Power for the Future

Pembina Institute for Appropriate Development

Canadian Environmental Law Association

Towards a Sustainable Electricity System for Ontario

Report Summary

Full report available at www.pembina.org • www.cela.ca

DARLINGTON PLANT: OPG; LAKEVIEW COAL PLANT STACK: MARTIN EDMONDS; WIND TURBINE: OPG; SOLAR PANEL: CANSIA; HYDRO: OCAA FILES

Ontario's Opportunity

The combination of the projected end of life of the province's existing coal-fired and nuclear generating stations and predictions of growing electricity demand have prompted a major debate over the province's future electricity needs and how those needs might be met. The options that have been proposed for Ontario range from ambitious energy efficiency programs accompanied by major investments in low-impact renewable energy sources, such as wind and small-scale hydro, to the construction of a series of new nuclear generating facilities.

A number of recent reports, such as that of the Ontario Power Generation Review Committee (the Manley Report), have suggested that energy efficiency measures, renewable energy sources and cogeneration can only make marginal contributions to meeting the province's future electricity demand. They have suggested that the province should focus on the development of new conventional sources of electricity supply, particularly nuclear energy, instead.

In this context, in the fall of 2003, the Pembina Institute and the Canadian Environmental Law Association initiated an independent investigation of the technical and economic potential for energy-efficiency measures, fuel switching, distributed generation, load shifting (demand response), and low-impact renewable energy sources, such as wind, small-scale hydro and biomass, to provide the foundation for a more sustainable, reliable and affordable electricity system for Ontario.

Using the CIMS computer model developed by researchers as Simon Fraser University, the study found that electricity demand could be reduced by 40% against business-as-usual projections by 2020 through the adoption of currently available energy efficient technologies and practices, fuel switching and increased industrial and commercial cogeneration. Taking into account the potential contributions from demand response measures and on-site generation, the study found that projected summer peak grid electricity demand could be reduced by nearly 50%.

The cost of achieving these savings would be substantial. The investments in energy efficient technologies, fuel switching and increased cogeneration would be more than $18 billion over 15 years. But more than 95% of this amount would be recovered by energy consumers through energy cost savings.

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Ontario's Opportunity

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By contrast, providing the same amount of electricity that could be saved by these investments through the construction of new nuclear generating facilities would cost more than $32 billion.

The study also found that currently available renewable energy technologies could make major contributions to the province's future electricity supply. The study concludes that on the basis of environmental impact, safety and security, reliability, costs and construction time, the remaining grid demand, once the opportunities for energy efficiency and low-impact renewable energy sources have been maximized, should be met through new high-efficiency combined cycle natural gas fired generating facilities. The study found that by 2020 this requirement would amount to substantially less than the province's current coal-fired generating capacity.

Ontario faces major choices over its future electricity path and all of these choices entail a measure of risk. In contrast to the option of investing in the construction of new nuclear generating facilities, a technology that is in large measure responsible for the environmental, reliability and financial crisises now facing Ontario's electricity system, the path outlined in the study relies on existing proven energy efficiency and low-impact renewable energy technologies. These technologies have well-established performance and costs, and major environmental, health, security, safety and reliability benefits relative to conventional sources of electricity supply. These factors make the best choice for Ontario's electricity future clear.

About the report

The past five years have been a period of extraordinary change and upheaval in Ontario's institutions and policies related to electricity. More changes have occurred in the electricity sector since 1998 than over the preceding nine decades following the creation of the Ontario Hydro-Electric Power Commission in 1906.

Today, there is growing concern among the public, energy consumers, and the government over both the province's short-term ability to meet peak electricity demand and its longer-term electricity supply. Public concerns about the security of the province's future electricity supply were further reinforced by the August 2003 blackout.

Ontario will need to make major decisions about long-term electricity policy in the relatively near future. These include questions on the shape of future demand and supply. In this context, the Pembina Institute and the Canadian Environmental Law Association undertook this study to answer four key questions regarding Ontario's future electricity path:

1. How much could future electricity demand in Ontario be realistically reduced through the adoption of energy efficient technologies, fuel switching, cogeneration, and demand response measures?
2. How much future supply might be realistically obtained from low-impact renewable energy sources, such as wind, the upgrading of existing hydroelectric facilities, and the development of new small-scale hydro plants, solar, and biomass?
3. How should the remaining grid demand, if any, be met once the technically and economically feasible contributions from energy efficiency, fuel switching, cogeneration, demand response measures, and low-impact renewable energy sources have been maximized?
4. What public policies and institutional arrangements should the province adopt to ensure the maximization of the contributions from energy efficiency and other demand side measures, low-impact renewable energy sources, and the most environmentally and economically sustainable supply mix to meet remaining future grid demand?

About us

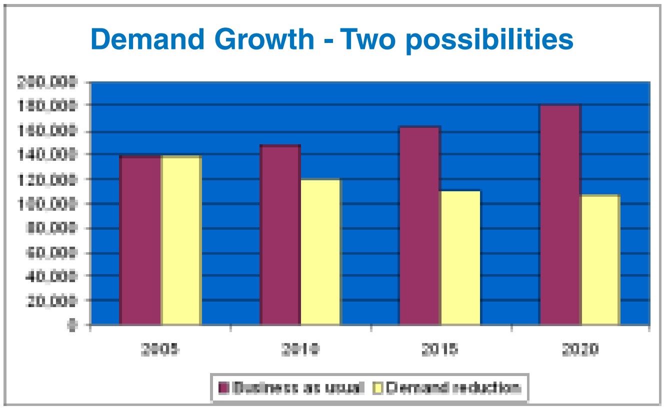
The Pembina Institute is an independent, not-for-profit environmental policy research and education organization specializing in the fields of sustainable energy, community sustainability, climate change and corporate environmental management. For more information on the Institute's work, please visit our website at www.pembina.org.

The Canadian Environmental Law Association (CELA) is a public interest law group founded in 1970 for the purpose of using and improving laws to protect the environment and public health and safety. CELA lawyers represent individuals and citizens' groups in the courts and before tribunals on a wide variety of environmental protection and resource management matters. In addition, CELA staff members are involved in a range of initiatives related to law reform, public education and community organization. www.cela.org

Reducing Consumption:

Study finds that curbing demand can have big benefits

In order to assess the potential impact of energy efficiency programs, a series of generic policy measures was proposed to promote the adoption of energy efficient technologies, cogeneration in the industrial and commercial sectors, and fuel switching from electricity to natural gas, where this is the most efficient option.



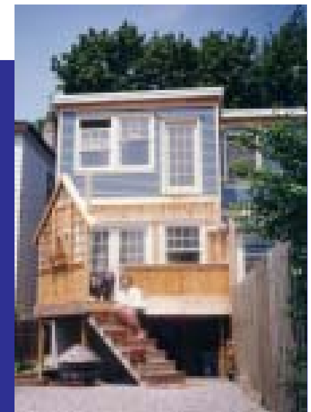
The Canadian Integrated Modeling System (CIMS) computer model, developed by the Energy and Materials Research Group at Simon Fraser University, was used to estimate the reduction in electricity consumption that could be achieved between the present and 2020 through the implementation of new energy policies; the incremental investment associated with achieving the 2020 energy savings; the resulting changes in natural gas demand from the adoption of energy efficient technologies and practices; and the net cost per kWh saved through energy efficiency measures.

Three types of policy intervention were simulated through the CIMS model:

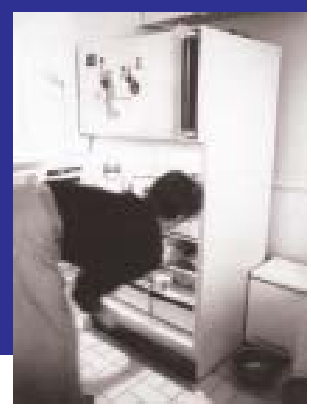
1. The provision of financial incentives in the form of grants, sales tax removal, or tax credits for the adoption of the most efficient technologies and industrial processes.
2. The provision of innovative financing programs for high-efficiency technologies and industrial processes to facilitate the faster payback of investments in these technologies and processes through energy savings.
3. The removal of barriers to cogeneration in the industrial and commercial sectors, through mechanisms such as net metering and power purchasing agreements.

The CIMS model forecast that energy consumption would rise from 138,890 GWh / year in 2005 to 180,775 in 2020 – an increase of more than 30% — under a business as usual scenario.

With the policy changes, the CIMS model forecast that energy consumption would decline significantly, from 138,890 GWh in 2005 to 107,276 GWh/ yr in 2020, a reduction of 40% against the business-as-usual scenario.



Better standards for buildngs and appliances are among the tools that can be used to reduce energy demand while also improving quality.



The electricity savings would result from three types of technological and behavioural changes:

1. The adoption of the most energy efficient technologies instead of conventional products in all sectors
2. The expansion of cogeneration in the industrial and commercial/institutional sectors as energy consumers take advantage of the efficiencies offered by combined heat and power, and generating power through cogeneration and micro-turbines instead of buying from the grid
3. A shift from electricity to natural gas for heating in the residential and commercial/institutional sectors

These changes would be achieved as energy users would take advantage of financial incentives that reduce the capital cost of energy efficient or non-electric technologies, and innovative financing that would allow them to make purchasing decisions more on a life-cycle cost rather than a first-cost basis.

The study finds that capital investments of $18.2 billion by energy consumers over the 2005–2020 period would

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be required to achieve these savings through energy efficiency, fuel switching, and cogeneration. However, 96% of these costs would be recovered by consumers through their savings in energy consumption resulting from these investments. Ontario's natural gas consumption would increase by 12% over business-as-usual projections by 2020 as a result of the technological and behavioural changes flowing from the measures tested through CIMS.

The study also considers the potential impact of demand response measures that encourage consumers to not use power at peak periods. This can be done through such measures as pricing designed to encourage consumers to delay or manage power-using activities on an hourly or daily basis at critical peak periods. Estimates developed for the IMO suggest that up to 10% of Ontario's peak demand could be shifted through demand response measures. Consideration is also given to the potential contribution of an on-site solar rooftop program to help address summer peak demand.

The total impact of the modelled energy efficiency measures and potential contribution of demand response programs and on-site solar generation on net grid peak demand are shown in Table 1.

As Table 1 shows, net summer peak demand could be reduced by nearly 50% against the business-as-usual projections through the adoption of more energy efficient technologies, fuel switching, cogeneration, demand response measures, and on-site generation.

Major policy tools for reducing demand

- Minimum efficiency codes, standards, and labelling of energy efficient technologies
- Financial incentives for the most energy efficient technologies and industrial processes
- Innovative financing programs for high-efficiency technologies and practices
- Net metering and power purchasing agreements for cogeneration
- Eliminating the use of electricity for heating

The current policy hurdles and disincentives for each of these measures are discussed in detail in the report. See the recommendations section for more on how Ontario can make the most of these demand reduction tools.

Table 1: Estimated Peak Demand Reduction and Net Grid Peak Demand 2010–2020

	2010 Peak (MW)		2015 Peak (MW)		2020 Peak (MW)	
	Winter	Summer	Winter	Summer	Winter	Summer
IMO Forecast for Peak Demand	26,000	27,800	26,500	28,700	28,000	30,000
Peak Demand Reduction from Energy Efficiency, Fuel Switching, and Cogeneration	(4,500)	(4,500)	(8,900)	(8,900)	(12,300)	(12,300)
Demand Response Measures	(2,330)	(2,330)	(1,980)	(1,980)	(1,770)	(1,770)
On-Site Generation		(250)		(500)		(750)
Net Grid Demand	19,170	20,700	15,670	17,320	13,930	15,180

The CIMS model

The CIMS model estimates future energy demand by simulating the addition and replacement of energy using "stock"—industrial process equipment, electric motors, commercial lighting equipment, residential appliances, etc. The addition of new stock is linked to forecasts of macroeconomic parameters such as industrial production, commercial floor space, and housing starts. Stock replacement is determined by the life of the piece of equipment, or its availability. CIMS also simulates a "competition" among technologies that can meet the demand for new or replaced stock. The distribution among the competing technologies depends on its capital cost, operating cost, and various parameters representing consumer preference.

Energy demand is then estimated by multiplying the stock number of each technology installed at any time by their energy use per unit. CIMS also aggregates the investment in the stock. The model allows the analyst to modify parameters to simulate policies that add or remove technologies, change energy prices, or manage consumer choice. By running a base case (business as usual) forecast followed by a forecast with the policy parameters changed, the analyst can estimate the reduction in energy use resulting from the policy change as well as the additional investment required to achieve these savings.

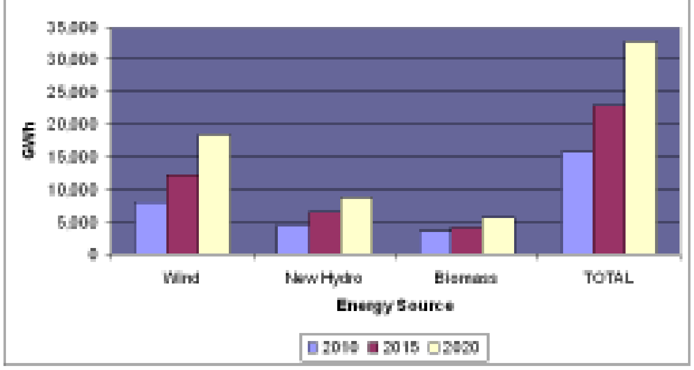
Because CIMS treats each energy end-use separately, the analyst can also construct a "supply" curve of energy efficiency measures showing which groups of measures are the most cost effective.

Meeting remaining demand:

Renewable energy's time has arrived

Once the reductions in power demand resulting from the policies outlined previously have been deducted from the projected growth in demand, our study found that there would be a need to for a reliable base load power of approximately 13,000 MW and additional capacity to meet another 2,000 MW of mid-load and peak demand by 2020.

Projected growth in renewable energy supplies



Ontario has a range of potential supply options to meet this remaining grid demand, from traditional sources like coal and nuclear to new technologies like wind and biogas. The study focused on renewable energy sources as the first- choice supply options for the following reasons:

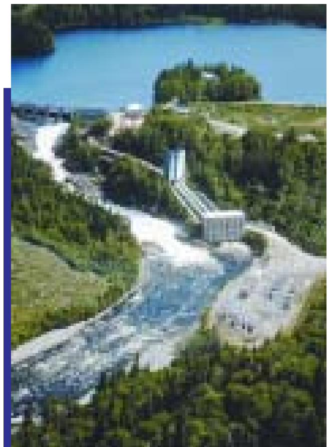
- Their low environmental and health impacts.
- Their low operating costs.
- They do not rely on imported fuels
- Their low security and safety risks relative to conventional energy sources, such as fossil-fuel fired or nuclear generation.

The study concludes that it would be reasonable to expect significant contributions to Ontario's electricity supply from low-impact renewable energy sources, such as small-scale hydro, wind, and biomass by 2020. While it is somewhat difficult to predict the potential of these sources due to limited data, it is estimated that wind, hydro and biogas together could be supplying more than 32,000 GWh of power per year in Ontario by 2020.

CANSIA

Rooftop solar can provide new energy

This leaves a gap of 25,000 GWh of supply to be filled by other power sources. On the basis of costs, environmental and health impacts, speed of construction and reliability, the study finds that this remaining base load requirement would be best met through combined cycle natural gas generating facilities. However, in light of the concern in the very long term regarding natural gas supplies in North America, these facilities should be seen as an interim measure towards a system that relies on more advanced renewable energy sources in the future.

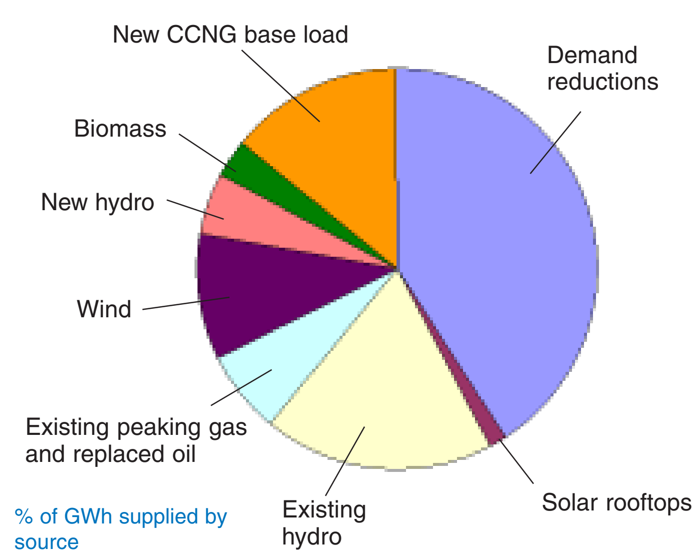


OCAA FILES

Hydro and wind potential is large

See the next page for a detailed breakdown of the projected new supply mix.

Meeting 2020 Demand:
A new power recipe for Ontario



CHRIS PHILP

Full report available online

You can download the full *Power for the Future* study from the Pembina Insititue and CELA websites at www.pembina.org or www.cela.ca

The full study consists of a 50-page main report and four appendixes:

- A report by Mark Jaccard and Associates on the CIMS modelling
- A report on the history and estimated timelines and refurbishment costs of Ontario's nuclear generating facilities
- A review of recent energy efficiency initiatives in North America, prepared by the Pembina Institute
- A review of combustion technologies for electricity generation, prepared by the Pembina Institute

Table 2: Final Estimated Grid Demand Reduction and Supply Mix, 2010–2020

	2010			2015			2020		
	GWh	Peak (MW)	Capacity (MW)	GWh	Peak (MW)	Capacity (MW)	GWh	Peak (MW)	Capacity (MW)
IMO Forecast	164,000	27,800		172,000	28,742		180,000	30,079	
Demand Reductions—Efficiency/Cogeneration	(26,867)	(4,510)		(53,002)	(8,898)		(73,499)	(12,339)	
Additional Load Shifting		(2,329)			(1,984)			(1,774)	
On-Site Solar Roofs Program	(876)	(250)	330	(1,752)	(500)	670	(2,628)	(750)	1,000
Grid Demand	136,257	20,711		117,246	17,360		103,873	15,216	
Existing Nuclear	51,246	5,994	9,000	22,776	2,664	4,000			
Existing Hydro	33,572	6,375	7,665	33,572	6,375	7,665	33,572	6,375	7,665
Existing Peaking Gas and Replaced Oil	12,208	3,060	4,645	12,208	3,060	4,645	12,208	3,060	4,645
Wind	7,884	1,317	3,000	13,140	2,196	5,000	18,396	3,074	7,000
New Hydro	4,380	600	1,000	6,570	900	1,500	8,760	1,200	2,000
Biomass	3,504	234	500	4,205	281	600	5,606	375	800
New CCNG Base Load	23,915	3,570	4,200	25,054	3,740	4,400	25,623	3,825	4,500
Total Supply	136,709	21,150	30,010	117,525	19,216	27,810	104,165	17,909	26,610
Contingency	452	440		278	1,856		292	2,693	

Moving toward a new energy future:

Conclusion and recommendations

Achieving the potential reduction in electricity demand identified in this study by 2020 will not be easy or without risk. However, the study notes that other jurisdictions in North America are implementing the types of program that will be needed in Ontario to achieve this target. California, for example, has reduced peak power demand by 20% or 10,000 MW over the past 20 years with a combination of utility demand-side management (DSM) programs and building and appliance standards.

The specific measures recommended to the province in the study are as follows:

1. The Government of Ontario should adopt minimum energy efficiency standards under the Energy Efficiency Act equivalent to the energy efficiency levels required for Energy Star labelling for all major electricity-using devices and equipment when the market share for new or replacement energy efficient models surpasses 50%, and not later than 2010 for all devices. The province should develop its own energy efficiency standards for equipment not covered by Energy Star.

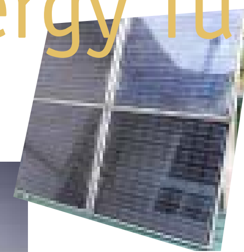
2. The provincial Building Code should be amended to require R2000, Canadian Building Improvement Program (CBIP), or equivalent energy efficiency performance for all new buildings and building renovations by 2010.

3. The Planning Act should be amended to permit municipalities to make energy efficiency design requirements a condition of planning and site approvals for new developments.

4. The most energy efficient technologies in all sectors and end-uses should be labelled through the Energy Star program or, if not included in Energy Star, through a provincial labelling system.

5. The OEB performance-based rate setting and DSM incentive mechanism model currently applied to Enbridge Gas Distribution should be extended to Hydro One and all of Ontario's electrical distribution utilities. All distribution utilities should be required to set targets for energy efficiency gains and be allowed to then share in the benefits of DSM programs. The incentive mechanisms should allow utilities without DSM capabilities to meet their targets by contracting the delivery of DSM programs to other electrical and gas utilities, the energy service industry, or specialized non-profit agencies.

6. The Government of Ontario should expand its current net metering policy to include all industrial, commercial/institutional and residential users, and develop grid inter-tie specifications and training programs for utility staff. A series of annual special RFPs or feed-in tariffs should be issued to encourage smaller industries and large commercial and institutional facilities to develop their cogeneration potential.



TORONTO WIND TURBINE: QUENTIN CHIOTTI; SOLAR PANEL: CANSIA

7. The Government of Ontario should establish a partnership with utilities, financial institutions, energy service companies, municipalities, and other stakeholders to offer a series of financing mechanisms to assist electricity consumers in all sectors to finance the adoption of energy efficient products and technologies and measures out of the savings they will achieve through these investments.

8. The Government of Ontario should enter into an agreement with the federal government under the auspices of the federal government's Kyoto Protocol implementation plan to share the costs of providing the following financial incentives for the adoption of energy efficient technologies:

- Grants for high efficiency home energy retrofits and new R2000 homes
- Grants towards the additional cost of new high-efficiency commercial buildings and commercial building retrofits
- Sales tax rebates for all Energy Star products in all sectors and small-scale renewable energy power sources
- Business tax credits for industrial energy efficiency equipment and cogeneration systems.

These incentives should focus initially on technologies where the largest reductions can be achieved at the lowest cost, such as commercial HVAC and lighting and industrial drive power. The incentives should be in effect only until the market share of the efficient technology reaches 50%.

9. Mechanisms to ensure the delivery of programs to low-income consumers should be incorporated into the DSM mandates and incentives provided to energy and electrical distribution utilities. A specific portion of DSM spending should be set aside for this purpose, including revenues from the Public Benefits Charge proposed in Recommendation 11.

10. The Government of Ontario should adopt legislation creating a new agency, the Ontario Sustainable Energy Authority, reporting to the Minister of Energy, to lead and coordinate the province's energy efficiency efforts. The agency's functions should include:

- The coordination and oversight of the development and implementation of provincial energy efficiency standards and labelling programs
- Ensuring the consideration of energy efficiency in the

policies and programs of provincial government agencies

- The ongoing assessment of the effectiveness of energy efficiency programs being delivered by utilities and provincial agencies, including low-income programs and the provision of recommendations for their improvement to the provincial government and the OEB.
- The forecasting of province's future electricity needs.
- Research, development, and education and information dissemination on energy efficient technologies and practices.

The proposed Ontario Power Authority, responsible for issuing requests for proposals for the construction of new generating capacity, should be a division of the new agency.

11. A Public Benefit Charge (PBC) of 0.3 cents/kWh should be applied on all electricity sales to finance energy efficiency and low-income assistance programs.

12. The Government of Ontario should implement the following demand response policies:

- The OEB should be directed to undertake a generic proceeding on demand response to consider the various issues impeding demand response and develop appropriate policies and codes to encourage greater demand response in the Ontario market.
- The Government of Ontario should assess the infrastructure needed to encourage and facilitate demand response in the Ontario market. A portion of the revenues generated by the PBC proposed in Recommendation 11 should be used to meet the costs of providing the required infrastructure.
- All electricity consumers should be able to participate in demand response programs, and should not be capped in terms of the level of their participation.

13. The Government of Ontario should undertake a design and costing study for a 200,000 unit solar PV roof program modelled on those undertaken in Europe and the United States, and implement this program using a feed-in tariff funding mechanism.

14. The Government of Ontario should issue, through the IMO or proposed Ontario Electricity Authority, RFPs for supply from wind, upgraded existing or new small scale hydro, solar, the use of waste-generated methane from municipal, agricultural, industrial sources and other low-impact renewable energy sources. The initial RFPs should seek to have 4,500 MW capacity in place by 2010, followed by additional calls for supply up to 7,100 MW by 2015 and 9,800 MW by 2020.

15. The Government of Ontario should undertake on an urgent basis a complete up-to-date assessment of the potential contributions from onshore and offshore wind generation, small scale hydro and the use of waste digestion-generated methane to the province's future energy supply. This effort should include primary research as required, including detailed wind-potential mapping.

16. The Government of Ontario should initiate a research and development program on renewable energy technologies funded through the PBC proposed in Recommendation 11. This should include both technology development and the resolution of grid integration issues.

17. The IMO should adopt management practices designed to forecast power outputs from wind power capacity and run-of-river hydro (and solar PV systems), and be prepared to dispatch hydro storage and existing natural gas facilities as needed to provide base load capacity.

18 The Government of Ontario should establish and expedite the completion of a consultative process to develop land-use guidelines for the siting of renewable energy generating facilities.

19. The Government of Ontario should develop guidelines, in conjunction with the federal government, for the approval of offshore wind power generation facilities.

20. The Government of Ontario should issue through the IMO or the proposed Ontario Electricity Authority a request for proposals for long-term base load supply, meeting the construction time, cost, reliability, and environmental, health and safety performance of combined cycle natural gas generating facilities. The call for proposals should seek to have 4,200 MW of new base load supply in place by 2007 and 4,500 MW in place by 2020.

In conclusion

The study concludes that Ontario is now at a critical juncture in terms of its future energy path and that the decisions made about electricity policy over the next year will set the province's course for the next 20 or 30 years. The choices the province makes will have major implications for the health, environment, safety and security of Ontario residents, as well as the competitiveness of Ontario's businesses and industries, for decades to come.

The study shows that the choice faced by the province is clear. The province can take the path of making a massive investment in a generation technology, namely nuclear power, that has never lived up to its promise and is in large measure responsible for the environmental, reliability and financial crises now facing Ontario's electricity system, and which carries with it enormous environmental and economic risks and costs to present and future generations of Ontarians.

In the alternative, the province can choose the path, as laid out in the study, of setting a policy framework that will result in the widespread adoption of proven energy efficient technologies and practices that will reduce consumers' energy bills, improve air quality, protect the health and safety of Ontario residents, and result in a more, safe, secure, and reliable electricity system.

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Toronto Atmospheric Fund