The Conference Board of Canada
Insights You Can Count On

Report February 2006

International Experience With Implementing Wind Energy

REGULATORY POLICY AND TAXATION

The Conference Board of Canada
Insights You Can Count On

International Experience With Implementing Wind Energy
by *Al Howatson* and *Jason L. Churchill*

About The Conference Board of Canada

We are:

- A not-for-profit Canadian organization that takes a business-like approach to its operations.
- Objective and non-partisan. We do not lobby for specific interests.
- Funded exclusively through the fees we charge for services to the private and public sectors.
- Experts in running conferences but also at conducting, publishing and disseminating research, helping people network, developing individual leadership skills and building organizational capacity.
- Specialists in economic trends, as well as organizational performance and public policy issues.
- Not a government department or agency, although we are often hired to provide services for all levels of government.
- Independent from, but affiliated with, The Conference Board, Inc. of New York, which serves nearly 2,000 companies in 60 nations and has offices in Brussels and Hong Kong.

ISBN 0-88763-722-1
Agreement No. 40063028
*Incorporated as AERIC Inc.

Preface

Over the past few years, public and governmental interest in clean, renewable energy technologies across North America, Europe and beyond has increased. Wind generation in particular has attracted substantial attention and has received significant amounts of public and private funding. However, wind technology has also attracted its share of controversy, mainly due to alleged visual and noise "pollution" accompanying large wind farms.

As part of an ongoing initiative to investigate energy policy options and the future of the Canadian energy system, the Canadian Nuclear Association contracted The Conference Board of Canada to conduct a comparative study of various countries' experiences with supporting and implementing large-scale wind projects.

International Experience With Implementing Wind Energy examines the relative costs, advantages and disadvantages of wind generation. In addition, the report explores infrastructure issues, public attitudes toward wind development, and the various policy instruments used to support the development of wind energy in countries that are leaders in implementing wind energy.

Contents

EXECUTIVE SUMMARY

International Experience With Implementing Wind Energy

Installed wind capacity worldwide has grown rapidly over the past decade, as countries search for environmentally friendly sources of energy. Driven by favourable public support mechanisms, unit costs of production have dropped substantially over the past 20 years, partly due to better siting and improved technology. In most locales, electricity from wind is still more costly to produce than power from traditional sources, but it is becoming competitive in some regions.

The intermittency of wind, and the subsequent challenges of integrating wind power into transmission grids, is recognized as the single biggest challenge for the development of wind energy. Experience in Europe indicates that the costs of integrating wind into the grid are likely in the range of 5 to 30 per cent of the costs of generation. But methodologies for estimating costs of integration have not been standardized; estimates vary, and further research is required.

In jurisdictions where installed wind capacity has grown rapidly over the past decade, public policies have played a critical role in this growth.

Public opinion favours the use of wind power in the abstract, but local opposition can be strong to specific proposals, as it can be to almost any kind of industrial development. Once wind farms have been operating for some time, however, public acceptance seems to grow again.

Strong market growth in renewable power has never occurred in Organisation for Economic Co-operation and Development (OECD) countries with only one policy instrument. In jurisdictions where installed wind capacity has grown rapidly over the past decade, public policies have played a critical role in this growth. Leading wind regions, such as Denmark and Germany, have made promotion of wind energy a focus of public policy. They have therefore used a suite of policy instruments—some affecting the supply side, others the demand side; some in the development stages and others during implementation.

Given current and proposed policy support and technological improvements, installed wind capacity will continue to grow worldwide. But there are practical limits to the amount of electricity that wind turbines can contribute to an electricity grid. Wind farm sites with adequate characteristics are scarce. A satisfactory site must have a wind resource that enables wind turbines to consistently produce a high output of power. The site must also be sufficiently close to users of the power to justify the costs of building and using transmission lines. Danish and German experience indicates that as the share of power generation from wind approaches 20 per cent in a region, both transmission and backup requirements become more costly. This may limit the wind fraction of a mixed system because a large amount of idle backup capacity is an inefficient use of scarce resources.

Highlights

- Electricity from wind tends to be more costly to produce than electricity from traditional sources, but is becoming competitive in some regions.
- Intermittency is the single biggest challenge for the development of wind energy.
- Public opinion favours the use of wind power in the abstract, but the initial stages of wind development tend to invite the “not in my backyard” (NIMBY) syndrome, although this may abate following installation.
- A variety of policy instruments is required to assist the market growth of wind energy.
- There are practical limits to the amount of electricity that wind turbines can contribute to an electricity grid based on the availability of sites with the desirable conditions and grid integration.

International Experience With Implementing Wind Energy

INTRODUCTION

Installed wind capacity worldwide has grown rapidly over the past decade as countries have sought environmentally friendly sources of electricity. Although growth has been rapid—an average of 22 per cent in the industrialized countries from 1990 to 2001—the fraction of total power generated by wind is still small. Wind in 2001 supplied less than 0.5 per cent of electricity, on average, in these nations. In that year, 86 per cent of installed capacity was concentrated in only four countries—Germany (with the largest installed capacity), Spain, the U.S. and Denmark.[1]

Currently, Germany has approximately 14,600 megawatts of wind capacity, accounting for around 6 per cent of its total energy needs. This figure is up from 2,800 megawatts five years previously and plans are in place that will expand capacity to roughly 40,000 megawatts by 2030.[2] Similarly, Spain went from an installed capacity of 830 megawatts in 1998 to approximately 6,000 megawatts by 2004 and has plans to extend capacity to 13,000 megawatts by 2011. It was aided in its efforts in 1997 by the European Investment Bank (EIB), which provided ECU 43 million in financing to establish three wind farms in Navarra.[3]

In 1999, Department of the Environment Secretary Bill Richardson pledged that by 2020 the United States would have 5 per cent of its energy provided via wind energy. That translated into a need to build 80,000 megawatts of wind capacity.[4] Currently, the U.S. has approximately 6,740 megawatts of wind energy feeding into its power grids.[5] In 2003, wind accounted for 13 per cent of electricity generated in the U.S. from non-hydro renewable sources. Biomass accounted for 71 per cent of the non-hydro totals, with geothermal providing 16 per cent and solar energy less than 1 per cent. The non-hydro renewable sector itself provided 2 per cent of the total American electricity generation.[6] The 2020 goal is ambitious and will require significant innovation and investment to become a reality.

Meanwhile, Denmark uses wind to supply 16 to 20 per cent of its national energy needs due, in part, to assistance from the EIB. In 2003, the Bank provided a €134-million loan to help finance the world's largest wind farm off the Danish coast. The project built 80 turbines producing 2 megawatts each.[7]

In 2002, Canada produced approximately 311 megawatts of wind-generated electricity. Thus wind accounted for 10.7 per cent of total generation from alternative sources, or approximately 0.2 per cent of the total Canadian electricity generation.[8] Canadian spending on wind initiatives is also substantial and is set to increase over the next 15 years.[9]

Installed wind capacity worldwide has grown rapidly over the past decade as countries have sought environmentally friendly sources of electricity.

However, the federal government plans to invest $920 million in wind energy initiatives to reach a production target of 4,000 megawatts by 2010. Federal efforts in places such as Prince Edward Island have been augmented by substantial provincial investment as well. In September 2005, the Atlantic Canada Opportunities Agency (ACOA) announced that it would invest $3.6 million to create a Canadian Wind Energy Institute (CanWEI) on the island. In addition, Natural Resources Canada, the PEI Energy Corporation and the provincial government pledged to invest over $2 million a year for two years to help with operating costs.[10]

In their operation, wind turbines use a renewable resource and avoid the environmental impacts arising from traditional generation sources. There are no air pollutants or greenhouse gas emissions, as from fossil fuels. No land is inundated or population displaced, as from the construction of large hydro dams. And wind poses no risk of radiation, as from the spent fuel of nuclear reactors. On the other hand, residents near proposed wind farms raise concerns about noise, visual blight and bird kill.[11]

While wind power tends to be more costly than traditional sources of generation, it is becoming more competitive in some jurisdictions. Driven by favourable public policies in leading countries, the cost of electricity from wind has dropped significantly over the past 20 years: better placement of wind farms has improved the power from each turbine, and better technology has improved the amount of wind power from each dollar of capital.

But wind energy is generated only when the wind blows. Intermittency has been the largest challenge in making wind a cost-competitive source of electricity and in using wind power on complex transmission systems.

As wind power moves from the margins to the mainstream, policy-makers and investors raise questions:

- How do the costs of electricity from wind compare with those from other energy sources?
- What are the costs associated with integrating wind power into transmission grids?
- How well does the general public accept wind power?
- What policy instruments have been used, and public costs incurred, in generating the existing level of power from wind?

The purpose of this briefing is to contribute to public policy discussions by addressing these questions, relying on existing data and experience from countries that are leaders in implementing wind power.

COMPARING COSTS

The cost of generating electricity from different energy sources is of interest to power producers, public policy decision-makers and major consumers of electricity. But how are costs compared?

The International Energy Agency (IEA) of the OECD has produced six studies since 1982 comparing the costs of electricity generation. The basis of comparison is called the levelized unit electricity cost (LUEC) approach. The LUEC is the price that the electricity consumer would need to pay to the producing investor to cover all capital and operating costs, with a rate of return equal to the discount rate. This method sums all projected costs of generation (capital, operating and maintenance, and fuel), and divides by the sum of annual outputs of electricity, with costs and outputs discounted in the year in which they occur.

The most recent study (2005) examines generating plant types that could be commissioned in the comparison countries between 2010 and 2015, and for which cost estimates are available. The levelized costs, or LUECs, do not include transmission or distribution costs, nor do they account for costs of residual emissions (including greenhouse gases). Investment costs are "overnight"—the total costs of building the plant are accounted for as if they were spent at once.

Driven by favourable public policies in leading countries, the cost of electricity from wind has dropped significantly over the past 20 years.

A further important consideration is that the LUECs do not incorporate investors' perceptions of risk in liberalized electricity markets. In such markets, investors may require more than the 5 or 10 per cent rate of return used in the IEA report, may require capital recovery in less than the 30- to 40-year study time frame used to amortize the investment, and may consider with care the time required to build the plant. Two examples will illustrate. Combined-cycle gas turbines (CCGT) have short build times and quicker capital recovery periods than either coal or nuclear plants. Despite gas prices that, by historical standards, are high and volatile, these factors weigh heavily with investors, and have contributed to the high number of CCGT installations in the OECD over the past decade. A different example illustrates the varying impact of technical risk on financial risk. The financial impact of shutting down a 500-megawatt nuclear plant is far greater than the failure of a single 3-megawatt wind turbine. Investors will incorporate these risk factors into their decisions, but such considerations do not enter into the LUEC calculations.

COSTS OF WIND ENERGY

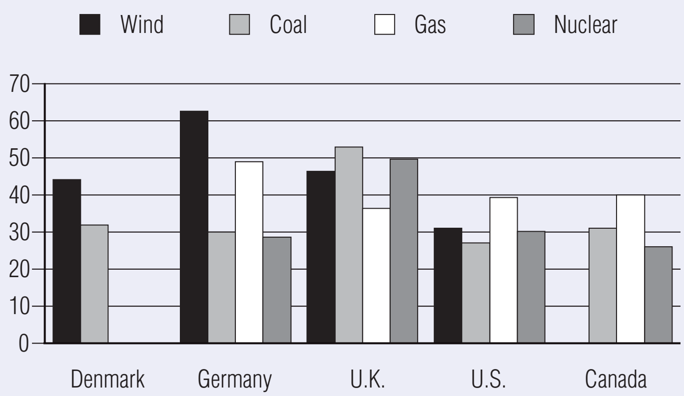
The 2005 IEA study indicates that electricity costs vary from country to country, and that no one energy source provides the least-cost power across all countries. Chart 1 summarizes a comparison of LUECs for five countries that have been active in implementing wind energy over the past decade or more. Note that while Canada participated in the study that culminated in the 2005 report, it did not report data for wind. Two key phenomena are of interest: the relative costs of electrical generation and the lower costs of wind energy in the U.S.

Experience in Denmark and Germany, the countries that have most heavily invested in wind, has shown that electricity from onshore wind (wind turbines located on land) is uneconomic in comparison with traditional alternatives.[12] A 2004 study by the Royal Academy of Engineering in Britain also found that energy produced from offshore wind projects would be more costly than land-based projects. The offshore wind energy would cost over double the same energy produced from gas or nuclear projects.[13] Such a divergence of results suggests that more experience is necessary to better characterize the costs of wind power from different sources. It is known that for intermittent renewable resources such as wind, capacity factors are critical to levelized cost. The capacity of a wind turbine is the maximum power that can be delivered to the grid. A turbine with a capacity factor of 40 per cent means that over a given time period, the turbine provided 40 per cent of its rated capacity. That is, a windmill that produced at 100 per cent of rated capacity whenever it operated, but operated only 12 hours per day, would have a capacity factor of 50 per cent. The LUEC estimate for wind does not include the costs of backup power required. Estimates are provided in a following section of this briefing.

Denmark and Germany have been the countries that have most heavily invested in wind; however, Table 1 reveals their wind capacity factor is lower than in the U.S. and U.K. Since the commencement of the early European wind farms over 20 years ago, wind resource assessment has improved due to improved technology and advances in understanding siting factors. This has permitted better siting and improved capacity factors. Offshore Danish and Dutch wind farms (located in the ocean near land-based power demand), for example, are estimated to have capacity factors of 40 to 45 per cent, in comparison with the 17 to 38 per cent range for onshore wind facilities across the countries reporting for the IEA study.

The experience of other nations, namely the U.K. and Canada, further illustrates the relative costs of wind power. The U.K. did not report estimates for typical power plants, but provided a range of costs for comparative technologies. (Chart 1 in this briefing used the mid-points of those ranges.) By way of contrast, the study by the Royal Academy of Engineering (referred to above) shows traditional technologies providing electricity at lower cost than wind. A common financing model with a nominal discount rate of 7.5 per cent was used to derive the estimates that are shown in Table 2. (The bracketed figures following the unit costs for wind are costs inclusive of standby generation that is required.)

Chart 1
Costs of Generation—Wind and Traditional Sources
(LUEC; $/MWh)



Notes:
1. Of interest is that while Denmark and Germany have invested the most into wind power, it remains uneconomic in both markets.
2. Canada did not report wind data for the study.
Source: Nuclear Energy Agency.

Table 1
Capacity Factors of Wind Turbines
(per cent)

	Capacity factor
U.S.	27
Denmark	24
Germany	30
U.K.	32

Source: International Energy Agency.

Table 2
Unit Costs of Generating Electricity in the U.K.
($/MWh)[1]

	Unit cost
Gas-fired CCGT plant	47
Nuclear fission plant	49
Coal-fired CFB steam plant	56
Onshore wind farm	79 (116)
Offshore wind farm	118 (154)
Wave and marine technologies	141

1 At a currency conversion of U.K. pound = CDN$2.14 (early July 2005).

Source: Adapted from Royal Academy of Engineering.

Although Canada did not submit cost estimates for typical wind plants for the 2005 IEA study, the Canadian Wind Energy Association (CanWEA) reports that the costs for wind generation at recently constructed wind farms in Quebec and Ontario are in the range of 8 to 12¢/kWh (cents per kilowatt-hour).[14] Table 3 provides estimates for three provinces.

The Ontario estimate is the average of all the projects accepted under the 2004 renewables Request for Proposals for 300 megawatts, which includes biomass and small hydro in addition to wind. The Quebec figure includes 1.3¢/kWh for transmission upgrades and 0.9¢/kWh for balancing costs. The Saskatchewan estimate is for SaskPower's expansion of the Cypress Wind facility. Alberta has the largest installed wind capacity of any province. But under Alberta's liberalized electricity markets, costs vary by project and are confidential. Wind capacity in operation, or planned, by province, may be found in Appendix 1.

Wind power is still more expensive, on a unit cost basis, than traditional sources in most regions. But the cost of wind power is becoming competitive in some places such as the U.S.

The second key point of interest is that the IEA study indicates that the levelized cost of electricity from wind in the U.S. is much lower than in other countries. Turbines in U.S. wind farms have been amortized over 40 years, in comparison with the reported technical lifetimes of 20 years for turbines in other countries.[15] Amortizing capital over a longer time will reduce the LUEC. Although wind turbines with the latest technology may have technical lives of somewhat more than 20 years, a comparison of 40-year with 20-year amortization would be misleading.

In summary, wind power is still more expensive, on a unit cost basis, than traditional sources in most regions. But the cost of wind power is becoming competitive in some places such as the United States, where longer amortization periods are reducing the LUEC. Unit costs of production have dropped substantially over the past 20 years, partly due to better siting and partly to improved technology. In Canada, the government has become a key player by subsidizing the development of wind energy and reducing its costs from approximately 30¢/kWh a decade ago to between 6 and 10¢/kWh in September 2005.[16]

Table 3
Costs of Alternative Energy Across Canada
($/MWh)

	Energy cost
Quebec	87
Ontario	80
Saskatchewan	70

Source: Canadian Electricity Association.

INTERMITTENCY AND GRID INTEGRATION

No source of energy delivers power with 100 per cent reliability; wind generation can only happen when the wind blows. As countries implement strategies and policies to increase the proportion of electricity generated by wind, the intermittency of wind can create challenges for the overall electricity system when the proportion of wind power approaches 15 to 20 per cent of total electricity generated on a system.[17] System costs due to wind are largely threefold:[18]

1. **Balancing costs**: The costs arising from other generating sources deviating from their original generation schedule when their production is required to balance a shortfall due to the absence of expected wind. Electricity generators that are given time to plan their operations can optimize their dispatch to meet demand. Flexibility in meeting instantaneous demand, though desirable, is usually expensive.[19]
2. **Capacity costs**: The costs of acquiring backup resources when there is no wind.
3. **Transmission and distribution (T&D) costs**: The costs of reinforcing the transmission grid and maintaining system control. Many of these costs arise from connecting power from remote wind farms to distant load centres. The T&D costs from adding large amounts of wind to the grid will be highly dependent on the specifics of a transmission grid.[20]

As would be the case with any incremental energy source, the most appropriate way to estimate these costs would be to analyze the costs of electricity to consumers with and then without wind. As it is, estimation methodologies are not fully developed, and estimates vary widely from study to study. For example, the designation of a cost as a balancing, capacity or operational reserve may well depend on the characteristics of the given electricity system and market. Table 4 provides estimates of the probable cost range from European empirical and modelling studies.[21]

The British ILEX study (2002) modelled costs using CCGT technology as backup.

The estimates from Western Denmark's transmission system operator, Danish Eltra, averages the total balancing costs for total wind power handled by Eltra in 2003. In Western Denmark, the local thermal (gas or coal) plant provides backup when the interconnections with Sweden and Norway are congested. But when interconnections allow, imported power from hydro provides the least-cost backup for wind.[22]

Two other estimates indicate somewhat large costs of integration, in the range of 30 to 40 per cent, as revealed in Table 5.

The U.K. estimate of integration cost is based on simple assumptions of the need for standby generation. As would be the case for any incremental sources of power, the Quebec integration cost is composed of 1.3¢/kWh for transmission upgrades and 0.9¢/kWh for balancing costs.

The system costs per megawatt-hour of wind, particularly for capacity and T&D, tend to increase with wind's share of the total power to the grid.[23] A February 2005 German study concluded that for increasing penetration beyond 20 per cent, as planned for 2015, "no system solution for the integration of wind power could be found."[24] A high priority for research would be to discover the degree to which this result is applicable in North America.

One aspect of increasing penetration is of particular interest to Canada. Hydropower, of which Canada has an abundant supply, provides an emissions-free backup for wind. A 2002 Hydro-Québec simulation indicates that when the installed wind capacity is marginal to the total system (a few hundred megawatts in Quebec), the effect on river flows is not a problem. But when installed capacity becomes large (several thousand megawatts), short-term flow fluctuations and flow reduction during summer dry periods become a problem.[25] Utilities with mixed sources could choose to deploy gas-fired units rather than hydro as backup to wind so as to retain the option of using a low-cost source—hydro—at other times. In addition, hydropower production is frequently constrained by water level and flow conditions, and backup dispatch may be limited.

However, using natural gas—a carbon-based resource—as a supplement could negate some of the environmental advantages of wind. This could potentially lessen credit afforded to wind in renewable portfolio standards (RPS) regulations discussed below. The strength of a wind-hydroelectric system would be the lack of any carbon-based fuels in providing energy. In terms of RPS, small-scale hydroelectric developments providing supplemental power would be the ideal. As explained later, some larger hydroelectric developments do not qualify for RPS credits.

Table 4
Experienced and Modelled Costs of Integrating Wind Power
($/MWh of wind power) [a, e]

	E.ON Netz[b]	Eltra	ILEX study[c]	GreenNet study[c]
Balancing	14.9	3.8	4.8[d]	2.2–3
Capacity costs	[f]	[f]	9.8	4.4–5.8
Transmission & distribution	[f]	[f]	5.8	3.7–4.4

a For comparison with other technologies, it must be taken into account that all technologies require integration costs.

b E.ON Netz (2004): Approximately 6,000 MW wind power in 2003 and costs of more than $146 million. It is not clear what these costs include. Assuming a load factor of 25%, $146 million corresponds to approximately $10.2/MWh wind power.

c At 20% wind power shares of consumption.

d These balancing costs include some costs for keeping operational reserves (spare capacity for times when the wind is not blowing, but electric production is still required).

e At a conversion factor of 1 euro = CDN$1.46.

f Empty cells are presented as in the original publication.

Source: International Energy Agency.

Table 5
Reported Integration Costs of Wind Generation
($/MWh)

	U.K.	Quebec
Generation costs	79	65
Integration costs	36	22

Source: U.K. Royal Academy of Engineering; Canadian Electricity Association.

The GreenNet study sponsored by the European Community concluded that the total integration costs are in the range of 5 to 10 per cent of generation costs, and projects that costs will migrate toward the lower end of the range as practical experience evolves. But other estimates would increase the upper bound of this range to 25 to 30 per cent. The cost of integrating wind power into transmission grids is an area requiring further research.

One of the obvious determinants of integration costs is distance from the energy source to the infrastructures available to get the energy to the markets. A Helimax Energy survey of potential wind sites in Quebec found a total potential of 415,500 megawatts. However, only approximately a quarter of that amount was located within 25 kilometres of existing transmission lines; therefore, the bulk of the power was deemed non-viable.[26]

One of the obvious determinants of integration costs is distance from the energy source to the infrastructures available to get the energy to markets.

Similar stories exist in the United States. The American Wind Energy Association (AWEA) considered transmission issues to be "one of the greatest impediments to wind development."[27] American energy expert David Berry said that often the best wind locations did not have access to transmission lines. He further argued that the potential wind capacity, especially with its intermittency, would often not justify the expense of building the requisite infrastructure.[28] AWEA added that the best sites were often distant from electric loads and therefore wind energy was "more dependent upon long-distance transmission and less able to avoid transmission problems."[29]

Meanwhile AWEA maintained that geographic proximity to existing infrastructure was only part of a broader problem. It argued that existing transmission regulations harmed the wind sector due to wind's intermittency and, often, its distance from markets. Wind's intermittency and capacity issues raise further problems for transmission systems planners in the U.S., who have to comply with reliability requirements. An additional problem is that advantageous conditions do not always align with times of peak demand.[30]

PUBLIC ACCEPTANCE OF WIND POWER

While not universally accurate, anecdotal evidence suggests that members of the general public think that wind power is a good thing, provided that "it isn't in my backyard" and that preferably it is out of sight. Opinion polls taken during the 1990s in leading wind countries support this notion. The results of opinion polls in Britain, the United States, Canada, Sweden, Germany, the Netherlands and Denmark concerning the public acceptance of wind power found that about 80 per cent of those polled indicated support for renewable energy in general, and wind in particular.[31] But the NIMBY syndrome applies to wind farms as well as to many other industrial sitings—new highways, bridges, airports and traditional power plants.

Anecdotal evidence suggests that members of the general public think that wind power is a good thing, provided that "it isn't in my backyard."

Some studies indicate that public acceptance appears to grow once the wind farms have been operating for some time. An American study discovered "a slight 'U' pattern: acceptance is high initially, it drops during the planning and construction, and increases almost to the initial level after the facilities open."[32] A 2005 report from the American Energy Information Administration further argued that projects involving smaller numbers of wind turbines were likely to be more publicly acceptable than massive wind farms. The opposition tended to be associated with concerns for birds, as well as concerns about the level of noise that would be associated with large wind operations.[33]

A 1994 British study examined public attitudes to wind energy in Wales. Public support was measured for wind in general, and for three specific wind farms, before and three years after installation. Seventy per cent of respondents supported wind development prior to construction in Wales, with 20 per cent opposed—roughly the same response as in Denmark and the Netherlands.[34]

However, only 40 per cent initially supported the three specific wind farm proposals. Opponents cited three reasons: noise (three out of four of those opposed), visual intrusion, and electromagnetic interference. The post-construction survey indicated that acceptance had risen by 25 per cent and opposition by 1.6 per cent, and that undecided had fallen by 18 per cent. In these three projects, the predominant shift was from undecided or not answering to favourable, with opponents (25 per cent) remaining opposed.[35]

A British Wind Energy Association review of British public opinion in the early 1990s concluded that familiarity breeds not contempt but acceptance when it comes to wind. A comparison of wind farm proposals in areas that already have wind farms with control areas where residents have no such experience indicates that new wind proposals are more accepted in areas with prior experience.[36]

Studies on the NIMBY syndrome in the Netherlands concluded that when citizens who live near proposed developments suffer the consequences, but enjoy few of the benefits, NIMBYism can arise. With respect to wind projects, general public support for wind energy does not necessarily translate into support for all wind farm projects. Secondly, the rejection of a specific plan does not mean the rejection of all further wind turbines in the area. Studies further suggest that opposition to siting can be mitigated through participative processes that include local residents and through developing a sophisticated understanding of the nature of the local opposition.[37]

National policy and culture will also affect public acceptance. A comparison of offshore wind development near Cape Cod, Massachusetts, and in Denmark illustrates this. Danish public policy seeks to site offshore wind farms with limited public input. Sites are chosen for superior capacity factors to optimize financial viability. Initial opposition from nearby residents tends to fade with time into acceptance, reflecting the "U" pattern observed elsewhere. On the other hand, the first major U.S. offshore wind development is proposing to place 130 large (40 stories tall) wind turbines off Nantucket Sound.[38] The wind farm would generate about 420 megawatts of power at market prices, almost enough for all of Cape Cod. But the project has its opponents. Local public opinion, according to polls, is almost equally divided. It remains to be seen how the Nantucket Sound decision will be affected by public opinion.

A survey of Canadian polling organizations—Compas, Decima Research, Ekos, Environics, Ipsos, Leger Marketing and SES Research—supplemented with a media search, revealed that there is a dearth of wind-specific public opinion data available. When mentioned at all, wind tends to be covered in people's attitudes toward alternative energy resources in general.[39]

Once wind farms have been operating for some time, however, public acceptance seems to grow again.

The often conflicting nature of public opinion concerning wind energy development is evident in Prince Edward Island, where PEI Energy's CEO reported that a major wind power initiative in the province "has broad local support."[40] Meanwhile, in the PEI village of Malpeque, over 700 area residents signed a petition against a 60- to 75-megawatt wind farm initiative being proposed for the region. They established a website soliciting support from visitors and linked to anti-wind energy groups in the United States, Ireland and the United Kingdom. In general, Canadian Wind Energy Association President Robert Hornung believes that while NIMBY concerns may have an impact on some local developments, it is not going to hinder overall development of wind energy resources.[41]

In summary, public opinion favours the use of wind power in the abstract, but local opposition can be strong to specific proposals, as it can be to almost any kind of industrial development. Once wind farms have been operating for some time, however, public acceptance seems to grow again.

Two other issues affect the acceptance of wind power among policy-makers and the public: the "land footprint" and possible employment stimulation.

LAND FOOTPRINT

To what extent do wind farms replace other productive uses of land? In rural areas, wind farms can and do complement agricultural and ranching uses of the same land area. The area of a wind farm unavailable for such uses amounts to about 5 per cent or less of the total land—the fraction of the land required for the turbine bases and access roads. Farmers can derive income from leasing or royalty arrangements with wind farm developers.

Wind farms proposed for lakeshores or coastal strips will compete directly with other uses of land, such as recreational property development. In these cases, and assuming that all other regulatory hurdles have been cleared, the wind farms will be built only if their prospective economic returns exceed those on the next best alternative uses.

The true land difficulty with power from wind and other renewable sources is low power density—the watts delivered per square metre of land required by the technology. It has been estimated that to replace a 1,000-megawatt nuclear plant by wind would require wind farms covering 770 square kilometres of land. If wind power alone could technically provide all of Canada's electricity, wind farms would cover a land area equivalent to the size of New Brunswick.[42] On a global scale, the September 2004 issue of *New Scientist* commented that there was ample wind energy to provide for the world's energy needs, but "it would take a wind farm the size of Saudi Arabia, and the electricity would cost twice as much as it does today."[43]

EMPLOYMENT POTENTIAL

It has been suggested that some renewable energy projects can be good employment generators, producing more jobs per unit of investment than more conventional energy supply projects due to the higher labour intensity of emerging renewable technologies.[44] A Pembina Institute report concluded that:

> *A review of some 30 studies of employment in the energy sectors in North America showed that renewable energy projects can create twice as many jobs as conventional energy projects per dollar invested. This review showed that a one-million dollar investment would create twelve jobs in alternative energy supply versus seven jobs in conventional energy supply.*[45]

The Canadian Wind Energy Association, for example, has a goal to install more than 10,000 megawatts of wind power capacity in Canada by 2010. CanWEA estimates that this will generate 80,000 to 160,000 permanent jobs by 2010. Figures are based on a source multiplier of eight full-time equivalent (FTE) jobs per million dollars of investment.[46]

MRG @Associates and the U.S. National Renewable Energy Laboratory combined their resources to develop the Job and Economic Development Impact (JEDI) to estimate economic impacts from wind projects.[47] As an example, the model was used to calculate the economic impacts from a 100-megawatt wind plant to be built in Colorado using 1.5-megawatt turbines at a cost of $1,000 per kilowatt. It was found that construction of the plant will generate approximately 220 local FTE jobs for a year—85 attributable to construction—and $12 million in local economic activity during the construction period. Once operational, benefits include 40 FTE jobs (20 directly at the wind farm) and spending of $1.3 million in each operating year in the local economy.[48]

If wind power alone could technically provide all of Canada's electricity, wind farms would cover a land area equivalent to the size of New Brunswick.

The CanWEA study argued that 8 to 16 permanent jobs would be created per megawatt of wind energy produced, or 8 to 16 jobs/MW. In contrast the U.S. study argued that the ratio of permanent jobs to megawatts of wind energy produced would be 40 jobs per 100 megawatts, or 0.4 jobs/MW. While it is beyond the scope of this study to determine the correct employment to energy-produced ratios, the discrepancy between the two reports suggests that additional research and methodological development are needed.

ENCOURAGING WIND POWER: POLICY INSTRUMENTS AND COSTS

In jurisdictions where installed wind capacity has grown rapidly over the past decade, public policies have played a critical role in this growth. Leading wind regions, such as Denmark and Germany, have made promotion of wind energy a focus of public policy. They have therefore used a suite of policy instruments—some affecting the supply side, some the demand; some in the development stages and some during implementation. Strong market growth in renewable power has never occurred in OECD countries with only one policy instrument.[49]

Table 6 indicates the main types of incentives used in leading countries and in Canada. Appendix 2 provides a brief description of these incentives. For further information, a country-by-country review of the incentives and rates used to promote wind energy may be found in ICF (2004), *IEA Wind Energy Report 2004* (2005) and *Wind Force 12*, a report released annually, and last year jointly by Greenpeace and the Global Wind Energy Council on June 30, 2005.

Public policy instruments have often been designed to work in tandem. For example, in the 1980s, the Danish government offered investment subsidies to install wind turbines. At the same time, a feed-in tariff at a premium rate offered a further incentive to wind investors. Starting in 1993, wind investors were provided a guaranteed market for their production, as utilities were required by law to purchase wind power at about 85 per cent of the retail price of electricity.[50] A measure of "effective net subsidy" per megawatt-hour of wind produced would require detailed economic analysis at the country level going beyond a listing of individual programs, incentives and rates.

Feed-in tariffs provided guaranteed markets and favourable prices that mitigated much of the risk for developers of wind technology and wind farms.

Some rough estimates of energy subsidies were made by the European Energy Agency of the EU in 2004. (See Table 7.)[51] "On-budget" measures would include R&D expenditures and differential taxation by fuel source. "Off-budget" would include measures such as price guarantees or demand quotas. The absolute level of subsidy is highest for fossil fuels, lowest for nuclear and intermediate for renewables.

North American governmental subsidy activity is more difficult to gather due to a lack of assembled primary data and a lack of clear methodological agreement as to what constitutes a subsidy. Meanwhile, secondary sources containing energy subsidy information tend to be of a partisan nature. However, it is clear the development of new energy technologies is facilitated through government support.[52]

Table 6
Summary of Policy Instruments Used to Promote Wind Development
(by country)

Policy instrument	Denmark	Germany	U.K.	U.S.	Canada	Spain
Feed-in tariffs/ Pricing policies	●	●			●	
Renewable portfolio standards			●	●	●	
Renewable energy credits			●	●		
Tax credits and subsidies	●	●		●	●	●
Soft loans and guarantees		●	●			●
R&D support	●	●	●	●	●	●
Complementary instruments	●	●			●	●

Source: ICF Consulting Canada; International Energy Agency.

Table 7
2001 Approximate Estimates of Total Energy Subsidies, EU 15
(EUR bn)

	Solid fuel	Oil and gas	Nuclear	Renewables	Total
2001 On-budget	> 6.4	> 0.2	> 1.0	> 0.6	> 8.2
2001 Off-budget	> 6.6	> 8.5	> 1.2	> 4.7	> 21.0
Total	> 13.0	> 8.7	> 2.2	> 5.3	> 29.2

Source: European Energy Agency.

FEED-IN TARIFFS

Feed-in tariffs (FITs) were instrumental in developing wind energy in Denmark, Germany and Spain. These incentives provided guaranteed markets and favourable prices that mitigated much of the risk for developers of wind technology and wind farms. Once the wind market is mature, however, feed-in tariffs are not particularly cost-effective. A fixed price per unit of production results in a flat, not downward-sloping, demand curve.[53] Producers face no pressure to cut costs.

The German system of feed-in tariffs for guaranteed prices for wind-generated electricity is also used by a number of other European nations. The subsidy programs, as of mid-2001 in euros/kWh, are noted in the box, "Feed-in Tariffs."[54]

Feed-in Tariffs
(EUR/kWh)

Austria	Feed-in tariff (FIT) of 0.05–0.09 depending on region
Denmark	Moving from FIT of 0.057 to TGC (Tradable Green Certificate) market rate
France	FIT of 0.073–0.087
Germany	FIT of 0.062–0.091
Greece	FIT of 0.06 mainland, 0.07 islands, additional loan subsidy
Ireland	Auction with price cap of 0.048 for projects greater than 3 MW
Italy	FIT of 0.1045 for first eight years, 0.0531 thereafter
Netherlands	Development of TGC market, current price 0.077
Portugal	FIT of 0.06, additional loan subsidies
Spain	FIT of 0.0626 or added 0.028 onto market price
Sweden	FIT of 0.046, additional investment grants, moving to TGC
U.K.	TGC with current value of 0.047

Source: Bear Stearns International.

Recent changes to Danish energy policy have produced an interesting result. As electricity markets have become liberalized and wind turbine technology has matured, Denmark has replaced the guaranteed feed-in tariff with a new market-based approach to increase competition and promote cost-efficiency. Since the introduction of this new market-based approach in 2003, investment in wind by private individuals, cooperatives and industrial enterprises has come to a complete stop, leaving municipalities and utilities to undertake new investment. This trend is likely related to the move "offshore" where incentives and risk management are more suited to large, specialized entities such as utilities. The long-term market effect of FIT incentives may need further consideration in market design.

RENEWABLE PORTFOLIO STANDARDS

Meanwhile, since the mid-1990s there has been a growing movement in the United States toward greater promotion of "green" energy sources. While the energy sector was moving toward greater privatization, key industry players expressed "a general feeling that total reliance on market forces to foster greater renewables deployment [was] not desirable," and there remained an important participatory role for governments.[55] Hence state governments began to develop renewable portfolio standards that have become important, alongside electricity market reforms, for developing wind energy in the U.S. states of Texas, Minnesota and Iowa. RPSs are likely to be more cost-effective than feed-in tariffs over the long run, since competition among renewable energy sources will drive down production costs.[56] By April 2005, 19 U.S. states had enacted RPS requirements, with 12 states having accompanying clean energy funds.[57]

The move toward RPS regulation in the New England states has had an impact on the Canadian electricity sector. RPS guidelines encourage the supplanting of fossil fuel resources with renewable energies such as wind, bio-fuels and hydroelectric developments up to a certain output, generally in the range of 80 megawatts or less.[58] RPS targets in New York State, for example, seek to have 1.4-million-megawatt RPS energy by 2006 and to incrementally increase that figure to 12 million megawatts by 2013, 25 per cent of the expected demand.[59]

The response of Canada's main electricity exporter to New England, Hydro-Québec, has been to identify six potential small hydro sites and to propose developing some of its estimated 100,000-megawatt wind power potential located within 25 kilometres of existing transmission infrastructure.[60]

Evidence suggests an emerging trend where RPS considerations will become an increasingly important part of energy sector discussions in both the United States and Canada. Beyond Quebec, Canadian interests in RPS are evident in the three Maritime provinces. An August 2005 study, *Maritimes Area Wind Integration Study*, announced that the provincial governments of the Maritimes intend to implement RPS requirements.[61]

Meanwhile, since the mid-1990s there has been a growing movement in the United States toward greater promotion of "green" energy sources.

Production and investment tax credits have typically been used in conjunction with feed-in tariffs and RPSs to help stimulate production of electricity from wind.[62] In the U.S., the Production Tax Credit (PTC) has worked alongside state incentives to promote wind in California and Texas. Introduced in 1992, the current credit is 1.9¢/kWh for the first 10 years of wind farm production. But the PTC is subject to the vagaries of

Congress, and has expired three times over the past six years, leading to a "boom and bust" cycle for wind power development. In Canada, the Wind Power Production Incentive (WPPI) pays wind energy producers 1¢/kWh for the first 10 years of production.

PRACTICAL LIMITS TO WIND POWER

The Canadian Electricity Association recently indicated that it believes the maximum potential for wind power in Canada is currently undetermined,[63] given the limited North American experience to date. The following are practical limits to the use of wind turbines to generate electricity for the grid:

1. **Adequate sites for wind**. The capacity factor is probably the single most important variable in determining the financial viability of a site. But good sites are limited.
2. **Distance of site to load**. In Canada, adequate wind sites may be found on the Pacific and Atlantic coasts, and in the North. But these are often too far from the load to make the costs of transmission viable. However, Pincher Creek wind farms have a market in Calgary, and some of the proposed wind farms in southern Ontario and Quebec are close enough to load to be economically viable.
3. **Backup requirements**. Danish and German experience indicates that as the fraction of generation from wind approaches 20 per cent in a region, both transmission and backup requirements become more costly. Germany, for example, is reluctant to build coal-fired capacity as backup for Danish wind. A large amount of idle backup capacity is an inefficient use of scarce resources.

CONCLUSION

Although installed wind capacity in four key countries has grown dramatically over the past decade, electricity from wind is still more costly to produce, on a unit cost basis, than power from traditional sources in most regions. However, unit costs of wind power have declined rapidly in the past 15 years, so that wind is a competitive generation source in some places.

Strong market growth in renewable power has never occurred in OECD countries with only one policy instrument. In jurisdictions where installed wind capacity has grown rapidly over the past decade, public policies have played a critical role in this growth. Leading wind regions, such as Denmark and Germany, have made promotion of wind energy a focus of public policy. They have therefore used a suite of policy instruments—some affecting the supply side, some the demand; some in the development stages and some during implementation.

The intermittency of wind, and the subsequent challenges of integrating wind power into transmission grids, is recognized as the single biggest challenge for development of wind energy. Other factors limiting the use of wind to generate grid power include the need to find sites with adequate wind resources and proximity of the wind farm to users of the power.

1 International Energy Agency (IEA), *Renewable Energy: Market and Policy Trends in IEA Countries* (Paris: OECD/IEA, 2004), p. 80.

2 James Varley, "Wind of Change Drives Mega Projects," *Modern Power Systems* (November 2004), p. 13; Andrew Whal, "Chasing the Wind," *Canadian Business* 78, 18 (September 12, 2005), pp. 34–39.

3 European Investment Bank, "Spain: Financing for Wind Energy in Navarra," European Investment Bank Press Release 1997-044, June 12, 1997, p. 1.; Canadian Electricity Association, "An Assessment of the Prospects for Wind Power Development in Canada," *Canadian Electricity and the Environment* (December 2004), p. 1.

4 American Wind Energy Association (AWEA), *Fair Transmission Access for Wind: A Brief Discussion of Priority Issues.* [online]. [cited October 13, 2005]. www.awea.org/policy/documents/transmission.PDF, p. 1.

5 Whal, "Chasing the Wind," pp. 34–39.

6 Energy Information Administration (EIA), *Policies to Promote Non-hydro Renewable Energy in the United States and Selected Countries February 2005.* [online]. [cited October 13, 2005]. www.eia.doe.gov/cneaf/solar.renewables/page/non_hydro/nonhydrorenewablespaper_final.pdf#page=1, p. 6.

7 European Investment Bank, *EIB Finances World's Largest Offshore Wind Farm In Denmark*, European Investment Bank Press Release 2003-047, May 19, 2003, p. 1; Whal, "Chasing the Wind," pp. 34–39.

8 The Energy Dialogue Group, *Canada's Energy Future: Towards a Canadian Energy Policy Process*, presented at Canadian Council of Energy Ministers Meeting, Halifax, September 2003.

9 Danylo Hawaleshka, "Power Hungry," *Maclean's* (February 28, 2005), pp. 22–23.

10 Appendix 1 to this report provides a provincial breakdown of wind capacity; Atlantic Canada Opportunities Agency (ACOA), "Canadian Wind Energy Institute to be Established at North Cape, Prince Edward Island," ACOA News Release, September 23, 2005. [online]. [cited October 13, 2005]. www.acoa.ca/e/media/press/press.shtml?3402).

11 Kate Ravilious, “Weather Hots Up Under The Turbines,” *New Scientist* 184, 2472 (November, 2004), p. 19; Peter Stock, “A Quarter-Billion Tossed to the Wind,” *The Report* (June 24, 2002), p. 18; Browen Parsons, “Where’s Canada’s Wind?,” *Canadian Consulting Engineer* (August/September 2003), p. 4; EIA, *Policies*, p. 27; David Wallace, “Letter to Ivor Caplin, 17 February 2004,” *The Royal Society*. [online]. [cited October 13, 2005]. www.royalsociety.org/displaypagedoc.asp?id=11450, p. 1.

12 IEA, *Renewable Energy*, p. 80.

13 “Wind Power ‘Costs Double Gas or Nuclear’ According to RAE Report,” *Professional Engineering* (March 10, 2004), p. 5.

14 Canadian Electricity Association, *Canadian Electricity and the Environment* (Canadian Electricity Association, December 2004), p. 4.

15 One Danish wind farm used a technical life of 25 years.

16 Whal, “Chasing the Wind,” pp. 34–39; Stock, “A Quarter-Billion,” p. 18.

17 Nuclear Energy Agency (NEA), *Projected Costs of Generating Electricity* (Paris: OECD, 2005), pp. 208–215.

18 These system costs apply to any source of power. This section deals only with those due to wind.

19 NEA, *Projected Costs*, p. 208.

20 NEA, *Projected Costs*, p. 214.

21 NEA, *Projected Costs*, p. 214.

22 NEA, *Projected Costs*, p. 210.

23 NEA, *Projected Costs*, p. 214.

24 Deutsche Energie-Agentur, *Planning of the Grid Integration of Wind Energy in Germany Onshore and Offshore up to the Year 2020 (dena Grid study)* (2005), p. 6.

25 Canadian Electricity Association, *Canadian Electricity*, p. 7, footnote xv.

26 “Quebec Study Finds Massive Viable Wind Energy Potential,” *WindSight* (May 2004), p. 2.

27 AWEA, *Fair Transmission*, pp. 2, 14.

28 David Berry, “Renewable Energy as a Natural Gas Price Hedge: The Case of Wind,” *Energy Policy* 33 (2005), p. 802.

29 AWEA, *Fair Transmission*, p. 3.

30 AWEA, *Fair Transmission*, pp. 3–14; Dave Dworzak, “The Costs of a Windless Day,” *Electric Perspectives* (May/June 2005), p. 79.

31 Steffen Damborg, *Public Attitudes Towards Wind Power* (Danish Wind Energy Association, May 2003).

32 Willet Kempton et al., “The Offshore Wind Power Debate: Views from Cape Cod,” *Coastal Management* 33, 119–145 (2005), p. 121.

33 EIA, *Policies*, p. 27; Damborg, *Public Attitudes*, p. 2.

34 Damborg, *Public Attitudes*, pp. 3–4.

35 Kempton et al., “Offshore,” p. 121; Damborg, *Public Attitudes*, p. 3.

36 Damborg, *Public Attitudes*, p. 2.

37 Maarten Wolsink, “Entanglement of Interests and Motives: Assumptions Behind the NIMBY Theory on Facility Sitting,” *Urban Studies* 31, 6 (June 1994), pp. 851–867; Maarten Wolsink, “Policy Beliefs in Spatial Decisions: Contrasting Core Beliefs Concerning Space-making for Waste Infrastructure,” *Urban Studies* 41, 13 (December 2004), pp. 2669–2670, 2682–2685.

38 Kempton et al., “Offshore.”

39 Searches conducted at The Conference Board of Canada on October 7 and 11, 2005.

40 Thomas F. Armistead, “Canadian Project Combines Hydrogen and Wind Systems,” *Engineering News-Record* 254, 24 (June 20, 2005), p. 18.

41 “Growing Industry Sensitive to NIMBY Concerns: Credible High-Quality Information Key to Addressing Potential Conflict,” *WindSight* (May 2004), p. 10; Campaign to Preserve Malpeque, *Preserve Malpeque*. [online]. [cited October 13, 2005]. www.preservemalpeque.org/petition.html, and www.preservemalpeque.org/facts.html.

42 Jesse H. Ausubel, “Renewable and Nuclear Heresies: An Address to the Canadian Nuclear Association,” Ottawa, March 10, 2005, p. 5.

43 Katharine Davis, “Enough Wind to Power the World,” *New Scientist* 183, 2466 (September 25, 2004), p. 12.

44 Daniel M. Kammen et al., *Putting Renewables to Work: How Many Jobs Can the Clean Energy Industry Generate?* (UCal Berkeley, April 2004).

45 Pembina Institute, *Economic Development from Renewable Energy: Yukon Opportunities* (Drayton Valley: Pembina Institute, October 1999), p. 6.

46 *Wind Vision for Canada*, June 6, 2001, p. 2; Pembina Institute, *Comparative Employment Benefits of Energy Investments* (Drayton Valley: Pembina Institute, 1997).

47 National Renewable Energy Laboratory, *Job and Economic Development Impact (JEDI) Model: A User-Friendly Tool to Calculate Economic Impacts from Wind Projects* (Golden, Colorado: National Renewable Energy Laboratory, March 2004).

48 Ibid., p. 6.

49 IEA, *Renewable Energy*, p. 94.

50 ICF Consulting, *A Review Analysis of Alternative Instruments to Promote Wind Energy used in Selected Countries* (NL: ICF Consulting Canada, 2004), p. 12. (Hereafter ICF Study.)

51 European Environment Agency, *Energy subsidies in the European Union: A brief overview* (European Environment Agency, 2004), p. 14.

52 For an American and a Canadian example, please see Marshall Goldberg, *Federal Energy Subsidies: Not All Technologies Are Created Equal* (Washington Renewable Energy Policy Project, 2000), pp. 13–18; David H. Martin, *Canadian Nuclear Subsidies: Fifty Years of Futile Funding* (Ottawa: Campaign for Nuclear Phaseout, 2003), pp. 3–6.

53 ICF Study, p. 28.

54 European Equity Research, *German Wind Farm Developers* (BearSterns, European Equity Research, August 2001), p. 32.

55 B.G. Swezey and T.M. Peterson, *Final Report: Second National Green Pricing and Green Marketing Conference, October 1997*. [online]. (Palo Alto: Electric Power Research Institute, 1997). [cited October 7, 2005]. www.eere.energy.gov/greenpower/conference/2gpmc97/report.html.

56 ICF Study, p. 30.

57 Natural Resources Council of Maine, "Written Comments of NRCM in Support of LDs 1065 and 1434 Relating to Renewable Portfolio Standards" (April 27, 2005), p. 1.

58 Natural Resources Council of Maine, "Written Comments," pp. 1–3.12.

59 State of New York, Public Service Commission, *CASE 03-E-0188: Order Regarding Retail Renewable Portfolio Standard* (September 24, 2004), p. 6.

60 Woolf et al., *Potential Costs*, p. 23; "Ontario Commits to Wind Power," *Modern Power Systems* (August 2003), p. 9; "Largest Windpower Contract in History," S, 27, 6 (November 2004), p. 4; "Quebec Study," p. 2.

61 New Brunswick Systems Operator, p. 2.

62 ICF Study, p. 39.

63 Canadian Electricity Association, *Canadian Electricity and the Environment: An Assassment of the Prospects for Wind Power Development in Canada* (December 2004), p. 2.

APPENDIX 1

Canadian Wind Capacity

NEWFOUNDLAND AND LABRADOR
- Developing a wind energy strategy

NOVA SCOTIA
- 5 MW in operation
- 27 MW under construction
- An additional 25 MW selected under an RFP, with a 30-MW RFP following on 75 MW projected by 2010 under RPS

PRINCE EDWARD ISLAND
- 14 MW in operation
- An additional 50 MW projected by 2010
- Government RPS for 15 per cent of electricity demand from wind energy by 2010
- Wind-hydrogen demonstration program and expectation of significantly higher wind penetration by 2015

NEW BRUNSWICK
- 20-MW project selected under an RFP
- New Brunswick Power has a target of 100 MW by 2010
- RPS under development

QUEBEC
- 113 megawatts (MW) in operation
- 90 MW under construction
- Signed contracts for 1,200 MW in new wind power to be in place by 2012
- An additional 1,000-MW wind-power RFP expected in autumn 2005, with the capacity to be in place by 2012

ONTARIO
- 15 MW in operation
- Signed contracts for 350 MW in new wind power to be in place by 2007
- Commitment under an RPS to 1,350 MW of new renewable energy capacity by 2007 and 2,700 MW from renewables by 2010
- RFP for an additional 1,000 MW of renewable energy released in April 2005
- A minimum of 1,400 MW of wind capacity expected to be in place by 2010

MANITOBA
- 99 MW under construction
- Wind energy RFP expected in autumn 2005
- Manitoba Hydro has a target of 250 MW by 2012; the Manitoba government has a target of 600 MW by approximately 2012

SASKATCHEWAN
- 22 MW in operation
- 150+ MW under construction
- By end of 2005, wind energy was expected to account for 5 per cent of electricity demand

ALBERTA
- 274 MW in operation
- 600 MW permitted, awaiting transmission line enhancements
- Target of 800 MW by 2008 under a voluntary RPS

BRITISH COLUMBIA
- 50-MW project selected under an RFP

Note: Information from Greenpeace and the Global Wind Energy Council, *Wind Force 12* (2005), pp. 27–28.

APPENDIX 2

Incentives to Promote Wind Energy

Feed-in Tariffs/Pricing Policies: Create guaranteed markets by allowing wind facilities to connect to the grid at a fixed price.

Renewable Portfolio Standards: Set a requirement for utilities to generate a target level of production from renewable sources.

Renewable Energy Credits: These are tradable certificates representing the renewable component of generation, and are commonly used with renewable portfolio standards.

Tax Credits and Subsidies: Various forms of tax benefits allocated to renewable generation and subsidies; include grants and other direct methods of investment by government.

Soft Loans and Guarantees: Loans with reduced interest rates or guarantees that allow lower rates to be achieved, thus reducing the capital cost of the plants.

RD&D Support: Government support for research, development and demonstration.

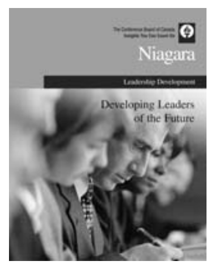
Complementary Instruments: Other methods not included in the above, such as "green" tax or regulatory reforms.

The Conference Board of Canada has a unique ability to bring together the senior leaders of Canada's top organizations to discuss issues, share and compare best practices, and learn from each other. Our main services are:

Executive Networks: Exchanging Ideas and Making New Contacts on Strategic Issues

Conferences, Seminars and Workshops: Learning from Best-Practice Organizations and Industry Experts

Custom-ordered Research: Tapping Our Research Expertise to Address Your Specific Issues

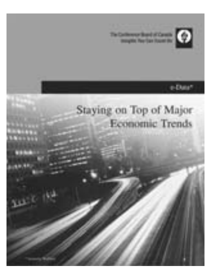


Niagara—Our Leadership Development Programs: Developing Leaders of the Future

Customized Solutions: Helping Your Organization Meet Challenges and Sustain Performance

e-Library: Accessing In-Depth Insights, When You Need Them Most

e-Data: Staying on Top of Major Economic Trends



The Directors College: Raising the Bar for Professional Standards

For more information, contact our Business Development team at 1-866-711-2262 or go to www.conferenceboard.ca.

The Conference Board of Canada
255 Smyth Road
Ottawa ON K1H 8M7 Canada
Tel. 1-866-711-2262
Fax (613) 526-4857
www.conferenceboard.ca

The Conference Board, Inc.
845 Third Avenue, New York NY
10022-6679 USA
Tel. (212) 759-0900
Fax (212) 980-7014
www.conference-board.org

The Conference Board Europe
Chaussée de La Hulpe 130, Box 11
B-1000 Brussels, Belgium
Tel. +32 2 675 54 05
Fax +32 2 675 03 95

The Conference Board Asia–Pacific
2802 Admiralty Centre, Tower 1
18 Harcourt Road, Admiralty
Hong Kong SAR
Tel. +852 2511 1630
Fax +852 2869 1403

Publication 155-06
E-copy: complimentary • Printed copy: $35

The Conference Board of Canada
Insights You Can Count On

255 Smyth Road, Ottawa ON K1H 8M7 Canada
Tel. (613) 526-3280 • *Fax* (613) 526-4857 • *Inquiries* 1-866-711-2262

www.conferenceboard.ca