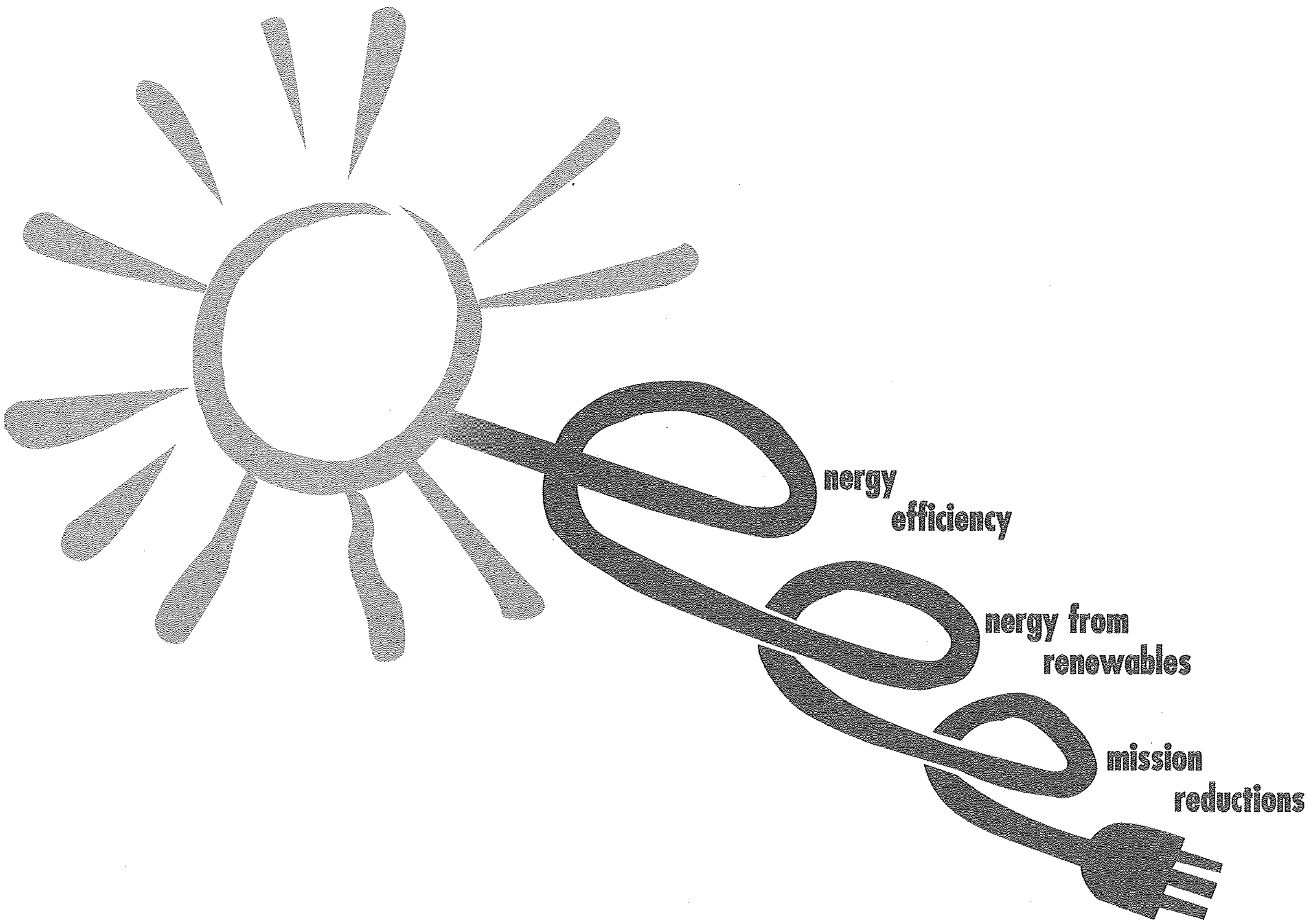
Environmental Protection in a Competitive Electricity Market in Ontario

SUMMARY REPORT



MAY 1999

POLLUTION PROBE

Institute for Environmental Studies
Institut pour l'Etude de l'Environnement

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Pollution Probe

Pollution Probe is a non-profit charitable organizati that works in partnership with all sectors of society to protect health by promoting clean air and clean water. Pollution Probe was established in 1969 following a gathering of 240 students and professor at the University of Toronto campus to discuss a series of disquieting pesticide-related stories that ha appeared in the media. Early issues tackled by Pollution Probe included urging the Canadian government to ban DDT for almost all uses, and campaigning for the clean-up of the Don River in Toronto. We encouraged curbside recycling in 140 Ontario communities and supported the development of the Blue Box programme. Pollution Probe has published several books, including *Profit from Pollution Prevention, The Green Consumer Guide* (which more than 225,000 copies were sold across Canada) and *Additive Alert.*

Since the 1990s, Pollution Probe has focused its programmes on issues related to air pollution and human health, including a major programme to remove human sources of mercury from the environment. Pollution Probe's scope has recently expanded to new concerns, including the unique risks that environmental contaminants pose to children, the health risks related to exposures withi indoor environments, and the development of innovative tools for promoting responsible environmental behavior.

Since 1993, as part of our ongoing commitment to improving air quality, Pollution Probe has held an annual Clean Air Campaign during the month of June to raise awareness of the relationships among vehicle emissions, smog, climate change and human respiratory problems. The Clean Air Campa has helped the Ontario Ministry of the Environmen develop a mandatory vehicle emissions testing programme.

Pollution Probe offers innovative and practical solutions to environmental issues pertaining to air and water pollution. In defining environmental problems and advocating practical solutions, we draw upon sound science and technology, mobi scientists and other experts, and build partnerships with industry, governments and communities.

May 1999

On behalf of Pollution Probe and the University of Toronto's Institute for Environmental Studies, we are pleased to release this report on *Environmental Protection in a Competitive Electricity Market in Ontario*. As the Province of Ontario implements the new *Energy Competition Act* and its regulations, we believe that the people of Ontario can and should receive both cleaner air and competitively priced electricity.

Just as Ontario has among the highest implementation rates in the world of the 3Rs of waste management — reduction, reuse and recycling — Pollution Probe and the Institute for Environmental Studies are now promoting the "3Es" of environmental protection in a competitive electricity market. These are, in order of priority:

- **Energy efficiency**
- **Energy from renewables**
- **Emission reductions**

Similar to the 3Rs concept which Pollution Probe developed in the early 1970s, the 3Es concept reinforces the need: first, to eliminate unnecessary energy use; second, to maximize the use of renewable energy resources; and, third, to minimize the emissions associated with electricity generation. This report proposes six policy measures that the Government of Ontario should put in place to implement the 3Es concept. Pollution Probe and the Institute for Environmental Studies urge the province to move forward on these measures without delay.

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The summary report is entirely the responsibility of Pollution Probe and the Institute for Environmental Studies.

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1. Introduction

The generation of electricity across North America is evolving from a utility monopoly-based structure to a deregulated, competitive marketplace. As with the long-distance telephone, airline and natural gas industries, demands for greater consumer choice and reduced cost, particularly from large industrial users, are the drivers for this change. Electricity is largely a provincially or state-regulated industry, and various states and provinces are in different stages of the deregulation process. Following publication of the MacDonald Committee report in May 1996 and the "White Paper" in November 1997, the Ontario government passed the *Energy Competition Act* in October 1998.

Unlike the deregulation of other former monopoly markets, there is potential for the deregulation of the electricity market to result in significant, negative impacts on human health and the environment. This same potential points, alternatively, to a tremendous opportunity to reconfigure Ontario's electricity generation infrastructure to include cleaner, more energy-efficient power plants.

Coal-fired electric stations are major emitters of sulphur dioxide (SO_2), nitrogen oxides (NO_x), particulate matter (PM_{10}), mercury (Hg), carbon dioxide (CO_2), and other air pollutants. These emissions contribute to the creation of acid aerosols, acid rain and smog, water pollution, and climate change. Due to the long-range transport of many of these air pollutants, any increase in the use of coal in the U.S. Ohio Valley/Great Lakes states region will affect areas to the east and northeast, including Ontario, Quebec, the U.S. Northeast and Atlantic Canada. The Great Lakes basin is particularly vulnerable to toxic fall-out from increased air emissions.

To ensure that appropriate measures will be introduced to reduce the negative environmental impacts of the electric power sector, Pollution Probe and the Institute for Environmental Studies (IES) recently conducted independent research on this important policy issue.

In the first phase of the research, a problem statement was formulated. This included a compilation of current emissions from coal-fired electric stations and a summary of the environmental and health effects of these emissions. The report of the findings, *Emissions from Coal-Fired Electric Stations: Environmental Health Effects and Reduction Options,* published in January 1998, is available from Pollution Probe. A summary of the major findings is presented in Section 2 of this report.

In the next major phase of the research, five specific, technically feasible, emission reduction scenarios were developed and assessed. A detailed description of the scenarios, as well as their estimated impacts on emissions in 2010, is included in the January 1998 report. A summary of the findings is provided here in Section 3.

In the next research phase, 22 policy measures were identified and described, and their enactment status was summarized. Of these measures, seven were selected for more detailed assessment of environmental and economic impacts as well as their potential to be implemented. The findings from this research were published in another report, *Environmental Protection in a Competitive Electricity Market in Ontario: Analysis of Environmental Policy Options,* released in August 1998 and also available from Pollution Probe. A summary of the major conclusions from this research is included in Section 4.

Section 5 of this report comprises recommendations for protecting the environment in a competitive electricity market in Ontario.

It should be noted that the latest phase of the project also included an analysis of the legal aspects associated with the seven selected policy options. Two reports, *Analysis of Current Legal Requirements for Control of Air Emissions in Canada and the U.S.*, March 1998, and *Legal Aspects of Energy Conservation Measures in a Restructured Electricity Industry in Ontario,* July 1998, summarize the findings of this analysis and are available from Pollution Probe. In addition, Pollution Probe is currently researching the potential economic savings associated with emissions trading.

2. Problem Statement

Coal-fired electric stations are major generators of the following five emissions (based on 1995 data):

- **SO_2** – When coal is burned, the sulphur present in the fuel oxidizes to form sulphur dioxide gas (SO_2). This gas further oxidizes into sulphuric acid, bisulphate and sulphate. These gases then combine with other materials to form acid aerosols and acid rain. In the U.S., 63 per cent of all SO_2 was generated by coal-fired electric stations; in Ontario, these types of stations accounted for 17 per cent of all SO_2 emissions.

- **NO_x** – During the combustion of coal, oxygen reacts with nitrogen to produce nitric oxide and nitrogen dioxide, commonly referred to together as nitrogen oxides (NO_x). Along with SO_2, NO_x contributes to acid depositions as gases and as wet and dry particles. NO_x also reacts with other pollutants to form ground-level ozone, commonly referred to as "smog." In the U.S., coal-fired electric stations were responsible for 26 per cent of all NO_x; in Ontario, they were responsible for 12 per cent. In this study, NO_x is measured as NO_2 emissions.

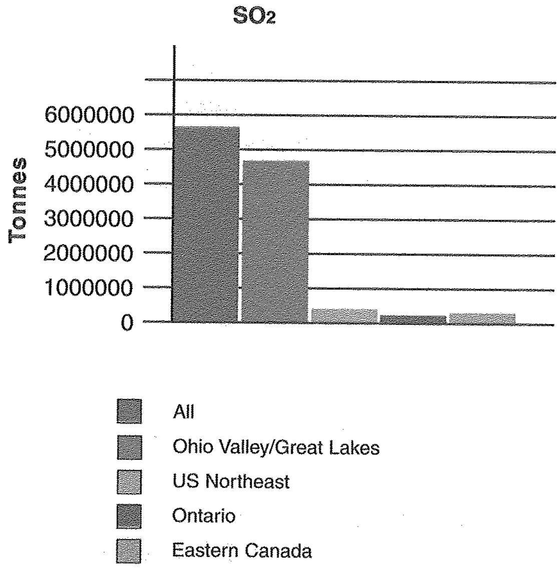
- **Mercury** – Mercury is a highly toxic, bioaccumulative, persistent substance. It occurs naturally in coal and is emitted into the air when coal is burned. All fossil fuel-fired stations in the U.S. (including gas- and oil-fired) accounted for approximately 21 per cent of all human-produced mercury emissions; in Ontario, the corresponding number was close to 10 per cent.

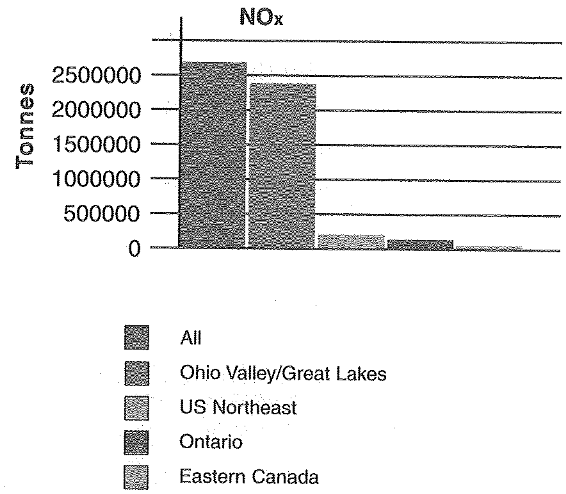
- **Particulate Matter** – Heavy metals and other solid emissions, when suspended as fine particles, are referred to as particulate matter. Given that they are inhalable, the greatest concern is with particles less than 10 micrometres (PM_{10}) in size. In the U.S., coal-fired stations accounted for 10 per cent of all PM_{10} emissions.

- **CO_2** – During combustion, carbon atoms in coal react with oxygen to form carbon dioxide (CO_2), the most prevalent of the greenhouse gases. These gases trap heat in the atmosphere and can lead to changes in global climate. In the U.S., coal-fired electric stations produced about 31 per cent of all CO_2; in Ontario, they produced about 18 per cent.

As part of this research, emission levels for each of these five pollutants were compiled for the 312 coal-fired electric stations in Ontario, Atlantic Canada, Ohio Valley/Great Lakes states and U.S. Northeast. It was found that about 90 per cent of each of the five emissions studied originated in the Ohio Valley/Great Lakes states. The relative dominance of SO_2 and NO_x emissions from this region as compared to the other regions is graphically illustrated in Figure 1; the profiles for the other three emissions are similar.

Figure 1: Emissions of SO_2 and NO_x in 1995 by Region





This large contribution of emissions from the Ohio Valley/Great Lakes region is mainly due to the fact that, at the time the data were collected in 1995, 74 per cent of the region's electricity was generated from coal-fired stations; in Ontario, the same figure was only 12 per cent. In addition, in the Ohio Valley/Great Lakes states area, average emission rates per unit of electricity generated are higher than in other regions.

This project included a summary of the health effects linked to fossil fuel combustion and identified the following common themes in the studies undertaken to date:

- Premature mortality is associated: consistently with exposure to inhalable (PM_{10}) and respirable ($PM_{2.5}$) particulate pollution, and especially sulphate; frequently with exposure to SO_2; and, in some studies, with exposure to NO_2 and CO.

- Hospital admissions for cardiac and/or respiratory disease are linked with exposure to each of the major pollutants emitted or produced by fossil fuel combustion.

- For the population as a whole, there

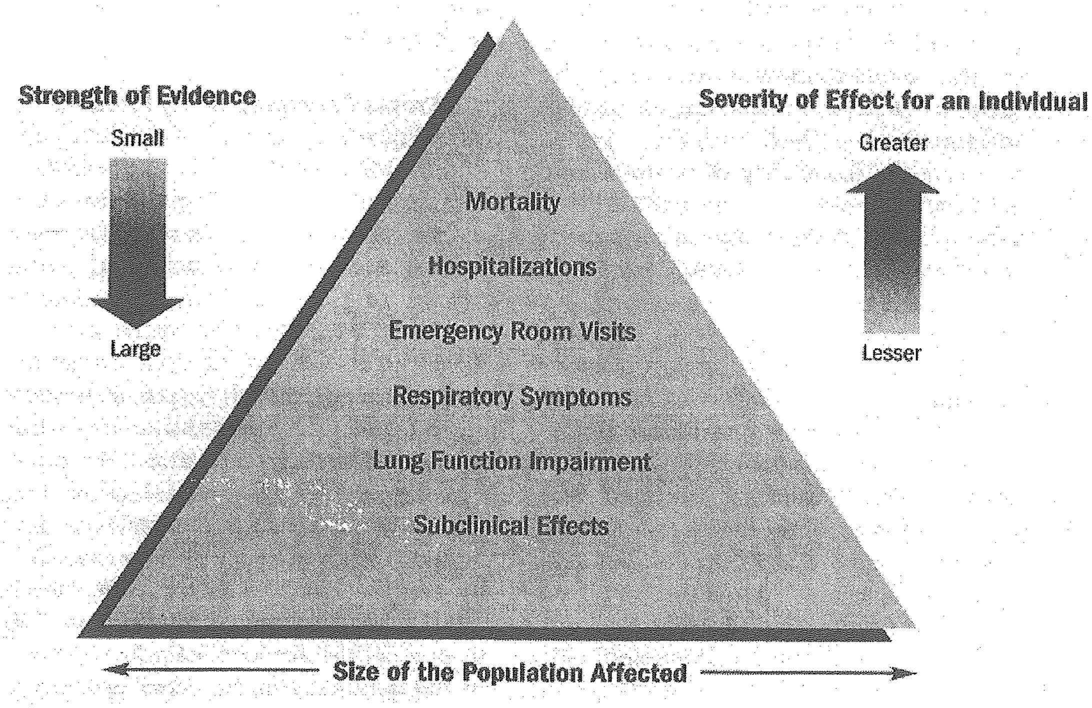
is no evidence that a threshold of effect exists for exposure to ozone, fine particles (especially sulphate), and possibly SO_2; in other words, for these pollutants, there does not appear to be a "safe" level of exposure.

It is possible to estimate quantitatively the burden of ill health on a given population based on the ambient concentration of the pollutant to which there is exposure.

Developed in 1985 by the American Thoracic Society, the "health effects pyramid" is a useful model for understanding the health effects of air pollutants. It is shown in Figure 2. This pyramid illustrates the relationship between severity of effect (with mortality as the most severe for the individual and sub-clinical effects as the least severe) and the proportion of the population affected.

The dimensions of this pyramid can be quantified for at least some pollutants. One recent report concluded that for every incident of premature mortality associated with the inhalation of PM_{10}, there are 0.8 hospital admissions, 34 emergency admissions, 407 asthma days, 6,085 reduced activity days, and 18,864 days of reported acute respiratory symptoms. The Ontario Ministry of the Environment has estimated that 1,800 Ontarians die prematurely each year due to smog pollution

Figure 2: Health Effects Pyramid



In a recent position paper, *Health Effects of Ground Level Ozone, Acid Aerosols and Particulate Matter,* May 1998, and based on its review of research in the area, the Ontario Medical Association recommended major reductions in emission limits for SO_2 and NO_x. This review included studies which have concluded that particulates may be responsible for between one and 10 per cent of all non-trauma mortality, and a Toronto study which indicated that a two to four per cent excess of respiratory deaths could be attributable to pollutant levels.

The effects of these emissions on the environment have also been clearly demonstrated; these are summarized in the Pollution Probe report, *Emissions from Coal-Fired Electric Stations: Environmental Health Effects and Reduction Options,* January 1998.

3. Emission Reduction Scenarios For 2010

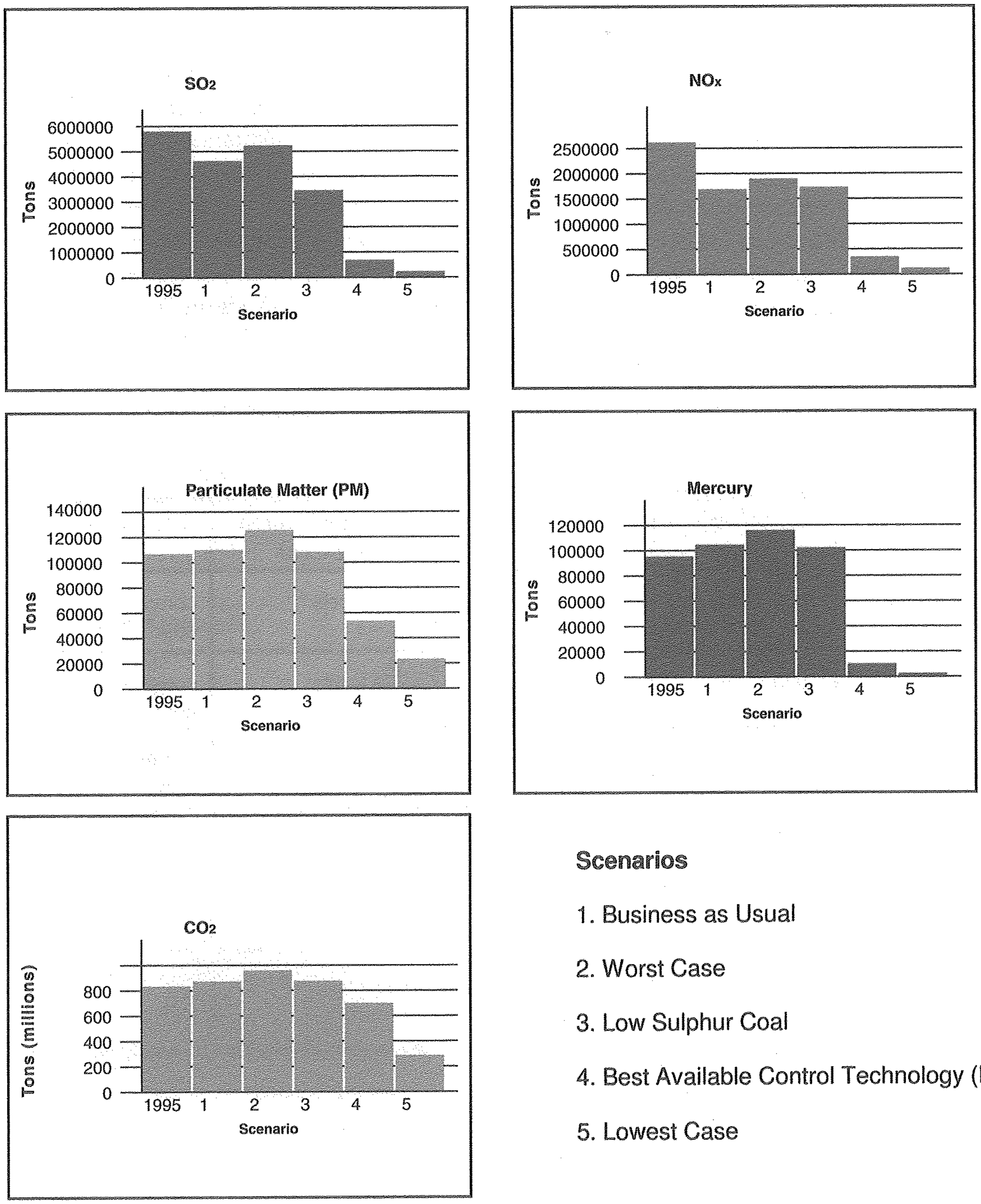
The air emissions produced by coal-fired electric stations in the future will depend on emission rates and the amount of electricity generated at these plants. In order to provide insight into possible future emissions, a reasonable range of five emission reduction scenarios was developed. The major assumptions associated with each scenario are summarized in Figure 3.

Figure 3: Major Assumptions Associated With Five Emission Reduction Scenarios

Scenario	Generation Capacity	Utilization Rate	Sulphur Content Of Coal	Emission Controls
1. Business as Usual	1996 levels	1996 levels	1996 levels	compliance with approved regulations
2. Worst Case	1996 levels	50% Ontario 70% other regions	1996 levels	compliance with approved regulations
3. Low Sulphur Coal	1996 levels	1996 levels	low sulphur for high SO_2 plants	average for existing low sulphur plants
4. Best Available Control Technology (BACT)	1996 levels	1996 levels	included in emission rates	best available control technology (BACT)
5. Lowest Case	post-1970 plants only	1996 levels	included in emission rates	best available control technology (BACT)

Figure 4 illustrates the estimated emissions of the five major pollutants investigated (SO_2, NO_x, PM_{10}, Hg, CO_2) in 1995 and in 2010 for each of the five scenarios and in each of the four regions. It must be noted that these scenarios are not projections of what will occur in the future, but, rather, suppositions of possible outcomes.

Figure 4: Estimated Emissions In 2010 Under Five Emission Reduction Scenarios



Scenarios

1. Business as Usual
2. Worst Case
3. Low Sulphur Coal
4. Best Available Control Technology (BACT)
5. Lowest Case

The following summarizes the results of each of the five scenarios, with the last four compared to the first.

1. **Business as Usual** – Compared to what was generated in 1995, and due to the implementation of the final stages of existing regulations and legislation, this scenario results in 21 per cent less SO_2 and 34 per cent less NO_x by the year 2010. However, it results in slightly higher emissions of CO_2, particulate matter, and mercury, since there are currently no binding limitations placed on them and the assumed utilization rate is slightly higher than in 1995.

2. **Worst Case** – This scenario reflects the implications of the maximum practical utilization of all existing coal-fired stations with emission rates consistent with approved regulations. The higher utilization rates assumed in this scenario result in a 12 to 13 per cent increase in all emissions as compared to the Business as Usual scenario.

3. **Low Sulphur** – This scenario results in a 22 per cent reduction in the generation of SO_2, as compared to the Business as Usual case. The other four emissions remain unchanged.

4. **Best Available Control Technology (BACT)** – This scenario results in a 78 to 80 per cent reduction in SO_2 and NO_x emissions, a 50 per cent reduction in particulate matter emissions and a 93 per cent reduction in mercury emissions. Due to the considerably lower potential for improvements that is possible with BACT, CO_2 emissions are only reduced by 16 per cent.

5. **Lowest Case** – This scenario results in a 90 per cent reduction in SO_2 and NO_x emissions, a 76 per cent reduction in particulate matter, a 96 per cent reduction in mercury, and a 61 per cent reduction in CO_2 emissions. This scenario assumes that about 76,200 MW of electricity generation capacity (the capacity of pre-1970 plants) is replaced with non-coal-fired electric stations.

4. Key Environmental Policy Options And Synergies

A wide range of policy options is available to reduce the environmental impacts associated with the production of electricity. While there has been extensive experience with some policy measures over the past 20 years, other measures are just now being developed as part of the restructuring that is occurring around the world. In Pollution Probe's August 1998 report, 22 such measures were identified and described, including comments on their enactment status. Of these 22, seven were selected for more detailed analysis using the following criteria:

- *Environmental Effectiveness* – How effective is the measure in achieving emission reductions?
- *Efficiency* – How efficient is the measure in terms of overall costs (administration, implementation, etc.)?
- *Political Acceptability* – What is the likelihood of the measure being adopted over the next 2 to 5 years?

- *Compatibility with Other Measures* – What measures are compatible and even synergistic with other measures?

- *Comparability* – Is the measure consistent with measures adopted or likely to be adopted in other jurisdictions with which Ontario trades? In other words, is there a level playing field?

It is interesting to note that, following identification of the seven measures by Pollution Probe and IES in March 1998, the Ontario government released the first draft of its proposed restructuring legislation in July 1998, which specifically included three of these measures (caps and tradable permits, emission rate standards and uniform mandatory disclosure). One of the other measures (codes and standards) is already included in other existing regulations; another (emission caps with voluntary agreement on source reductions) was found by Pollution Probe and IES to be less attractive than the others. Thus, only two of the seven measures identified (system benefits fund and renewable portfolio standard) were not specifically included in the draft regulations; proposed amendments to the *Ontario Energy Board Act*, however, contain objectives which could include provision for both of these measures.

The following sections briefly summarize the most important features of each of the seven selected measures.

4.1 Emission Caps with Tradable Permits

This measure establishes a maximum emission level for a defined jurisdiction and then allows generators to trade permits among themselves with the total allowable amount of permits set to equal the emission cap. Under a closed system, emission allowances can only be traded within the electricity sector. Under an open system, allowances can be traded outside the sector as well. There may also be a requirement that industries agree to emisson limits. The advantage of using an emission cap with tradable permits is that the specified reduction target is achieved at a lower cost and generators are offered greater flexibility in the means they use to achieve these reductions. Such trading systems are currently used in the U.S. for SO_2, and there has been a great deal of discussion as of late about using this approach to achieve the CO_2 reduction targets established at Kyoto. One of the challenges of such a system is the initial allocation of allowances.

There is the potential for the success of this measure in achieving environmental improvements to be affected by four policy considerations: location and timing of the emissions that are traded; inclusion of trading by generators outside the province; initial allocation of the caps; and, trading by non-utilities. These considerations are discussed in more detail in Pollution Probe's August 1998 report.

The economic impacts of this measure will depend on the level at which the caps are set, the utilization rates of the plants, and the efficiency gained through the use of trading.

In the U.S. it has been estimated that the annual cost savings of using emissions trading under the Acid Rain Program will be as high as $1.7 billion after the year 2000. It is also interesting to note that, since the time the U.S. program introduced SO_2 permits at $2,000/ton, the price has dropped to $140/ton, signaling a major shift in the economics of emission reductions. Based on the U.S. experience, administration costs for a similar program in Ontario would not be expected to be particularly high; program development costs, however, would require a considerable investment of time and resources.

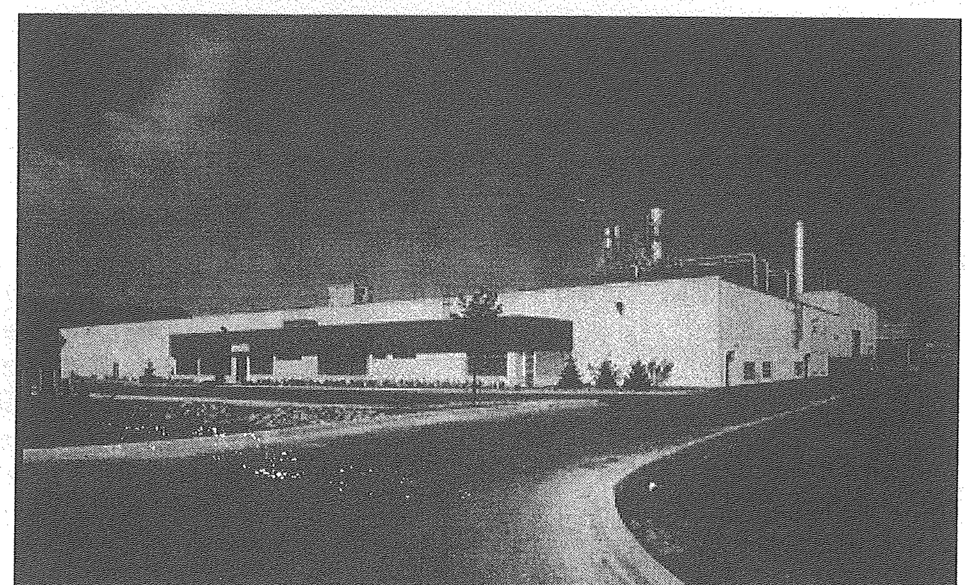
4.2 Emission Caps with Voluntary Agreement on Source Reductions

To allocate the emission reductions that are required to meet specified emission caps, an alternative method is for each generator or group of generators to voluntarily agree to reduce emissions, with the sum of these voluntary reductions equaling the total required reductions. As for caps with tradable permits, the environmental benefits depend on the caps that are established, the limitations placed on the location and timing of emission reductions, and the participation of generators outside the province.

At least theoretically, this measure should allow achievement of overall economic savings similar to emission caps with tradable permits. This would require that all participants act in good faith, have similar bargaining power, and share reliable information on the costs of alternative means of achieving emission controls.

This measure has two main advantages over the cap and trade measure: it avoids the problems associated with the initial allocation of tradable permits; and, it eliminates the need to establish and oversee the trading process. However, the uncertainty of the outcome of a voluntary trading initiative makes it questionable from a public policy perspective. It is thus unlikely to receive support from environmental and public health interest groups.

Figure 5: TransAlta Windsor-Essex Co-generation Plant



This natural gas-fired co-generation unit is a transitional technology that is much cleaner than a coal-fired plant.

4.3 Emission Performance Standard

This mechanism establishes the maximum allowable emission rate, expressed typically as a weight of emission/unit of energy input (kg/MJ), or sometimes as a weight of emission/unit of power output (kg/MWh). The latter is referred to as a generation performance standard. Again, while typically applied to each generation source, this mechanism could be applied to all or part of a corporate portfolio.

The environmental impacts associated with this measure depend on both the level of the standard and the utilization rate of the facility. This is a particularly important consideration in Ontario where, in 1995, the average plant utilization rate of 25 per cent was less than half the average rate in bordering U.S. states. Thus, with an emission rate standard that requires BACT, it is possible that plants in Ontario could generate approximately twice the emissions they would have compared to an emission cap that is based on BACT and current utilization rates.

As with environmental impacts, the cost of complying with emission performance standards depends on the levels set, as well as the utilization rates achieved. The cost is also influenced by whether the standards are imposed on a plant-by-plant basis (as is the case in the U.S. for new plants), on the total number of coal-fired plants owned by a single utility, or on the total electricity generation from one utility (thus including hydro and potentially other forms of electricity generation). In a plant-by-plant case, the cost of complying with emission performance standards is determined solely by the level at which the emission standards are set for each pollutant. There is no opportunity to capitalize on the fact that, for some generators, the cost to reduce emissions below the required levels may be less than for other generators to simply meet the minimum requirements. Standards imposed on a utility-wide basis, or where "emission rate credits" can be traded, allow lower emission rate performers to offset or sell excess credits to higher emitters.

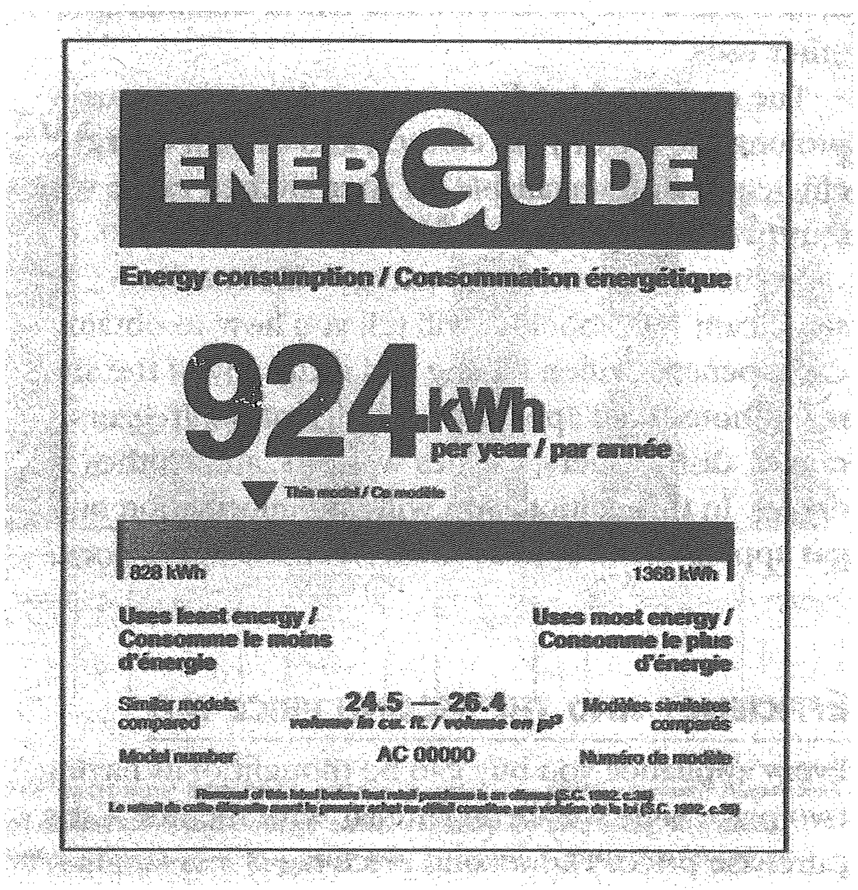
4.4 System Benefits Fund

A system benefits fund distributes money to approved public benefits programs, such as those concerned with energy efficiency and renewable energy. The name refers to the overall system benefits that are attributable to such investments. Although it can be funded in different ways, the most common is through a non-bypassable, non-discriminatory, user-based charge, referred to as a "system benefits charge" or "wires charge." This charge ensures continued funding of important public benefits, such as energy efficiency, that may be at risk of being ignored in a restructured electricity system.

Although the environmental impacts of a system benefits fund are difficult to estimate, based on statistics from the Demand Side Management (DSM) programs in New York State, applying a 1.2 per cent charge for investment in energy efficiency measures would result in energy savings in Ontario of about 5 TWh after 10 years. As Ontario currently generates about 25 TWh from coal-fired stations that are used to meet peak demand, this would represent a 20 per cent reduction in current electricity production from these stations. In terms of technical potential for cost-effective energy efficiency, it has been estimated that current U.S. electricity demand could be reduced by more than 30 per cent. If the same potential exists for Canada, then considerable savings could be realized at relatively modest costs.

The same study of New York DSM programs concluded that, over four years, net savings to consumers in energy generation and capacity costs were about $1.4 billion. The study also concluded that the DSM programs resulted in an estimated 27,000 job years of employment and that the economic benefits exceeded the costs by a margin of nearly three to one (i.e., for every $1 spent on energy conservation programs, the utility, its customers and society in general received $3 in direct financial benefits). The same study estimated that the environmental benefits were an additional $600 million.

Figure 6: EnerGuide Label

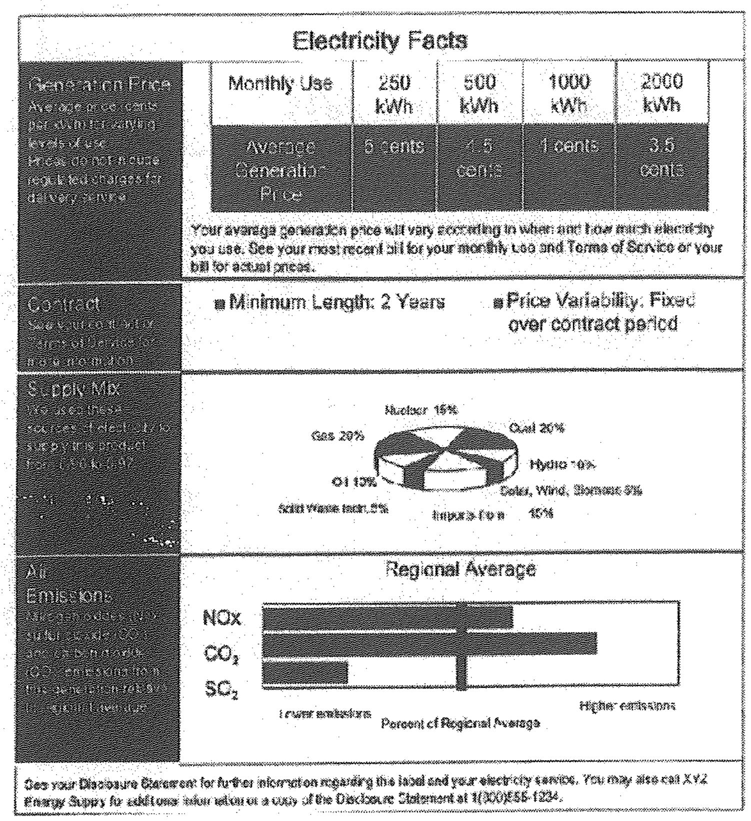


4.5 Uniform Mandatory Disclosure

This measure requires retailers of electricity to disclose pertinent information on the electricity they are sèlling, such as generation source and air emissions, as well as information on the price, length of contract, and so on.

It is not easy to measure and quantify the environmental results associated with giving consumers information on the sources and related environmental impacts of the electricity offered by suppliers. It is noteworthy, however, that consumer surveys have repeatedly indicated strong support for paying a premium for renewable or "green" energy. The consumer's ability to exercise this preference will be enhanced if all electricity marketers are required to disclose the sources of and related emissions associated with the electricity they are marketing. In addition to the issue of environmental impact, another reason to require the uniform mandatory disclosure of information on the sources and related emissions of the electricity being supplied is the growing trend in North America to recognize the consumer's right to have this information. Consumer "right-to-know" legislation and regulations are emerging requirements of healthy, competitive markets, equal in importance to consumer protection measures. Information disclosure can also reduce the potential for fraud by energy marketers.

Figure 7: Proposed New England Energy Label

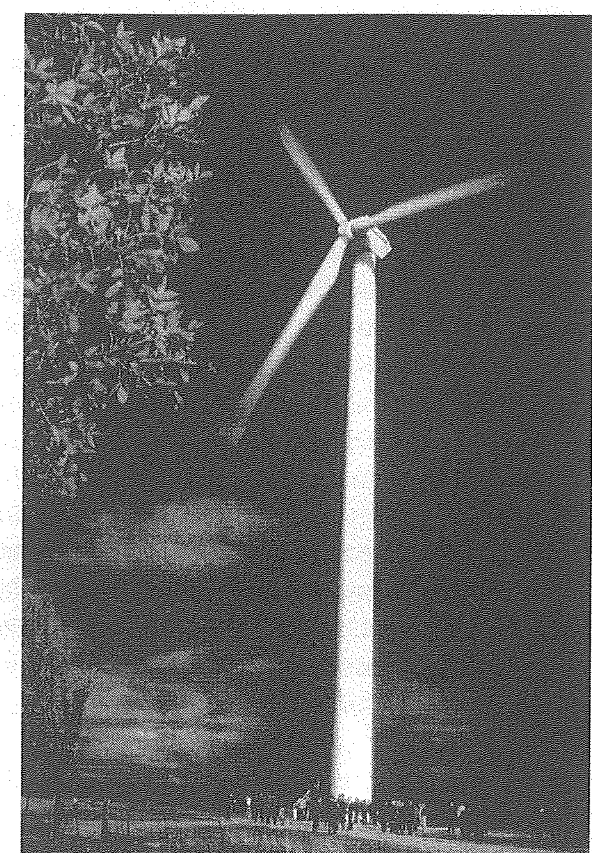


4.6 Renewable Portfolio Standard

A renewable portfolio standard requires electricity suppliers to include a specified fraction of renewable energy generation in their supply portfolio as a condition of doing business. While there is general agreement on most of the technologies that would be included, there are differences of opinion as to whether large hydro projects should be included. There has also been debate as to whether highly efficient technologies, such as fuel cells and combined cycle co-generation units, should be included as alternative energy technologies.

As with the system benefits fund, the environmental impacts of the renewable portfolio standard will depend on both the level that is set and the generation sources that are being replaced by the renewable energy. However, as coal-fired stations are typically used to meet peak demand, their use is the first to be reduced when a new energy supply becomes available. This issue is further complicated by the fact that two renewable energy sources, solar photovoltaics and wind, can only be used when the sun is shining and the wind is blowing, respectively. For photovoltaics, their use is more likely to correspond with periods of higher demand, when coal-fired stations are being used.

Figure 8: Ontario Hydro's Tiverton Wind-turbine



The economic impacts of a renewable portfolio standard on electricity rates will depend on the level that is set and the premium that must be paid for the renewable energy. The premium amount is difficult to estimate and will continue to change as renewable energy technologies are further developed. In Ontario, a recent study noted that it is entirely possible that the average price of green power could be in the 0.05-0.07 $/kWh range. If this premium is assumed to be 2.5 per cent and the portfolio standard is 5 per cent, overall electricity prices would increase by about 1.25 per cent. Another recent study concluded that, in the U.S., a 4 per cent renewable portfolio standard by the year 2010 would raise electricity prices by only 3/100th of a cent.

4.7 Codes and Standards

Codes and standards establish minimum energy efficiency levels that a specified product must meet before it is sold. An example is the *Ontario Energy Efficiency Act*, which is the enabling legislation for regulations setting minimum energy efficiency provisions for selected products and appliances. The Ontario Building Code is another example, and includes minimum energy efficiency requirements for new buildings.

A comprehensive assessment of the potential electricity savings from energy efficiency codes and standards in Ontario estimated that a reasonable set of improved codes could result in electricity savings of 18 per cent by the year 2015, compared to the reference forecast. It is important to note that the past imposition of minimum energy efficiency levels has always resulted in an average efficiency of all units sold that is significantly greater than the minimum required by law. As with other measures designed to promote energy efficiency and the development of renewable energy resources, the actual impact of the expected electricity savings on the environment would depend on the generation source being displaced.

To the extent that energy efficiency codes and standards are cost effective, the overall impact on the cost of electricity to consumers would be positive in the medium term.

4.8 Synergies Among Selected Measures

Of the seven measures selected, only two are mutually exclusive: emission caps with trading and emission caps with voluntary agreements. Environmental groups generally prefer emission caps with trading to caps with voluntary agreements.

Although emission caps and emission rate standards are different approaches to reducing emissions, they are potentially compatible policy options and can, in fact, work very well together, provided they are properly orchestrated. Similarly, a system benefits fund and codes and standards are also very compatible, with the former mainly used to improve the energy efficiency of existing buildings and processes and the latter focussed on appliances and the construction of new buildings.

The application of the environmental policy measures studied will lead to three changes that, in turn, will result in reduced emissions from coal-fired electric stations (the major source of the pollutants of concern studied):

- ***Reduced Utilization*** – As coal-fired stations in Ontario are primarily used to meet peak load, measures which result in reduced demand for electricity during these peak periods, or increases in electricity production from other generation sources, will result in lower utilization rates at coal-fired plants. The three measures which would be most effective in reducing utilization rates at coal-fired stations are: a system benefits fund; codes and standards, since they ensure reduced demand; and, the renewable portfolio standard, as it promotes generation from alternative sources. Emission caps and trading will have less impact on utilization rates, since their main impact will be to promote new plant construction, fuel switching and/or emission control retrofits. Emission performance standards could actually result in increased utilization rates as generators who retrofit their plants to meet these standards may be expected to increase utilization of the plants in order to reduce the per kWh costs of the retrofits. Lower utilization is a highly desirable objective as it results in reductions of all emissions, including CO_2, and is the change that promotes the greatest level of sustainability due to a reduced reliance on fossil fuels.

- ***New Gas-Fired Stations / Repowering Coal Stations*** – The imposition of both emission caps and emission rate standards will encourage the construction of new gas-fired stations and the conversion of existing coal-fired plants to use natural gas. Of the other measures studied, only the mandatory labelling measure might encourage such construction and repowering. The construction of new plants and the repowering of existing coal stations will result in reductions of all emissions, including CO_2. However, since burning natural gas also produces emissions, these reductions will not be as high as those associated with reduced utilization of coal plants.

- ***Emission Control Retrofits*** – The introduction of emission caps and emission performance standards would result in the retrofitting of emission controls onto existing coal-fired plants. The other four measures would have little or no effect on promoting this change. It is significant to note that, as emission control technologies exist for these pollutants, implementing this change could lead to reductions in SO_2, NO_x, particulate matter, and, to a lesser extent, mercury. There are not, however, emission control technologies that can reduce CO_2 emissions. It should also be noted that, since the average emission rates of coal-fired plants in the U.S. are currently higher than those in Ontario, the cost to install control technologies in the U.S. is likely to be higher than that to install similar technologies in Ontario. However, the higher utilization rates in the U.S. allow U.S. utilities to amortize these costs over a greater amount of electricity that is sold. As with fuel switching, emission control retrofits do not promote long-term sustainability since they would likely increase the use of coal as a fuel.

5. Conclusions and Recommendations

As a conceptual framework for ensuring that an integrated approach is sought, Pollution Probe and the Institute for Environmental Studies advocate the "3Es" of environmental protection in a restructured electricity market. These are:

- **Energy efficiency**
- **Energy from renewables**
- **Emission reductions (through fuel substitution or emission controls)**

Similar to the 3Rs (Reduce, Reuse, Recycle) concept which Pollution Probe developed in the early 1970s for waste management, the 3Es reinforce the idea that the priority should be: first, to reduce the problem as much as possible; second, to maximize the utilization of renewable resources; and, finally, to ensure that the emissions associated with the generation of the remaining electricity are reduced as much as possible.

Pollution Probe and the Institute for Environmental Studies conclude that, as Ontario's electricity generation industry is restructured through *The Energy Competition Act*, progressive policy measures must be implemented to reduce the environmental impacts associated with the production of electricity from coal-fired plants.

The six measures that were analysed and found to be fully compatible with each other were:

- emission caps with trading
- emission performance standards
- system benefits fund
- uniform mandatory disclosure
- renewable portfolio standard
- codes and standards

With the exception of codes and standards (addressed under other legislation), the remaining policy measures should be implemented as Ontario's electricity system is restructured. In addition, the Province of Ontario should maintain and strengthen its commitment to energy-efficiency codes and standards through *The Ontario Energy Efficiency Act* and the Ontario Building Code. The synergies that could be realized through the harmonious interactions of these six policy measures should be recognized and captured in the newly emerging competitive electricity market in Ontario.

Pollution Probe and the Institute for Environmental Studies believe that the Ontario government now has an unparalleled opportunity to provide the people of Ontario with more cost-effective, competitively priced and cleaner electricity than has ever before existed in this province. This opportunity should be pursued with the utmost vigour and determination.