GREEN POWER OPPORTUNITIES FOR ONTARIO

David Suzuki Foundation
Finding solutions

Canadian Institute for Environmental Law and Policy

Toronto Renewable Energy Co-operative

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Prepared For the Ontario Legislative Alternative Fuels Committee, the Toronto Renewable Energy Cooperative and the David Suzuki Foundation.

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In conducting this study one of the largest barriers encountered was the paucity of information and the lack of centralization of data. Current wind energy assessments taken from reasonable locations are rare, and data on energy efficiency are also difficult to obtain in a useful format. Given the growing importance of environmental data, not only for local and provincial decision making, but also for meeting Canada's international commitments, efforts should be made to change this situation dramatically.

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1 ABSTRACT

The Potential for Green Power in Ontario Study demonstrates that it is within Ontario's capacity to economically reduce energy waste and generate sufficient 'green energy' (i.e., energy from a renewable and environmentally benign sources) for the province to decommission its coal burning power plants (and reduce its reliance on nuclear generation) while moving toward a sustainable energy economy. This goal could be attained by pursuing a threefold policy: removing hidden subsidies to polluting forms of generation; implementing a robust Demand Side Management Program; and reforming the price of electricity so that all costs are included and all forms of generation can compete on a truly level playing field. A legislated Renewable Portfolio Standard – requiring electricity providers to include a growing percentage of new renewable electricity in the supply portfolio they offer – is an alternative to immediate price reform and a key measure to ensure a sustainable energy future. In light of widespread support for this measure, the government should adopt it before the electricity market opens in May 2002.

2 INTRODUCTION

Ontario has the capability and resources to cost-effectively eliminate the need to generate elec tricity from coal power. The approximately 40,000 Gigawatt hours (GWH) per year of power generated from the 7,519MW of coal fired stations in this province could be eliminated though a combination of energy efficiency measures and new sources of renewable, low environmental impact electric generation. Additionally, because some renewables are in highest supply during peak load hours and because energy efficiency measures have a direct effect on peak loads, coal's use as a means of meeting peak load can be eliminated.

Energy efficiency measures, referred to as Demand Side Management (DSM) when facilitated by utility programs as in the case of Ontario's natural gas sector, can be implemented in a number of ways. Working examples from other sectors and jurisdictions include: making transmission or distribution monopolies responsible for DSM, or creating a new corporation for the purpose that will interact with regional electricity distributors. Energy efficiency can account for a large part of the 40,000 GWH goal, and indeed could even achieve the whole goal itself, but the potential is dependent on the price of electricity and the long term projection for demand. Thus it is conservative to include in working estimates only measures that can be implemented at or near the current cost of electricity. With such a restriction in mind this paper concludes that it is possible to make a conservative estimate of the potential for energy efficiency measures in Ontario of at least 20,000 GWH over the decade.

Assuming conservative DSM efforts, the goal of eliminating electricity generation from coal burning requires the use of renewable energy to meet between one third and one half of the 40,000 GWH target. Although the technical capacity in Ontario is well above this level, the amount of renewable energy that comes online is highly dependent on the price of electricity. Consequently, a supportive policy framework, such as the quick adoption of an RPS, is integral to any such attempt.

Summary of Findings

CAPACITY FOR RENEWABLE ENERGY SOURCES AND ENERGY EFFICIENCY MEASURES

There are three major sources of available renewable energy for electricity generation in Ontario. These sources are wind, water, and biogas. The potential for renewable energy is summarized in the table below, using the most conservative figures available in each category. Such an estimate leads to a total figure of 19,059 GWH, or approximately 20,000 GWH of available low-environmental impact renewable energy in the province. In addition there is a minimum of 20,000 GWH of enhanced energy efficiency which can be easily achieved in Ontario by the implementation of Demand Management (DSM) Initiatives for the electricity sector.

RENEWABLE ENERGY SOURCE	MINIMUM TECHNICAL POTENTIAL (IN MW)	MINIMUM TECHNICAL POTENTIAL (IN GWH/YEAR, ROUNDED DOWN)
Wind	6,390.0	15,600
Hydro	953.0	2,859
Biogas	70.6	600
Total	7,413.6	19,059
Total including DSM		39,059

NOTE: *wind power is assumed to operate at 28% capacity over 8760 hours. Solar energy is not included here but in the energy efficiency section instead because of its primary use for water heating, not electric generation.*

3 COAL POWER: PROBLEMS AND SOLUTIONS

Although most Ontarians do not recognize coal as a major source of power, coal provides over 26% of the electricity generated in the province.[1] Further, coal burning plants account for much of Ontario's electricity exports to the United States, although the lion's share of the environmental and health impacts of these plants are felt in Ontario.[2] The negative impacts of coal burning include the effects of pollution on contaminant levels in natural ecosystems, impacts on materials as well as visibility, the health effects of pollution to human beings, and the contribution of greenhouse gases to the problem of global warming.

There are five coal fired power plants in Ontario all currently publically owned by Ontario Power Generation (OPG):

POWER PLANT	CAPACITY (IN MW)
Lambton	1980
Nanticoke	3876
Lakeview	1138
Thunder Bay	310
Atikokan	215
Total:	7519

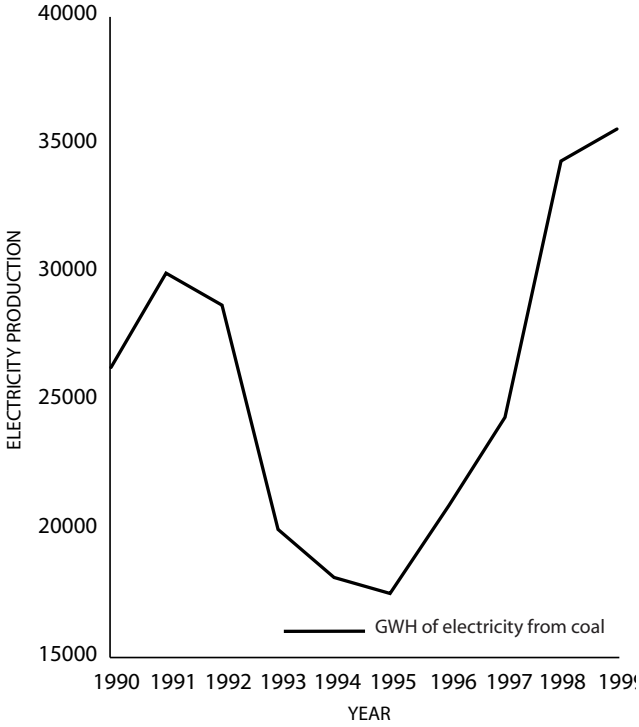
Ontario Power Generation's five coal fired power plants emit:

- 23% of Ontario's sulphur dioxide and 14% of Ontario's nitrogen oxides emissions[3] – key ingredients in the formation of both smog and acid rain.
- 23% of Ontario's mercury emissions[4] – mercury builds up in natural ecosystems and can lead to serious health problems if ingested, especially in pregnant women.
- 19% of Ontario's carbon dioxide emissions[5] – a key greenhouse gas. In order to meet Kyoto Protocol obligations, Canada is obliged to begin reducing the emission of greenhouse gases, especially carbon dioxide.

In order to meet Kyoto Protocol obligations the federal government estimates that Ontario must reduce its use of electricity from coal burning plants by a minimum of 9.3TWH (93,000 GWH) by 2010. This is the equivalent of shutting down these plants for over 2 years.[6]

Rather than reducing the use of coal power, however, the general trend for the past ten years has been to increase the use of coal power in the face of mounting evidence of climate change and pollution induced social costs. Today Ontario is reaching extremely high levels of coal power use. This has been in large part a response to the failure of nuclear power, not to growth in the demand for electricity. Ontario's electricity consumption in the past ten years has been fairly stable.

GWH OF ELECTRICITY FROM COAL



At the beginning of the nineties Ontario was using a substantial amount of power generated by nuclear reactors, and the rise in the use of coal fired plants came about from the need to close down some of those reactors at the Bruce and Pickering stations and by extended difficulties at the Darlington reactors. As these plants went offline, the use of coal power increased to compensate for the lack of nuclear power. As of 1999 Ontario used over 38,000 GWH of electricity from coal fired power plants[7], and by year end of 2001 that number will most probably be over 40,000 GWH. Thus to close down coal fired power plants requires the ability to eliminate or replace 40,000 GWH of annual electricity consumption.

The demand for electricity use is not constant; it changes with the time of day and the season. There are peaks of demand daily from around 8:00 am to 10:00pm, and there are seasonal peaks in the winter (for heating) and in the summer (for cooling).[8] Because nuclear power plants are capital intensive and can not easily raise or lower the amount of power generated, they are run at a steady rate to cover the base electricity requirement that is needed 24 hours a day. Peak demand that exceeds the base is met in part by hydro power (water is held back during off peak hours and released during peak hours), but is largely met by coal power. Any plan to replace the use of coal needs to meet peak demand, either by providing electricity that is modular (can be brought on and off line incrementally) and available at peak hours, or by reducing the peak energy load. Energy efficiency measures and many sources of renewable energy are remarkably well suited for these purposes. In Ontario the wind blows hardest in the winter, and generally tends to be strongest in the afternoon. This coincides directly with peak demand times. Wind turbines could thus be expected to generate their maximal output during peak hours. Water can also be *temporarily* held above a turbine to meet peak demand and still meet the EcoLogo certification standards, as long as 'held' means being delayed for less than 48 hours (for example, reducing flow in the middle of the night to increase flow during the day) instead of for several days[9].

Energy efficiency measures are particularly well suited to reducing demand during peak periods. Some energy savings can be realized from electrical systems that run 24 hours a day, but many of the greatest savings exist in commercial buildings and industrial establishments that have electricity demand patterns that are responsible for creating the peak in the first place. Commercial building lighting and ventilating systems, office equipment, industrial motors, lighting and home appliances such as dishwashers and laundary machines are all examples of technologies that contribute to the daily peak demand for electricity and which have great potential for energy savings. The seasonal peaks of electricity demand in the heating and air conditioning seasons are also met largely with coal fired power generation. Here again energy efficiency, fuel switching and renewable sources are well suited to reducing the need for the coal burning.

Meeting increasing peak demand with the addition of generating facilities raises another difficulty faced by both nuclear and coal power. Just as nuclear reactors cannot easily run at half capacity, it is not possible to build half a power plant. Coal and nuclear plants both suffer from the limitation that they are not very modular, they can only be built economically (if at all) as large plants, and those plants take many years to build. This requires accurate forecasting of the demand for electricity. Long range demand forecasts are notoriously inaccurate; in fact it was in large part the inaccuracy of Ontario Hydro's load forecasts in the 1970's and 1980's that resulted in the inappropriate investments that led to the utility's demise. When Ontario Hydro put forward its long range Demand Supply Plan in 1990, electricity demand was forecast to grow by tens of thousands of gigawatt-hours in the 1990's. In fact, there has been only very slight increases in the demand for electricity in the past ten years, a critically important fact that is too often overlooked in discussions of the future of electricity supply and demand in Ontario. .

By contrast, renewable energy sources are typically modular. Wind turbines, for example can be built quickly and easily. Wind power experts and industry players estimate that if efficient environmental assessment practices were already in place and if a strong windpower industry already existed in Ontario, wind powered turbines could be in place within one year of a project's approval. As for modularity, when more turbines are needed they can be built, and it is only

necessary to build as many turbines as are needed. The horizon of demand forecasting required is much shorter.

Cumulatively, it quickly becomes apparent that coal is a less than desirable electricity source. It contributes greatly to smog and acid rain, contaminates natural ecosystems with mercury, and produces large amounts of carbon dioxide, driving global warming. Additionally, coal and nuclear power plants have long build times that require accurate forecasting and unaccounted for social costs.

Although any attempt to replace coal must deal with the need to meet peak energy loads, energy efficiency measures and renewable energy sources do just that. Further, they do not carry with them any of the negative effects caused by air pollution. The advantage that coal appears to enjoy over both energy efficiency and renewable energy sources is price. On the face of it, coal-fired power appears to be relatively cheap, but this is because like nulcear power, there are massive and hidden subsidies to coal-fired electricity. Even with these subsidies, electricity efficiency continues to beat coal in the marketplace, and if these subsidiens were removed, coal power would not be competitive with alternative sources of electricity supply. . Meanwhile energy efficiency measures are much less expensive and have a degree of natural uptake, but transaction and information costs impede the delivery of these services to consumers. In general, the price of electricity is a critical factor in determining how much electricity is generated and from what source, and that price is highly structured today in favor of coal and nuclear power.

4 ENERGY PRICING

In a properly restructured energy market all forms of electricity generation would be able to compete on an even playing field. All costs of generation would be included and all of the necessary information would be made available to all actors involved in the supply and purchase of electricity, including generators, bulk purchasers, and end consumers. In theoretical terms such a market would include the value of all costs including transaction and information costs, and there would be no external costs like higher healthcare bills, air pollution, and climate change. Such a market does not exist of course, but since an ideal market is the goal of the current Ontario electricity sector reform project, it is a logical place to begin an analysis of current energy price issues.

The theory behind restructuring the electricity market is that in a competitive market producers and consumers would provide and purchase as much electricity as needed. Producers would decide on a rational basis what the preferred method of generating that electricity would be by calculating where the lowest cost of production exists. Consumers will act rationally in purchasing the product with the lowest total cost. The process of generating electricity would be socially optimal, no resources (including labour and capital) would be wasted.

But in order for the optimal price decision to be made all actors need to have access to all of the information available about costs, and all the costs need to be included in the price paid for electricity. This includes, as stated above, the cost of gathering information, the cost of conducting transactions, and the external costs that are not now included directly in the bill but are covered by hidden subsidies or are paid elsewhere (like hospital bills from smog related illnesses). The price for each type of electrical power determined in this way can be considered, in an economic sense, its optimal or 'real' price. This price is not the same price as is obtained by a free market in the real world owing to externalities, information barriers and transaction costs. Finding this price is nonetheless a useful thing to do because it allows one to compare the cost of electricity in the real world with the 'real' cost of electricity that society actually pays.

The real costs of both coal and nuclear power are extremely high, much higher than the price of energy efficiency measures, and higher or comparable to many forms of renewable energy generation. In a recent study, American economists estimated the real price of coal at between 5.5 and 8.3 U.S. cents per kWh.[10] In Canadian dollars that is equivalent to 8.25 – 12.5 cents per kWh[11]. When the costs of compensating coal miners for lung disease, paying for the effects of acid deposition, smog, respiratory and cardiovascular disease, and other health and environmental costs are all factored in coal is not quite as cheap as the 3.5 cents per kWh Ontarians assume. These findings are in line with European Union figures released recently estimating that if all the hidden costs were included, the price of producing electricity from coal or oil would double and the price of producing electricity from natural gas would rise 30%[12]. Ontarians have been paying the higher price all along, it's simply been hidden in higher taxes, healthcare costs, environmental degradation, and other impacts. As an illustration of this idea, the Ontario Medical Association estimated last year that air pollution costs Ontario over $1 billion annually in health care bills, and when lost work time, pain, suffering and other expenses are totaled in the monetary loss reaches $9.9 billion. This is on top of causing an estimated 1,900 premature deaths per year.[13]

The price of nuclear power is also artificially lowered in a variety of ways. The nuclear industry has enjoyed direct government subsidies for many years, subsidies worth over $15-billion[14] . A recently announced deal with Bruce Power (an entity controlled by British Nuclear) will hand over the operation of the Bruce plants to a private company while leaving the past debt with Ontario electricity consumers and taxpayers. Of particular concern is the fact that the company will not face full responsibility for the adequacy of the funding for radioactive waste management or reactor decommissioning. The largest subsidy to nuclear power is in the form of the *Nuclear Liability Act*, a federal law

which shields nuclear plant operators from financial liability in the event of a reactor accident and limits the total liability to $75 million in the event of a nuclear accident.

The actual future costs of nuclear power are unknown, but certainly significant and likely to be far higher than the minimal amounts included in electricity rates to cover these costs. According to the U.S. Atomic Energy Commission, "Commercial high level [nuclear] wastes… have such a high radioactive content of long lived isotopes that they require long-term storage in isolation and under essentially perpetual surveillance at storage sites."[15] At one time the United States the Department of Energy has estimated that the cost of disposing of spent fuel (which composes only one part of the nuclear waste produced by power plants) is over US$300 per kilogram.[16] Although it is difficult to quantify the rise in the price of nuclear power that would result from factoring in the full amount of these externalized or deferred costs it is safe to say that the real price of nuclear power is far higher than the price currently paid for it, likely 2 to 3 times higher.

Most recently and by way of comparison, the British government's review of the national energy strategy estimates that if insurance costs were born properly by plants, as is expected to occur by the year 2020, nuclear power would be twice as expensive as wind power. The report goes on to note that "nowhere in the world have new nuclear stations yet been financed within a liberalized electricity market".[17]

The cost of wind, water (both electrical generation and solar water heating), and certain forms of electricity generation from biomass are comparable to or lower than the real cost of coal power or nuclear power. Of the types of biomass generation that are comparable in price, landfill gas, methane from organic solid waste, sewage digester gas, and the use of waste wood from sustainable managed timber predominate. Although electric generation from all of these sources is both possible and perhaps desirable, as shown in the first table above the primary sources of renewable in Ontario are overwhelmingly wind and low environmental impact water power.

It would seem that if these technologies are in fact competitive with conventional ones, then economically there is no problem. The market will naturally come around to these newer technologies. Unfortunately, as noted above in the discussion on the disparity between real world and economically 'real' costs, this is incorrect. As with any other market, it is not enough for an idea to be economically sound. These technologies have to overcome multiple barriers to market entry. Payback periods of four years or more, poor information, a need to achieve economies of scale, and taxation and regulation barriers all pose problems for renewable technologies and energy efficiency measures. The fact that an idea has social merit and is theoretically economically sound is not enough to generate acceptance. A supportive policy environment is an absolute necessity. In the case of renewable energy sources, price policy is especially important because the amount of wind and water power that becomes available is highly sensitive to the price of electricity. Although the technical capacity exists in Ontario, the resource base will not be tapped if prices of electricity are kept artificially low through hidden subsidies and other regulatory barriers. Of course immediately raising the price of power to include all hidden costs may be more attractive to economists and environmentalists than it is to politicians. An alternative is to tap renewable resources through the implementation of a Renewable Portfolio Standard or RPS.

Renewable Portfolio Standards have been introduced in several jurisdictions, Texas being a leading North American example. An RPS is simply a requirement for retailers of electricity to include a set minimum proportion of new renewably generated power in their offerings to the public. The percentage required can be ramped up over time. The effect of an RPS is to slightly raise average power prices to cover the added cost (if any) of the renewable portion. An RPS allows the market to provide the renewable power in whatever way is most economical from time to time. The results of this study indicate that in Ontario it is practical to implement an RPS that would ultimately ensure the take up of approximately 20,000 GWH/year.

5 ENERGY EFFICIENCY

Availability and Price

A key indicator of the performance of the electricity sector is the overall electricity productivity of the economy – the economic output of the provincial economy, divided by total electricity consumption in the province. Like labour and capital productivity, increasing electricity productivity so that more economic value is being produced for every kilowatt.hour of electricity consumed, leads to a stronger and more competitive economy. Electricity productivity goes up whenever the efficiency of electricity use increases, and whenever the value of the mix of goods and services produced in Ontairo grows faster than the consumption of electricity.

The "electricity productivity resource" is too often underestimated or overlooked entirely in considerations of the future of the electricity supply and demand balance, and this is the key historical reason why Ontario Hydro and the Ontario energy policy community were so badly mistaken in their assessments of the need for new electricity supply in Ontario. As we show in more detail below, the electricity productivity "resource" is a "supergiant" that has barely been tapped and yet still delivered more useful new electricity services to Ontarians in the 1990's than all the other new sources of supply combined, including all the new coal, nuclear and gas generation in the past ten years.

Of particular importance to this study is the role of electricity productivity improvements in providing a foundation for a transition to a sustainable and renewalbe electricity supply system. Electricity productivity improvement is in many ways the ultimate renewable resource. It is perfectly matched in scale and quality to demand, it is virtually pollution free, and it is a key contributor to the economic competiativenss of the provincial economy. Further, saving electricity creates jobs in the development, manufacturing and installation of efficiency technologies. Every dollar spent on imported coal to power fossil-fired generation is a dollar that leaves the Ontario economy, whereas a dollar spent on efficiency is likely to be at least partially spent on domestically produced technology or labour. Thus increased electricity productivity is a highly desirable goal of public policy, yet so far such a policy is lacking.

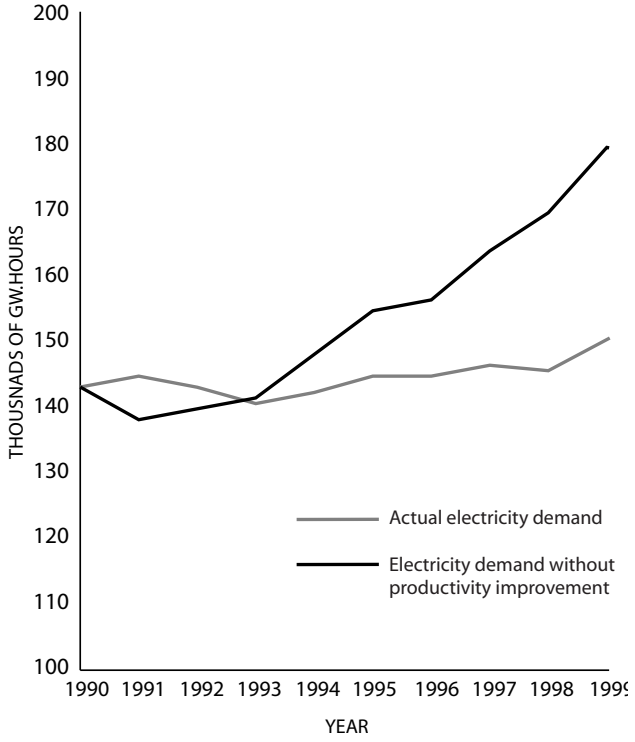
The potential for increased electricity productivity is massive, and no systematic exploitation of this resource has yet been undertaken. In the 1990's domestic electricity demand was reduced by 25,000 GWH annually from the expected figure. Torrie-Smith Associates has estimated that savings of another 20,000 GWH are easily within reach if systematic efforts are made to capture these savings. The role of utilities is key to this goal.

Electrical utilities are mandated to meet society's need for electricity. This is very different than being mandated to produce as much electricity as society consumes. The difference lies in recognizing that in general people do not want electricity – they want the services and conveniences that electricity makes possible—heat, light, refrigeration, motive power, electronics, etc. If there are more efficient ways of providing those services (for example, through a better designed and insulated refrigerator, or an energy efficiency light bulb, or a better insulated wate tank, or computer controlled processes that optimize electricity consumption, etc.), then , then part of the job of a utility should be helping to replace the use of electricity when a better fuel source is available, or promoting technologies that consume less electricity and produce the desired service to customers. The current structure of electricity production and the tentative proposals for the deregulated market reward generators and distributors for supplying as much electricity as they can, not for providing the energy needed. "Conventional regulation provides powerful disincentives to utility investment in energy efficiency and equally powerful positive incentives for utilities to increase sales".[18] Every time customers save electricity the revenues of generators and distributors fall, while every time electricity is used wastefully the generators and distributors profit. Clearly an incentive is built into the system to encourage electricity use and to discourage efficient use of energy. Solving this problem requires taking an integrated approach to energy issues –

rewarding suppliers of electricity not just for providing energy but for ensuring that electricity is used as a power source only where lower cost options do not already exist and only in the quantity in which it is needed. The process of doing this is typically called Demand Side Management (DSM).

Above and beyond what can be done at the level of a DSM program by a utility, modern construction methods and research and development allow for substantial energy savings through improved building and energy use practices. Rather than generating more electricity, it is possible to lower the amount of electricity that a user draws from the power grid by designing energy efficient buildings and meeting some of the energy needs of a building through alternative power technologies such as solar water heating. Energy saving has the potential to provide Ontario with massive reductions in electricity use, primarily because our current use of electricity is remarkably wasteful.

As private and public sector research has advanced, the potential for energy savings, without losses of economic efficiency, has grown. Today energy efficient design specialists are designing homes and commercial buildings that not only have lower energy costs, but lower construction costs than conventional design methods. Simultaneously, the costs of components for energy savings devices like solar water heating units are dropping, making energy savings economical. All these new technologies must overcome massive hurdles in order to compete in the market. They are new, go against current practice, and are not widely known. Moving such technologies 'from the lab to the market' would provide society with substantial benefits.



The efficiency measures considered in this paper do not include such things as new construction techniques or the potential gains from solar water heating because it is difficult to quantify the potential savings. These concepts are given only as examples of what is possible. The only figures included in this paper are for measures such as changing the ballast in commercial lighting fixtures and upgrading home appliances to more energy efficient ones (typically at the end of the useful life of the existing appliance) – measures that consist of taking technologies already in use and spreading them as widely as possible. This means that the figures given here are minimal estimates of the potential available from energy efficiency measures.

Energy Efficiency, The Success Story of the 1990's

In 1990, primary electricity in Ontario came mainly from nuclear power, hydro, and coal. During the 1990's however, electricity productivity (the ratio of electricity demand to provincial output) grew dramatically. GDP growth in the 1990's outpaced the growth of electricity demand, or in other words, Ontario uses less electricity today per dollar of GDP. Ontario's economy is becoming less electricity intensive – we are learning how to avoid wasting electricity. Taking 1990 as a starting point, by 1999 a wide gap had opened between actual electricity consumption and projections based on the growth of GDP. By thinking of this saved electricity as a source of supply it can be said that by 1999 over 16% of Ontario's primary electricity was coming from increased electricity productivity. Electricity productivity is thus a source of energy that is already almost on par with coal.

Without any coordination, without any significant Demand Side Management plan (Ontario Hydro's DSM programs were wound down in the early 90's),

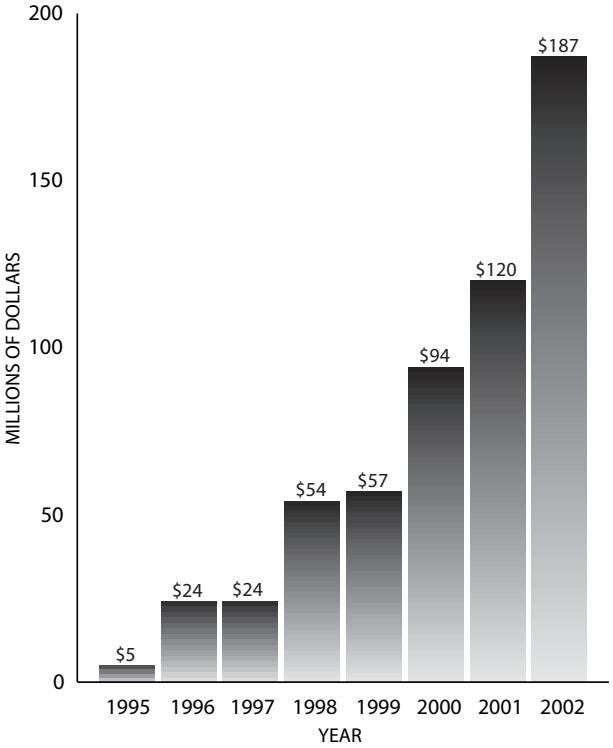
and in the face of numerous market and non-market barriers to fair competition with the provincially supplied power sources, electricity productivity emerged in the 1990's as the fastest growing source of new electricity supply. **In fact, by 1999, electricity productivity improvement was providing more electricity services to Ontarians than all the new coal, oil, gas, nuclear, and hydro resources combined over the same period.** The potential of increased electricity productivity is massive, and no systematic exploitation of this resource has yet been undertaken. Domestic electricity demand has already been reduced by 25,000 GWH annually from the expected figure. Torrie-Smith Associates estimates that savings of another 20,000 GWH over the next decade are easily within reach if systematic efforts are made to capture these savings.

Overcoming the Barriers to Energy Efficiency

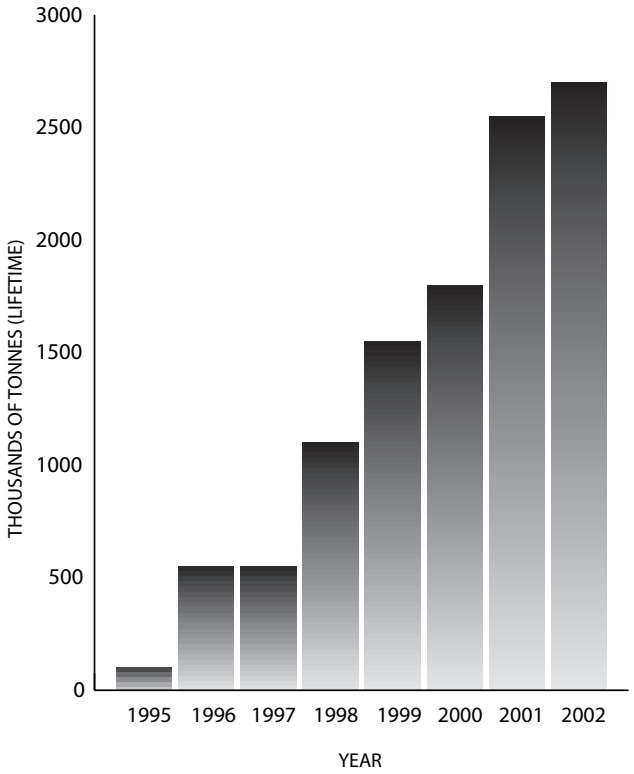
The primary barriers to greater energy efficiency are information costs, transaction costs, and payback periods. It is difficult, expensive and time consuming for an individual consumer to learn about new technologies, assess his or her electricity use, and implement a plan to reduce electricity consumption by replacing old appliances, switching to more efficient lights, or any other equivalent measure. Further, the payback period for such actions is often several years but according to survey data over 85% of all people and businesses in Ontario tend to use a three or four year payback period as their maximal wait time. If an energy saving measure requires longer than four years to pay itself back in savings then close to 90% of consumers will opt not to pursue it.[19] In contrast, if a consumer foregoes the investment in efficiency that may have a five or ten year pay back, the electricity sector will respond with new generation investment that typically requires a twenty – forty year payback.

Similar problems to these were encountered in the gas sector years ago. A framework was established by the Ontario Energy Board in 1993 in which to implement efficiency measures in the gas sector[20]. Today the gas sector in Ontario is reporting great successes in managing gas demand via a series of mechanisms that promote and reward DSM (Demand Side Management) in the gas sector. Demand Side Management could work just as effectively in the electric market as it does in the gas market. Many parts of North America already have successful DSM projects in the electric sector.[21] The key to successful DSM is to remove the financial disincentives that the regulatory system typically creates. Advanced programs give the utility an incentive to engage in conservation and create penalties for failing to conserve electricity.

In the gas sector, a regulatory system was created in which the utility is first compensated for lost revenue (due to foregone gas sales) and the cost of implementing the DSM program through rate adjustments. In order to then encourage the utilities' participation in the DSM program a target for gas savings is defined, and if the utility exceeds that target it is entitled to a share of the savings it is helping to create. Similarly, if the utility fails to reach the target it pays back a portion of the difference between the projected and actual savings to consumers. To date the DSM in Ontario's gas sector has proven to be a win-win situation. In 2002 Enbridge Consumers Gas will spend $13million on energy efficiency programs which will result in efficiency



CO_2 REDUCTIONS FROM ENBRIDGE DSM



investments that will result in net savings of approximately $200 million over the lifetime of those measures. The bulk of the cost will be paid by the participants. The utility will save more than the $13 million it will spend due to reduced peak storage and pipeline costs in the long-term.[22]

The experiences of the gas sector can certainly be transferred to the electricity sector. Although some may be quick to argue that in Ontario's new market there will be no monopoly generator to implement such a program, this has not affected the DSM program in the gas sector where the gas commodity has been deregulated for over a decade, and would not affect a program in the electric sector. Further the dramatic savings in the gas sector likely understate what is cost-effective in the electricity sector since more homes and businesses are served by electricity than gas, more end uses utilize electricity than gas, electricity is more expensive than gas and electricity conserving technologies tend to save a far greater proportion of energy.

In different jurisdictions DSM plans have been implemented by the transmission monopoly, at the distribution level, or at the provincial or state level (as in the case of Vermont) where a new entity can be established to specifically handle DSM. Any of these plans could be adapted to the Ontario context for the electricity sector.

As noted previously the potential for energy savings is high. When newer technologies and building techniques are taken into account the potential for energy savings escalates greatly. For the most part such techniques are practical and cost effective, but require support to overcome barriers to market penetration and to help in dissemination efforts. If research and development efforts were put into these technologies the potential grows further. But to ensure that the estimates given here are as conservative as possible further advances are excluded from the analysis presented here.

6 RENEWABLE ENERGY

Summary of Potential Sources

As renewable energy technologies have matured the basic science has not changed much, but the costs have come down dramatically. This is due to advances in materials and designs, greater experience and more accurate estimates, and economies of scale.

In 1992 the Independent Power Producer's Society of Ontario commissioned a study which showed that Ontario had the technical capacity to generate 22,634 MW of electricity from non-utility sources. This is a broad category which lumps together all the gains to be had from sources as diverse as sewage digester gas, wind turbines, and natural gas burning cogeneration plants. Most of this capacity came from cogeneration, and very little of it came from renewable sources like wind turbines or biomass. Since that time, less than 10 years ago, the costs of certain types of renewable energy have come down dramatically and the potential in Ontario has gone up accordingly.

TECHNICAL CAPACITY FOR RENEWABLE ENERGY SOURCES

RENEWABLE ENERGY SOURCE	MINIMUM TECHNICAL POTENTIAL (IN MW)	MINIMUM TECHNICAL POTENTIAL (IN GWH/YEAR, ROUNDED DOWN)
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Total	7,413.6	19,059

NOTE: *wind power is assumed to operate at 28% capacity over 8760 hours. Solar energy is not included here but in the energy efficiency section instead because of its primary use for water heating, not electric generation.*

Renewable low-impact energy for commercial generation in Ontario is available from four sources – wind, small hydro, wood, and biogas. A closer examination of these estimates is in order.

Wind – Availability and Price

Wind power is harnessed by building turbines in areas with average wind speeds of over 5 meters per second (at a height of 50 metres). Although at first glance much of Ontario seems poorly suited to wind power generation due to low wind regimes, this is in fact untrue as local topography can drastically affect the suitability of an area for wind powered generation. Hills that block or channel wind and local vegetation can raise windspeeds at certain elevations. Consequently two areas in close proximity can in fact have very different average windspeeds. In broad terms, Northern Ontario has been identified as a poor prospect for wind power but much of the coastal area around the Great Lakes including Lake Erie and Lake Ontario is promising. Wind speed data gathered on the northern and eastern shores of Lakes Superior and Huron indicate a strong potential for wind farms.

Note that the figure in the above table does not include windspeeds offshore of Lake Erie, despite the assertion by industry that there is excellent potential for offshore turbines in the lake. This is due to the presently prohibitive cost of such an undertaking. This limitation may be quite conservative given recent developments in Europe. Recently Ireland approved a 500 MW offshore windfarm.

Of all the figures in the chart above, the figure of 6,390 MW of installed capacity for wind generation is probably the most understated. This figure was derived in 1992 with several assumptions in place – including that the average turbine was located on a tower not more than 50 meters tall, the rotors had a diameter of 26 meters, all turbines were spaced 10 rotor diameters apart, and that the average turbine produced 250kW of electricity. Today, due to technological advancements in the state of wind turbine technology and construction techniques this estimate is very safely on the low side. Today's turbines are in the .6 – 1.8MW range (over 5 times as much rated capacity), and sit on towers 70 meters tall. They have far larger blade diameters than in the past too, consequently more energy can be generated per square kilometer given over to wind

production today than in the past. Where in the past capacity factors (the energy output actually achieved – as opposed to the rated power) for turbines in wind regimes of 5- 7+ meters/second were in the range of 12-27%, today that range is closer to 25-34%, with an average capacity factor that is closer to 28%. In short, today's turbines are more powerful, more efficient, and can produce more electricity per area of land that allows for wind farming. Today's windmills do the job far more cheaply too.

While in the past a 250 kW turbine cost approximately $1.1-million dollars (not including the cost of laying transmission lines to connect to the grid), today a wind turbine with 5 times the capacity costs only $1.3-million. Even allowing for inflation, the reductions in cost are massive, and they will only increase as economies of scale come into effect in this industry. Historically prices of wind turbines have dropped 4-5% per annum in the last decade. Although industry estimates vary from producer to producer, the current range of price estimates is from 9 to 12 cents per kWh for wind power, with 10 cents per kWh being an often quoted figure[23]. This price is expected to decrease further as large scale building of turbines begins locally and costs drop. Note that this is not the social cost of wind, but the actual price that producers name when asked what price they would require in order to arrange financing, complete estimates, construct and operate wind farms and generate a satisfactory return to capital. Again, because of the threshold effect in place with wind power, very little power may be available before this price of 10 cents per kWh, but once this threshold is crossed over 15,000 GWH of electricity can become available. This is equivalent to 37.5% of the 40,000 GWH target. Some producers have indicated a willingness to provide wind power at a lower cost by 'bundling' forms of renewable energy together to create a mix of assets which would have a lower average price, closer to 8 cents/kWh.

Water- Availability and Price

AVAILABILITY

Although many earlier hydro projects around the world were environmentally destructive, silting spawning beds and prohibiting fish from migrating upstream, today's hydro projects can use run of river designs and other mechanisms to mitigate the impact of electricity generation. There are two general divisions of water power – small and large scale power. Small scale hydro projects are those under 20 megawatts, often utilizing run of river techniques, and are typically considered to be the most environmentally friendly form of electrical generation from water. In 2001 The Ontario Ministry of the Environment estimated that there is about 953 MW of potential capacity in smaller hydro stations, although this capacity would be somewhat lower if strict environmental regulation were applied[24]. We assume this source of power would meet Ecologo guidelines on low impact renewable electricity.[25]

In 1992 the Independent Power Producers Society of Ontario (IPPSO) commissioned a study into the potential for small hydro projects, under 20 MW, in Ontario. They arrived at a figure of 2,325 MW of capacity based on government estimates of 2,194 potential hydro electric sites.[26] About 1,500 MW of this capacity comes from projects in the 1-10 MW range.[27] Given the IPPSO report, our listing of the MoE's technical potential figure for water powered generation in Ontario is a safely conservative estimate.

PRICE

IPPSO's 1992 study argued that some of the projects it examined would become financially feasible with electricity prices as low as 5 cents/kWh, well below the real cost of coal power. At such a price level however, only between 60 and 133 MW would become available (depending on how high a return on equity is demanded).[28] With a price of 8 cents/kWh between 240 and 626 MW of power becomes available, and the returns increase from there. Because this study was done in 1991 dollars these prices will have changed, but to counterbalance this there are several factors. Firstly today's interest rates are lower, bringing costs down. Secondly, the original study does not examine the potential economies resulting from developing multiple sites on the same watercourse. Thus at prices as low as 8 cents/kWh small hydro projects could contribute significant amounts of power annually, and the potential exists for far more than this.

Biogas – Availability and Price

Biogas is a conglomeration of different gas sources that have organic origins. When organic matter decomposes it releases a variety of gases, but especially methane. Methane is a greenhouse gas 26 times more powerful than carbon dioxide[29] that can be captured and burned rather than being allowed to migrate freely into the atmosphere. Thermal plants that make use of this gas can also engage in cogeneration, using the energy that is lost in the act of creating electricity (some 60%) as process heat to warm nearby buildings if any exist. Biogas comes in several forms including gas from properly separated organics gathered from municipal solid waste, landfill gas, animal manure gas, and gas from anaerobic sewage digesters. All of these are available in different proportions. When added together the figures for sewage and municipal solid waste energy lead to a total estimate of 70.6 MW of continuous potential, or approximately 600 GWH/year of electricity. This figure does not include the power available from landfill gas, a source which the Ministry of the Environment has estimated at 74 MW of power already and described as having "significant additional potential".[30]

Compared to wind or water, the potential for biogas in Ontario is relatively limited. However, many of these projects have incidental benefits which make utilization of this resource a high priority. Sewage is already treated in plants, and the city of Toronto has constructed a plant to generate power by burning the gas from the sewage digesters.[31] Landfill gas, if simply allowed to escape into the atmosphere, has significant global warming impacts. Many dumps already flare the gas. Rather than simply flaring the gas it is possible to generate electricity from it. Additionally, municipal solid waste is fast becoming an issue in Ontario as the environmental and fiscal costs of dumping rise. Thus although these sources represent fairly small sources of energy, there are other important reasons for their inclusion.

Sewage digester gas could potentially account for 20.6 MW of production capacity spread over 50 sites, according to an IPPSO estimate.[32] Landfill gas capacity is harder to gauge. Only sites that are new enough and large enough to produce significant amounts of gas are considered. IPPSO's 1992 survey put the total capacity for landfill gas at 87.2 MW, but newer data is needed. The Ministry of Energy estimates that Ontario is currently generating 74 MW of electrical power from landfills, including 30 MW at the Keele Valley landfill site in the City of Vaughan. This site alone meets the power needs of 15,000 homes. The ministry also concludes that significant additional potential still exists for landfill gas, but did not quantify that estimate.[33]

Landfill gas, however, comes with a significant caveat. In burning the gas there exists a potential to release dioxins. The gas that comes out of a landfill contains many chemical compounds and elements other than methane. If not properly captured and/or filtered, some of those chemicals can be burned in the generator and recombine in the stack later to form dioxins and toxic chemicals. The Ecologo program provides standards for landfill gas.

Municipal solid waste, when properly sorted, can be substantially diverted away from landfills by separating out the organic components. The organic components can be broken down in an anaerobic digestion process into gases and a peat like substance. The capacity figures for this process are currently contested as this area is relatively new in Ontario. SUBBOR, a company that runs an anaerobic digester program in Guelph, has estimated that Toronto's waste alone has a continuous potential of 150MW[34]. This estimate does not distinguish, however, between heat and electric energy. Allen Kani Associates has designed a program for Toronto's waste diversion needs and the estimated figures suggest 50MW of heat energy and 50MW of electrical energy can be recovered per year. This would place the recoverable electrical energy at approximately 425 GWH/year. The Allen Kani design is estimated to be revenue neutral for the city government over the lifetime of the program. The combined sales of the peat, electric power, and heat energy along with the avoided tipping fees are equivalent to the costs of the program. Expanding this estimate out at the provincial level requires more detailed analysis because there are economies of scale and transportation costs depending on the size of a community. The 50MW figure for Toronto is thus most certainly a drastic understatement of the potential for energy recovery from municipal waste in Ontario.[35]

The potential energy contribution from animal manure gas has not been examined here. Although IPPSO estimated the potential for generation at over

450 MW, the costs at the time made the project impractical, with rough estimates of price beginning at over 17 cents/kWh due to transportation and storage costs. Although some industry spokespersons mention progress in the design of modular generating units that would lower the cost of generation by allowing the power to be produced on or near the farm, public data are not readily available. In 2001, the Ministry of Agriculture, Food and Rural Affairs estimated the potential for animal manure gas at 500MW, enough to power 160,000 homes. No price figures were available.[36] The inclusion of animal manure gas as a possible energy source should not be taken as an endorsement of Intensive Livestock Operations (ILO's). If modular units are available than they could be used on farms that do not use intensive livestock methods.

Wood – Wood is an abundant resource in Ontario, but it is very difficult to decide when wood burning qualifies as a source of renewable and environmentally friendly generation. Cutting down wild forests for fuel is certainly not acceptable, burning used wood from municipal waste is expensive because of sorting costs, and the potential for chemically treated wood to cause environmental and public health problems when burnt also needs to be addressed. There are two potential sources in Ontario for wood that are less controversial than the above – sawmill waste and 'slash'- the waste wood that never reaches a logging truck and is piled up at cut sites. Most sawmill residue has a higher value when reused for products like microlams and particle boards, so the one practical source of wood for electric generation in Ontario is 'slash' – logging residue. IPPSO estimated the potential for this source at 201MW, assuming that a typical harvest is 18.8 million cubic metres.[37] However this figure would have to be revised downwards if only waste from sustainably managed forests were included, since wood culled from unsustainable forestry practices cannot be considered a renewable resource. Because of the complexity of these calculations, the lack of data, and the relatively high costs of waste wood (minimal social cost estimates begin at 12 cents/kWh[38]) the figure is mentioned here as an existing source of power capacity but is not included in the totals for renewable energy capacity

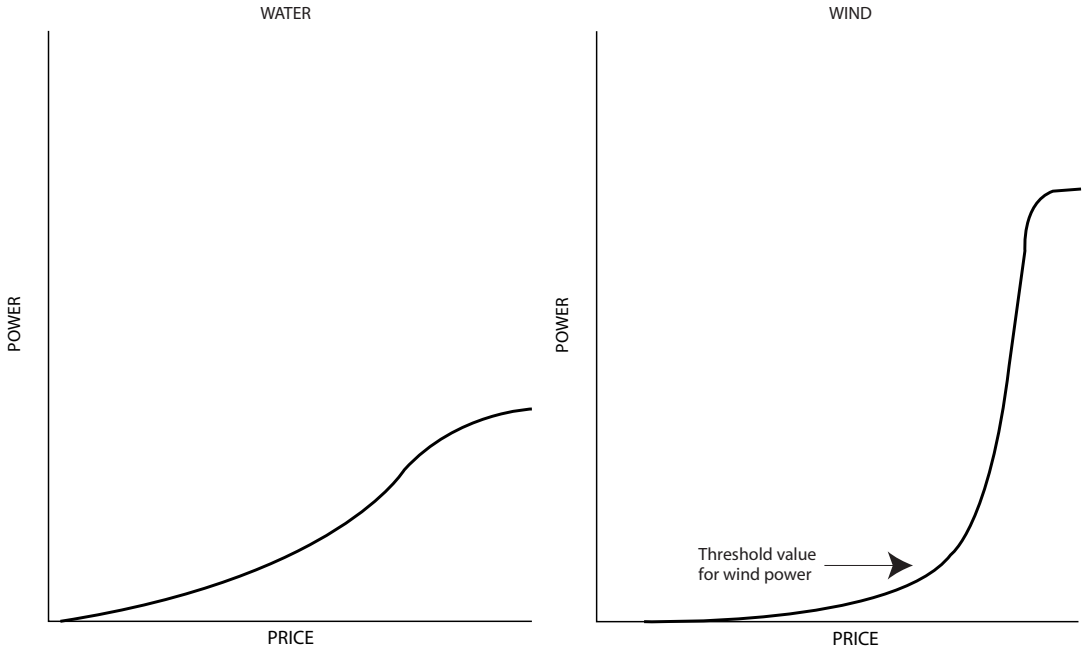
A NOTE ON ESTIMATES

The above estimates are generally extremely conservative, but their attainment is highly contingent on the issue of price. Because renewable energy is price sensitive, the amount of energy available depends largely on the price paid in the market for that energy. The sensitivity of renewable energy to electricity price varies from source to source, and is highest in one of the most abundant resources – wind. This can best be explained by comparing electric generation from wind and water.

Water power involves diverting part of the flow of a river through a channel called a stock pen to flow through a turbine which generates electricity. The amount of power generated and the cost per KWH depend on the amount of water, the type of construction that is needed, the height that the water falls from to build up energy, the distance from transmission lines, and many other factors. Consequently there tends to be a range for water power projects, where certain projects are more or less expensive than others, and if a graph of power generated at different prices is made the line rises in a fairly gentle curve.

By contrast, wind power is not dependent on as many factors. The primary factor in determining wind power costs is the average wind speed. There is much potential for wind in this province, but most sites that have been examined by wind power experts for the purposes of generating power have fairly similar average wind speeds – typically near 6.0 meters/second. Below this average speed it quickly ceases to be practical to generate wind power, and Ontario's winds reach 7.0 and 7.1 meters/second averages only offshore in Lake Erie, an area which for now is not under consideration. Consequently most of the wind power in Ontario becomes economically feasible at around the same price. The graph of wind power is much steeper than the water power graph. There is a threshold to cross, and once the price of electricity crosses that minimal threshold an abundant amount of wind energy can make its way to market. Prior to that threshold virtually no wind energy comes to market.

PRODUCTION CURVES FOR WIND AND WATER POWER



CONCLUSIONS

The analysis put forth above leads to the conclusion that it is both technically possible and economically feasible to end coal burning (or dramatically reduce reliance upon nuclear power) for electricity generation in Ontario. The largest share of this target can be accomplished by the implementation of energy efficiency measures. Indeed, given the proper support, the entire goal could be accomplished through energy efficiency measures. But in order to achieve a sustainable energy future and security of supply, renewable energy resources must also come into play. The extent to which those resources are available depends upon the market price of electricity and reforming the price of electricity so that all costs are included. A legislated Renewable Portfolio Standard would help level the playing field so that green power generation can compete on a truly level playing field. There is wide support for this measure. The Ontario government could and should adopt it before the electricity market opens in May 2002.

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NOTES

1 See Independent Market Operator's website for 10 Year Outlook at http://www.theimo.com/imoweb/pubs/marketReports/10YearOutlook_2001jun.pdf and Environics International, "Public Attitudes Toward Green Electricity", 1999

2 See Independent Market Operator 10 Year Outlook, ibid.

3 Ontario Clean Air Alliance, "Nanticoke Conversion Study", 2001

4 Ontario Clean Air Alliance, "Nanticoke Conversion Study", 2001

5 Ontario Clean Air Alliance, "Nanticoke Conversion Study", 2001

6 National Climate Change Process, "Electric Table Options Paper", available at www.nccp.ca

7 Data for this and for the accompanying graph were drawn from Statistics Canada, "Energy Supply-Demand in Canada" 1990-1999

8 Exact demand figures available from the Independent Market Operator's website – www.imo.org The low point of daily demand is approximately 2:00-3:00am, where electric use can be around 14,000 MW, while peak demand has exceeded 25,000 MW during 2001.

9 Environment Canada's Environmental Choice program features an Ecologo for low impact renewable electricity sources, to see draft Guidelines for certification, visit www.environmetalchoice.com/

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13 Ontario Medical Association, "The Illness Costs of Air Pollution in Ontario: A Summary of Findings" 2000. Available at www.oma.org

14 in 1997 dollars. Campaign for Nuclear Phaseout, "Canada's Green Energy Future"

15 quoted in Hellman and Hellman, "Competitive Economics of Nuclear and Coal Power", 1983. Note that this quote is limited only to high level wastes. There are different but nonetheless expensive costs related to transuranic wastes as well, and there are dangers inherent in the processing of low level wastes too.

16 Hellman and Hellman p.95

17 quoted in Edwards, "Death Knell Sounds for Nuclear Energy", 2001

18 Moskovitz, "Why Regulatory Reform for DSM" in Nadel, Reid and Wolcott eds., "Regulatory Incentives for Demand Side Management" 1992

19 Carpenter, Caffell and McClenahan, p. 8

20 1993 Ontario Energy Board Order 169 – III

21 examples include Portland, Oregon and the state of Vermont.

22 Enbridge Consumers Gas 2002 rate case, RP 2001-0032, Exhibit A, Tab 15.

23 Estimates gathered from discussions with various wind power industry figures including representatives from Sky Generation, Canadian Renewable Energy Corporation, and the Independent Power Producers Society of Ontario.

24 Legislative Assembly of Ontario, Select Committee on Alternative Fuel Sources, Interim Report (henceforward: Interim Report)

25 See footnote 9 above.

26 Provincial estimate from the mid 1990's. The survey of potential small hydro sites has been posted on the web at www.small-hydro.com

27 IPPSO 1992

28 IPPSO 1992 appendix A-11

29 On a per molecule basis methane traps 26 times as much heat as carbon dioxide. But carbon dioxide emissions are so many orders of magnitude greater than methane emissions that it is still the leading greenhouse gas in terms of absolute numbers.

30 Interim Report p.68

31 WDO Study: Implementation Schedule and Roll-Out Strategy for Anaerobic Digestion of Residential Waste in City of Toronto, Prepared for the City of Toronto, and see WDO Study: Implications of Different Waste Feed Streams (Source-Separated Organics and Mixed Waste) On Collection Options on Anaerobic Digestion Processing Facility Design, Equipment and Costs, Prepared for the City of Toronto by Allen Kani Associates with Enviro RIS Ltd., April 9, 2001 (henceforth: WDO Study)

32 IPPSO 1992 p.54

33 Interim Report p.68

34 WDO Study

35 WDO Study

36 Interim Report p.71

37 IPPSO 1992 p.73

38 IPPSO 1992 p.91