2003.
[90] Available at http://www.ec.gc.ca/pdb/ghg/ghg_tables_2001_e.cfm.
[91] Available at http://www.ec.gc.ca/pdb/ape/cape_home_e.cfm.
[92] Available at http://nrcan.gc.ca/es/ceo/update.htm.