ICF CONSULTING

The Electricity Supply/Demand Gap and the Role of Efficiency and Renewables in Ontario

Prepared for:

Pollution Probe

Prepared by:

ICF Consulting
277 Wellington St. West, St. 808
Toronto, ON M5V 3E4
Canada

March 3, 2006

The Electricity Supply/Demand Gap and the Role of Efficiency and Renewables in Ontario

Introduction

The objective of this paper is to explore the importance of conservation and efficiency in Ontario's electricity system, including how that potential affects the development and potential contribution of renewable generation. The paper has been prepared as a backgrounder for Pollution Probe's participation in the current public policy discussion about the future of Ontario's electric power system, with particular reference to the Ontario Power Authority's *Supply Mix Advice Report.*

We take a broad approach to the question of the importance of efficiency and conservation, and demand side management in general. If we have learned anything from the previous failed attempts at power system planning in Ontario, it is that the importance of conservation and efficiency in our use of electricity, and what that might mean to the need to build new power stations – renewable or otherwise – can only be fully appreciated in the broader context of the underlying drivers of the demand for electricity. It has been our failure to do this that has been largely responsible for why we have failed in previous attempts to develop an effective long range investment strategy for our power system in Ontario.

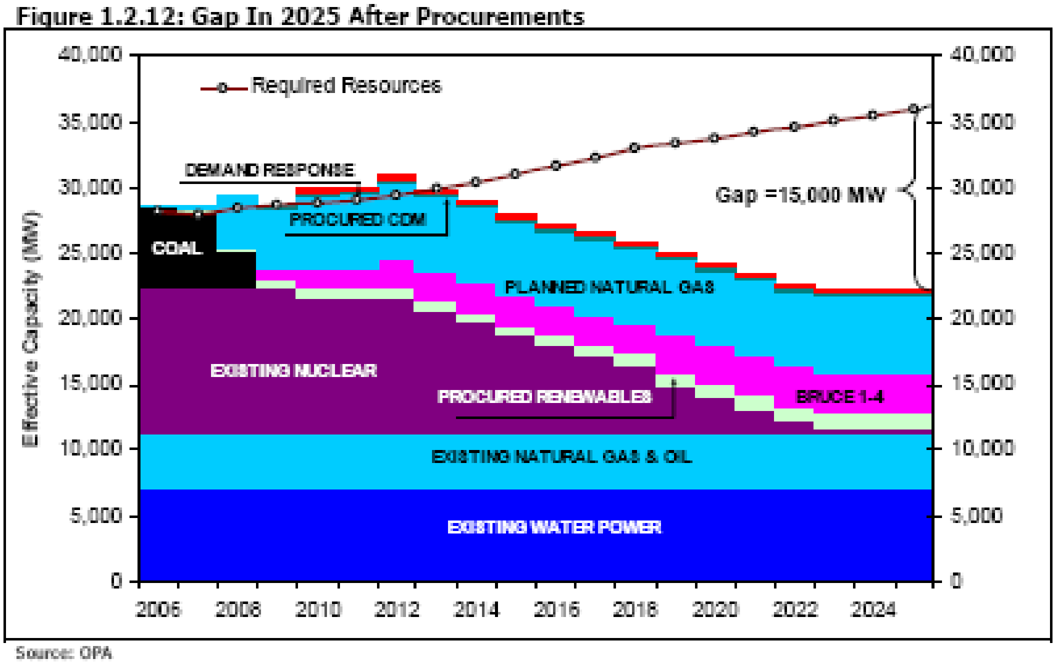
"Gapology" and Power Planning in Ontario

The central focus of the Supply Mix Advice, and the central focus of the public policy debate even before the OPA report was prepared, is an impending "gap" between the future supply and demand for electricity in Ontario. The OPA version of the gap is reproduced in Figure 1. The gap is defined by a top line that reflects a forecast of peak demand[1] and a bottom line that is the effective capacity expected to be available to supply that peak demand. In the version from the *Supply Mix Advice* report shown in Figure 1, the gap is delayed until 2013 and grows to 15,000 MW by 2025, due to the assumed addition of natural gas generation, the retubing of the Bruce A reactors, additional wind and other renewable supply, and the impact of conservation and demand management initiatives.

[1] In Ontario, the peak demand for power was about 26,000 MW in 2005 and occurs on a summer afternoon, usually in early July, when the air conditioning load sends the demand for electricity soaring above normal levels. The system also has a winter peak driven by electric space heating, which until 1998 was higher than the summer peak and which is still comparable in size.

Figure 1

Supply/Demand Gap in 2025 After Procurements, Renewables and CDM



This type of supply/demand gap was the basis of electric power planning in Ontario for decades, up until long-term electric power planning ceased altogether in the early 1990's. The supply-demand gap provides a simple and compelling framework for thinking about the future; but unfortunately on every occasion when "gapology" has been used as the basis for investment planning in the Ontario power system, it has failed when the gap failed to materialize.

- For example, in 1976, Ontario Hydro argued that by 1997 there would be a 38,000 MW gap between supply and demand in Ontario unless the province built and had in service an additional 24 nuclear reactors and 18 coal-fired generators, *over and above* the sixteen reactors that were in various stages of design and construction at the time (Bruce A, Pickering B, Bruce B and Darlington). The plan was based on a forecast system peak of 57,000 MW in 1997; low and high variations were examined that had the peak in 1997 at 36,000 MW and 67,000 MW, respectively, with the assertion that "it is unlikely the actual load will be outside the range of these scenarios".[2] The actual peak demand in 1997 was 22,200 MW. None of the 42 additional nuclear and coal stations that were deemed necessary by 1997 were ever built, and the gap never materialized.

- Ontario's last foray into gap-driven system planning was the plan produced in the late 1980's entitled *Providing the Balance of Power*.[3] The supply/demand gap in that plan was projected to open up in the mid-1990's, reaching 9,700 MW by 2005 and 21,300 MW by 2014, leading to Ontario Hydro's proposal for several additional nuclear and coal-fired

[2] Ontario Hydro, "Planning of the Ontario Hydro East System", Report No. 573 SP, November 15, 1977.Part 2, page 3-1 ff.

[3] Ontario Hydro, "Providing the Balance of Power: Ontario Hydro's Plan to Serve Customers Electricity Needs", Ontario Hydro, Toronto, 1989.

generating facilities. The bottom of the gap was defined by declining capacity from the existing system, especially after 2005, and the top line was driven by a forecast in which peak demand reached 34,900 MW by 2005 and 39,800 MW by 2014. It was asserted that there was only a 10% probability the actual load would fall below a lower bound forecast that reached 28,700 MW by 2004 and 33,500 MW by 2014. Actual demand peaked at 25,000 MW in 2004, 10,000 MW below the median forecast in *Providing the Balance of Power* and 3,700 MW below even the lower boundary (less than 10% probability) of the forecast bandwidth. The plan was eventually withdrawn by Ontario Hydro. None of the proposed facilities were built and the gap never materialized.

The planning and analysis efforts of the 1970's and 1980's were wrong partly because they underestimated the narrowly defined potential for more efficient use of electricity. But the reason they were so grossly and egregiously wrong was their failure to grasp the magnitude of the underlying changes that were occurring (and that are continuing to occur) in the level and pattern of the demand for the energy services that electricity helps provide. These past efforts overestimated the peak demand for electricity by tens of thousands of Megawatts and the associated need for investment in nuclear and coal megaprojects by tens of billions of dollars. To be sure, this was partly because conservation and efficiency delivered more than anticipated, but it was primarily because of deeper, ongoing changes in the energy services market that have resulted in dramatic improvements in the overall electricity productivity of Ontario society, changes that resulted in the anticipated supply-demand gaps never materializing.

How Much Is the Demand Side Really Delivering?

In a recent retrospective analysis of electricity demand patterns in Ontario since 1990,[4] we analyzed the impact of improvements in the electricity productivity of the Ontario economy[5] over the 1990-2004 period. Electricity demand growth stalled in Ontario between 1989 and 1993 as the Ontario economy went into recession, but when Ontario's economic output returned to pre-recession levels in 1994 and began to grow again, electricity growth did not rebound with it, and the electricity productivity of the Ontario economy has been growing on a steep curve ever since.

One way to appreciate the significance of this trend is to think of electricity productivity as a new "source" of power, and to consider how much additional electricity would have been needed in

[4] ICF Consulting, "Electricity Demand in Ontario: A Retrospective Analysis", prepared for the Ontario Power Authority, Revised November 2005. Available online at http://www.powerauthority.on.ca/Storage/14/995_Factor_Analysis_of_Ontario_Electricity_Use_1990-2003.pdf.

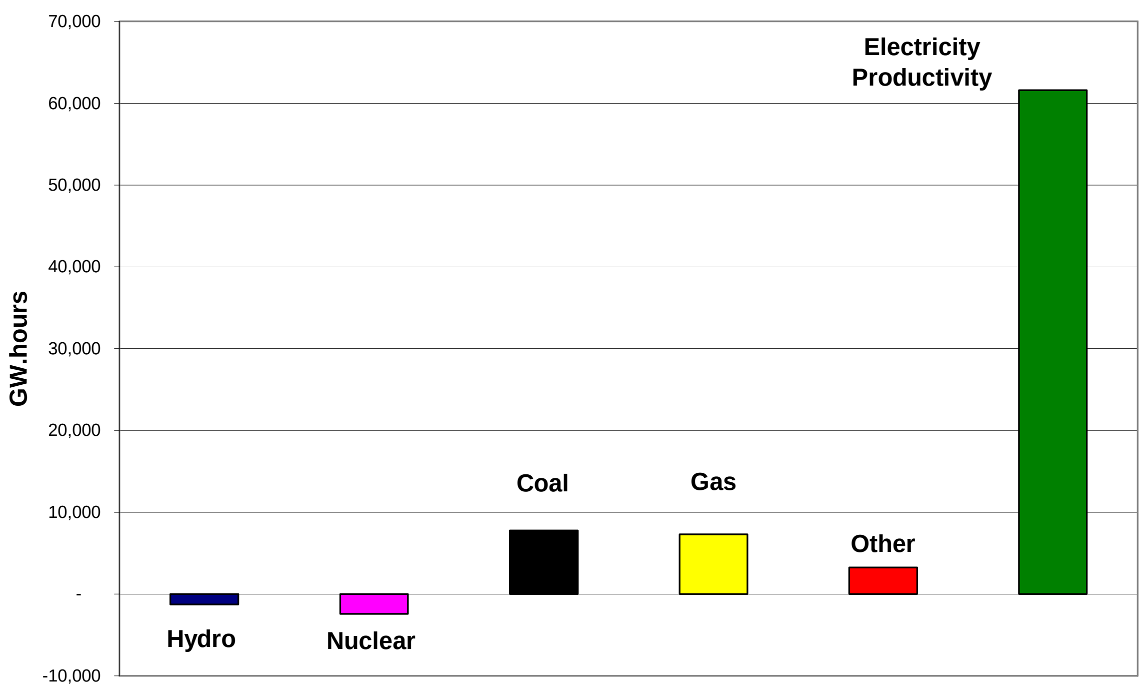
[5] The electricity productivity of the economy is defined here as the ratio of the electricity consumed to the Gross Provincial Product, in dollars per kilowatt.hour. It is the inverse of the electricity intensity of the economy, defined as the kilowatt.hours consumed per dollar of GPP. The electricity productivity of the economy – the GPP produced per kilowatt-hour of electricity consumed – is an aggregate indicator and reflects both the structure of the economy and the technological efficiency of electricity use. A relative shift in output from electricity intensive activities such as smelting and paper making toward general manufacturing or services will cause electricity productivity to increase. The same effect is caused by shifts within the electricity intensive industries toward higher value-added output. The electricity productivity of the economy will also improve if there is a shift away from the use of electricity for heating applications, or if the efficiency of electricity using technologies, from lights to computer screens, improves. All of these factors have been at work in Ontario over the past fifteen years, although there is very little research and understanding of their relative importance.

Ontario in 2004 if not for the productivity improvement. Viewed this way, as illustrated in **Figure 2**, electricity productivity emerges as the biggest story in Ontario's electricity economy; by 2004 the productivity improvement was displacing the need for over 60,000 GW.hours of generation. Expressed in "gapology" terms, the electricity productivity improvement in Ontario since 1990 is now providing over 5,000 MW of effective peak capacity, and is far and away the single largest explanation for why the supply/demand gap in Ontario Hydro's *Providing the Balance of Power* plan never materialized.

Because we no longer gather detailed information about how we use electricity in Ontario by sector and subsector and end use, we can only estimate how much of this productivity improvement is conservation and efficiency in the narrow sense (more efficient lighting, refrigerators, etc) and how much of it is due to changes in the demographics and economic structure of Ontario. There is no doubt however that the understudied and often ignored demand side resource is the largest and fastest growing "supply" of electricity services in Ontario.

Figure 2

Changes in Electricity Supply in 2004 Relative to 1993



Is This Time Different?

Every new supply-demand gap comes with the argument that "this time it's different". "This time we have learned from our past mistakes. This time our forecast is better. This time the historical context has changed, this time the gap is real". These arguments have not proven valid in the past, but perhaps they will be this time. Among experts and people who worry about the power system one certainly senses a consensus that we are headed into a supply-demand crunch. But then a similar consensus, or at least majority opinion, has surrounded previous exercises in "gapology" in Ontario electric power planning. Most experts thought Ontario Hydro was more-or-less right in 1978 when they said Ontario needed to build dozens of new nuclear and coal plants to secure the future supply of electricity. Only a dissenting minority thought changes on the demand side could obviate the need for the expansion. By the late 1980's there were more who questioned the validity of the supply-demand gap in *Providing the Balance of Power* as a basis for power system planning, but they still represented a minority opinion.

One argument advanced for why the current supply/demand gap is more credible than previous gaps is that this time the gap exists because the bottom line of the gap is dropping and we need to replace existing capacity. The top line forecast is "only" 0.9% per year, and there is evidently a perception that it can't go much lower.[6] But it really makes no difference whether the gap is being "caused" by a falling bottom line or a rising top line; it is the gap itself that motivates our concern. In this context, it remains vitally important to examine the validity of both the top and bottom lines in deciding what should be done by when to maintain a reliable supply of electricity in Ontario.

The Supply/Demand Gap in the Supply Mix Advice Report

The short time given to the OPA to produce the Supply Mix Advice put them in a difficult position. In a calmer planning environment, one of the first priorities of an agency charged with responsibility for providing advice and investment planning strategies for the electric power sector would be to assemble the necessary databases and analytical tools needed for detailed scenario analysis of the system. This means databases that identify how electricity is used by sector and end use, and tools that allow the exploration of how the level and pattern of electricity use would vary given different assumptions about future Ontario population, housing preferences, industrial structure, technological efficiency, etc. Unfortunately, for the past fifteen years there has been almost no work done in this area in Ontario. Since the demise of Ontario Hydro, the capacity to analyze the demand for electricity and to construct useful and insightful scenarios has atrophied, as have the databases of end-use patterns, technology saturation rates and market shares needed to support such analyses. While the OPA has started work to re-build this capacity, its absence affects not only our understanding of the drivers of future growth but our ability to measure the potential for DSM (i.e. understanding current levels of efficiency in key end uses and how the extent to which efficient choices are being made at the margin).

The IESO had been publishing energy and peak demand forecasts that went out ten years, but these are single line forecasts with no sector or end-use content. These types of simple forecasting exercises are all that the IESO required to support its focus on short-term operation and balance in the system, but they are inadequate as a basis for strategic planning and decision support for long-range planning and investment.[7] Nevertheless, faced with the impossibility of putting the necessary

[6] For example the OPA Supply Mix Advice includes a forecast variation in which the demand is higher than the 0.9% annual growth (energy) used to construct the supply/demand gap, but includes no consideration of a low forecast variation and its attendant risks.

[7] This is not to be critical of the IESO in this regard; even ten years is well beyond the mandate and focus of the IESO mandate. It would presumably have been difficult for them to justify the considerable resources it takes to gather the

databases and capacity in place to conduct more useful long-term scenario analysis of the Ontario electricity system, the OPA picked up the IESO forecast of electricity demand to the year 2015, as extrapolated to 2025 by Navigant Consulting.

The IESO/Navigant Forecast

It is the IESO/Navigant forecast[8] that defines the "top line" of the supply/demand gap shown in Figure 1, and the cornerstone of the *Supply Mix Advice* report. The forecast is shown in Figure 3. It is a single line forecast, with very little information content. The original IESO forecast went out to 2015 and was generated using forecasts of the provincial labour force and housing stock to predict the demand for electricity, based on the historical relation between the demand for electricity and these variables. There is no breakdown by sector and there is no breakdown by end use. There is no population or level of economic activity explicitly identified with the forecast. There is no separate consideration for electricity growth in markets held captive by electricity (e.g. electronics, motors, lighting, etc) and those in which it competes with other energy commodities (space and water heating). The forecast predicts that electrical energy demand will grow at 0.9% per year and that the peak will grow faster – at 1.3% per year. Navigant extrapolated the forecast to 2025 by extending these same growth rates.[9]

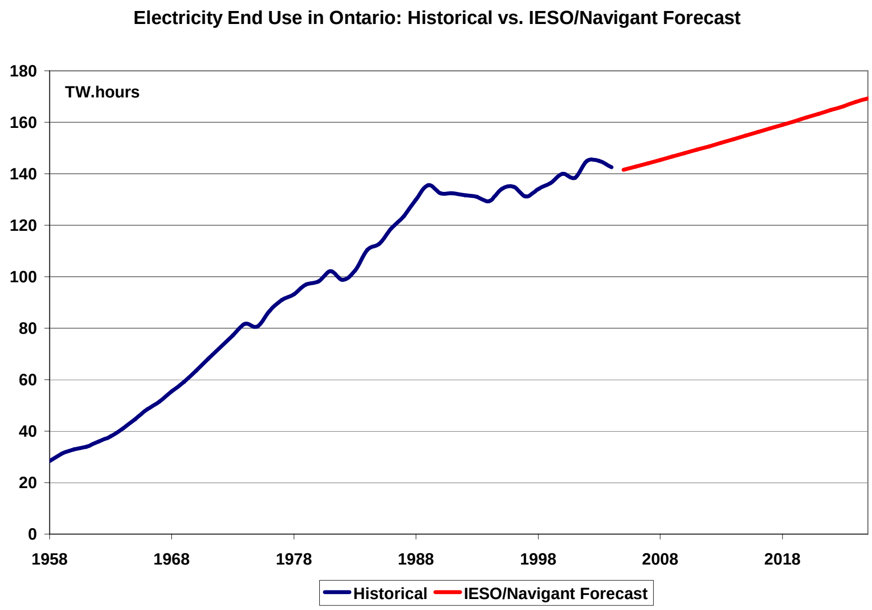
The IESO/Navigant forecast was not intended to support a long-term power planning exercise and it is not suited for such a purpose. It clearly does not provide the level of detail necessary for a thorough assessment of the potential for conservation and demand management. More important, in the past it has been our reliance on this type of single line aggregate forecast that has led us to predict supply/demand gaps that never materialized. If we are to move forward with both long-term investment planning for the electric power sector while avoiding the pitfalls of the past, and if we are to proceed with strategic development of the demand side resource, we need much better information. We must establish both the databases and the analytical capacity needed to understand electricity use patterns in Ontario and to explore multiple scenarios of how electricity demand would evolve given different assumptions with regard to key factors such as population growth, industrial structure (in particular the future of the electricity intensive industries), space and water heating market share, technology saturation rates and market shares.

data and maintain the analytical capacity required to think rigorously about the future demand for electricity on a time scale of ten years and more.

[8] Navigant Consulting Ltd., "Avoided Cost Analysis for the Evaluation of CDM Measures Presented to Hydro One Networks Inc.", June 14, 2005. The Navigant forecast is an extrapolation the "Median Growth Scenario" in the IESO 10-Year Outlook: Ontario Demand Forecast from January 2005 to December 2014 (March 31, 2004).

[9] It is noteworthy that the IESO forecast prepared one year earlier, in 2004, assumed that the growth in summer peak would decline to 0.9% per year after 2010.

Figure 3



The Supply/Demand Gap and its Implications for Efficiency and Renewable Potential

Unlike supply side resources like coal or wind, the demand-side resource has no physical limit; it grows when electricity using activity grows and it grows whenever someone devises a new way of getting more value for less electricity, either through increased electricity productivity (more economic value per kilowatt-hour) or through the invention of techniques and technologies that use electricity more efficiently. Another feature of energy efficient technology is that when compared on a "level playing field" with supply-side resources, it tends to deliver saved energy for a much lower unit cost than the equivalent supply. The efficiency resources are also increasingly global in the way they are developed and marketed. While the R&D of more efficient technologies will tend to be strongest in those countries with the highest electricity prices, more often than not the results of that R&D are technologies for the efficient use of electricity that are cost competitive in most places, and become adopted as standard practice on a time scale that is short compared to the lead time of a power plant megaproject.

The conservation and demand management (CDM) resources that are shown in Figure 1 have been evaluated relative to a single end use calibration of the IESO/Navigant forecast and are sensitive to changes in the level or the end-use structure of the future demand for electricity. Different calibrations of the IESO/Navigant forecast would yield different estimates of the DSM potential, as would lower or higher forecasts. The technological potential for efficiency improvement varies by sector and by end use, so one cannot assume that the CDM resource will simply scale up or down in proportion to different forecasts of future demand. While the range of CDM potentials included in the *Supply Mix Advice* report reflect conventional wisdom of the range that could be achieved in an industrial economy like Ontario's, the CDM potential could be overshadowed, as it has been in past planning efforts in Ontario, by the other dynamics of Ontario electricity demand, dynamics that remain unexplored at this stage in the planning effort.

For renewable potential, the issues are somewhat simpler. The technical potential for wind and other renewables does not depend on the demand side dynamics except in some secondary and indirect ways. However the economics and cost competitiveness of renewables are strongly affected by demand side dynamics, and the CDM resource has historically represented formidable competition for the renewable technologies. When past predictions of supply/demand gaps have failed to materialize due to changes in the level and pattern of electricity demand in Ontario, the renewable electricity industry's expectations were no less affected than those of the nuclear industry.

Electricity Productivity is Likely to Continue to Improve in Ontario.

Improvement in the overall electricity productivity of the Ontario economy has been the single most important reason that past forecasts of future electricity demand in Ontario have been too high and that previous supply/demand gaps have not materialized. While the 0.9% annual energy growth rate used as the base planning assumption in the *Supply Mix Advice* report may seem low to those who remember another era when electricity growth rates were 7% per year, it is higher than the 0.5% average that has prevailed since 1990, and it could go lower. The 0.9% per year growth rate used as the foundation planning assumption in the *Supply Mix Advice* represents a significant *acceleration* of electricity growth in Ontario as compared with the last fifteen years. Even without considering the potential for conservation, efficiency, and fuel switching, there remains a large potential for the electricity productivity of the Ontario economy to increase as the shift from primary to secondary manufacturing and from manufacturing to services continues, and as the electricity/output ratios of the surviving primary producers continue to improve. We need explicit analysis of this critically important determinant of the amount of electricity Ontario will need in the future.

Peak Demand Will Not Outstrip Energy Demand Indefinitely.

The IESO/Navigant forecast assumes the peak demand will grow faster than the average demand throughout the forecast period. This is a good illustration of the need for an end-use "reality check" on the single line forecast. The peak demand occurs in the summer and is driven by the air conditioning load, and more specifically by the peak air conditioning load[10]. This peak has been growing faster than average energy demand because more and more Ontarians have been installing central air conditioning in their homes for the first time. However well over half Ontario homes and an even higher percentage of commercial and institutional buildings now have air conditioners. The differential growth rate in peak demand will slow down and eventually go to zero (long before 2025) as the air conditioning market becomes saturated. Our preliminary calculations indicate that ignoring the air conditioning saturation effect results in an overestimate in the supply/demand gap of at least 1,000 MW. This is an example of one type of "phantom load" that has made up supply/demand gaps in the past.

[10] While the air conditioning load will grow as the air conditioning season grows longer, the peak air conditioning load is essentially determined by how many air conditioners are on the system (and their size). In fact, all else being equal, a longer air conditioning season will increase the system load factor.

Closing the Gap

Notwithstanding the validity of the supply/demand gap itself, there are sufficient "demand side" resources available to close the gap, or at least to delay its appearance until beyond 2020. Even if the various moderating trends that have been contributing to electricity productivity improvement in Ontario for the past fifteen years were to slow down or reverse in a way that led to the accelerated growth in demand reflected in the IESO/Navigant forecast, a supply/demand "gap" would still not materialize if about 50% of the potential for fuel substitution, demand management and energy efficiency were realized, along with a modest growth in cogeneration. We consider each of these in turn in the following sections.

Table 1: Closing the "Gap"

Demand Side Resource	Contribution by 2020 (MW)	Percentage of Achievable Economic Potential
Fuel Substitution	400	50%
Demand Reduction	1,500	50%
Cogeneration	8,250	50%
Energy Efficiency	2,150	50%
Total	***12,300***	***50%***

* Demand reduction potential could be increased if Smart Meters provide enabling technology.
** Co-generation estimate is conservative – based on economic potential at $50/MWh.

Fuel Substitution -- Space and Water Heating Load as a Resource

Electric space and water heating continue to account for 37% of total residential electricity use. High efficiency gas heating is now roughly 40% cheaper. It seems unlikely that market shares for electric space and water heating won't deteriorate over the period. These loads could represent a significant opportunity for both energy and peak savings. The overall system efficiency of delivering power from gas-fired generation is generally less than 25% while new gas furnaces are over 90% efficient. Given the recommended expansion of natural gas-fired electricity generation, it would seem prudent to assess the options for using the natural gas directly to provide the heat.

For water heating, there is an array of interdependent options that need to be considered, including peak demand reduction (perhaps facilitated by smart meters), hot water conservation, switching to natural gas, and system efficiency improvements. The water heating load is particularly important in the context of the supply/demand gap as this load contributes an estimated 800 MW to the summer peak. Another serious contender for this market is solar water heating where commoditization and improved production design and management have brought unit costs down to competitive levels.

We know that well over half of the electric space heating is provided by baseboard heaters, usually in dwellings that are not equipped with the hot air ducts required for a forced air heating system. The capital cost of retrofitting such dwellings has generally been considered prohibitive, not to mention the nuisance factor of a retrofit of that magnitude. However there have been advances in small diameter, flexible piping, hydronic heat distribution systems that allow conversions from electric baseboard heating with relatively little disruption to the household and at much lower capital cost compared to retrofitting a dwelling with forced hot air distribution and return system.

To date, there has been no detailed assessment of the potential for converting electric space and water heating to other fuels. Yet this represents a significant resource that could eliminate the need for expenditures on new supply. To really understand the potential magnitude of this resource requires an assessment of current saturations of electric space and water heating, system types and such factors as the availability of alternative fuels and the potential to expand gas distribution systems into electrically heated areas.

Demand-Side Management Potential

DSM is generally defined to include any actions that impact the consumer's side of the supply/demand equation in order to change the level or pattern of demand for energy. Fully exploited, Demand Side Management would therefore include consideration of improving the efficiency with which a service is provided, decreasing the underlying demand for the service, as well as influencing or controlling the timing of the service demanded. Some studies also include distributed on-site generation in this category as this reduces energy requirements from the electricity grid.

There has not been a definitive study of the potential for all elements of DSM in Ontario in the past decade. The following sections outline elements of the potential as described in the most recent reports available:

- ***Power for the Future: Towards a Sustainable Electricity System for Ontario***, prepared for the Pembina Institute and Canadian Environmental Law Association (CELA)
- ***Electricity Demand in Ontario – Assessing the Conservation and Demand Management (CDM) Potential,*** prepared by ICF Consulting for the Ontario Power Authority
- ***Blueprint for Demand Response in Ontario*** prepared by Navigant Consulting in 2003 for the then Independent Electricity Market Operator (later the IESO).

Each of these reports looked at different elements of DSM and differed in their approach and assumptions as shown in Table 2 below.

- The Pembina/CELA report modeled policies to reduce energy use through efficiency improvements, fuel switching and small scale co-generation, assumed a level of demand reduction based on the remaining load and then proposed a supply mix to meet the remaining grid demand.
- The ICF study looked only at efficiency improvements, estimating the technical and economic potential based on current energy use patterns. It then went on to estimate "achievable" potential based on 1) experience in other jurisdictions and 2) by modeling four different levels of support and incentives.
- The Navigant report on Demand Reduction reviewed the current status of DR in Ontario and other jurisdictions and put forward a series of recommendations on measures and policies that could be put in place to make best use of the DR potential.

Table 2

	Assumptions and Measures Included in Report				
	Based on IESO Forecast?	Efficiency Improvements	Fuel Switching	Small Scale Cogeneration	Covers Period To
Pembina/CELA	No*	Yes	Yes	Yes	2020
ICF Consulting	Yes	Yes	No	No	2025

** calibrated to 2000 electricity use reported by Statistics Canada*

Demand Reduction

In 2003, Navigant Consulting prepared a review of Demand Response in Ontario for what was then referred to as the Independent Electricity Market Operator (later re-named the Independent Electricity System Operator or IESO).

In 2004, the system load only exceeded 20,000 MW for 10% of the hours during the year (876 hours). As discussed in the Navigant study, demand reductions targeted to these specific hours would be particularly valuable. The re-commissioning of LDC load control programs could potentially aid in controlling air conditioning and other loads during these periods. The creation of a two-way communication potential associated with Smart Metering also offers a unique potential to target these critical hours. Neither of these potentials has been addressed in the studies carried out, to date.

In outlining its vision for 2010, Navigant states that Demand Response should be able to provide a 10% reduction in overall demand during high priced periods[11]. In real terms this represents a 3,000 MW load reduction potential assuming the IESO's forecast that the peak demand will reach 30,000 MW by 2025. The Navigant report includes a series of recommendations for achieving the 3,000 MW potential by 2010; in our illustration of how the supply/demand gap can be closed we have included only 1,500 MW of this potential.

In discussing elasticity, Navigant notes that the introduction of load control and other enabling technologies in combination with demand response rates can greatly enhance their effectiveness. In California, rates combined "with technology achieved reductions 2.1 times greater than those without technology". Given that Ontario is leading other North American jurisdictions in the implementation of Smart Meters and time-sensitive rates, this suggests that a significant opportunity exists to increase this potential. Encouraging the inclusion of enabling technologies such as load control and home automation as part of Smart Metering systems that will be put in place over the next 5 years could provide up to twice the price response from these systems. Not including this capability could represent a very significant lost opportunity for the province and electricity consumers. Some of the LDC pilot's currently underway involve systems that offer options such as home automation and in-home feedback displays.

[11] ***Blueprint for Demand Response in Ontario*** prepared by Navigant Consulting in 2003 for the Independent Electricity Market Operator (later the IESO, page 67.

Cogeneration

The Supply Mix Report includes provision for 1,000 MW of procured natural-gas fired co-generation. Cogeneration or 'combined heat and power' (CHP) offer an opportunity for businesses and industries to self-generate their own power, increasing overall efficiency and displacing generation otherwise drawn from the Ontario system. Recent changes to allow "net metering" are expected to encourage this type of "load displacement" generation.

Currently co-generation supplies about 6% of all electricity in Canada, most of which is in the Pulp & Paper, Chemical, and Petroleum Refining industries. By contrast, several European countries, Finland and Denmark for example, generate one-third and one-half of their power from co-generation and combined heat and power plants.

Most of the co-generation potential lies in industry. Efficient pulp and paper plants, for example, could potentially be net suppliers of power to the grid, addressing current critical competitive pressures. Micro-turbines are just starting to become economic for small industrial and commercial facilities with significant heating or cooling loads, with prices comparable to those presented for new nuclear.

A 2000 study conducted for the Ministry of Energy indicated that the technical potential for co-generation in Ontario by 2020 could be over 16,500 MW. Of this, it estimated that by 2010 over 3,800 MW would be economic, with at least 400 MW of this located in the GTA.[12] The economic hurdle used at that time, was competition with power at $50/MWh delivered, or about 40% below current prices. The report comments that all of the technical potential would be economic if prices rose to $78/MWh delivered. Delivered power costs for businesses now average around $85-$90/MWh.

Energy Efficiency

The ICF assessment found that the technical potential to improve energy efficiency could reduce current electricity use by 36.6 TWh and cut peak demand by 8.2 GW. This is equivalent to 26% of Ontario's current electricity use and 33% of the system peak. This compares with analysis in other jurisdictions which found technical potential ranging from 17-41% of energy requirements across different sectors.

The Economic Potential was then calculated based on applying all available technologies that met the Total Resource Cost (TRC) test based on a recent estimate of avoided costs. Not surprisingly, the economic potential was slightly lower than the full technical potential at 29.6 TWh and 5.2 GW. This still represents 21% of total energy sales and peak demand. Similar studies in other jurisdictions reported economic potential ranging from 6% to 35% across different sectors.

[12] Ontario Ministry of Energy Science and TechnologyOntario Ministry of Energy Science and Technology, "Potential for Cogeneration in Ontario, Final Report", August 2000. Prepared by Haigler Bailly, AGRA Monenco and Lourie and Love Environmental Management Consulting.

Table 3: ***Technical and Economic Potential – Based on Accounting Model (ICF Consulting)***

	Energy (GWh)		Demand (GW)	
	GWh	% of 2004 Load	GW	% of 2004 Load
Technical Potential	36,600	26%	8.2	33%
Economic Potential	29,600	21%	5.2	21%

Achievability

Virtually without exception, it is assumed in assessments of DSM potential that the economic potential cannot be realized, only some fraction. This fraction – the so-called "achievable" potential – is typically determined by comparing the most successful DSM programs in other jurisdictions or by imposing some model of how quickly new technologies will be picked up given different levels of incentives, usually to be provided by utilities.

ICF modeled demand reductions due to efficiency improvements ranging from 1,500 MW to 4,300 MW based on varying levels of support for DSM. ICF also reviewed numerous US and Canadian DSM projects to develop a range of "achievable" DSM based on that experience. However, this experience only shows us what has been done – not what could be done. There are a few examples of initiatives that specifically set out to maximize the amount of economic potential achieved – and succeeded.

In communities such as Espanola, Ontario and Hood River, Oregon, community-wide energy management programs have demonstrated that it is possible to extract the majority of available energy saving in a fairly short period.

What if we could capture efficiency . . .

As discussed earlier, we have not developed the kind of databases required to fully explore the size of the DSM 'reserve'. Nor have we fully explored the extent to which we could tap that reserve. However, the following illustration is intended to give some indication of the value that could be created by doing so. The Minister has recently commented on problems created by a lack of capacity to serve the growing demands of downtown Toronto. If we assume that approximately 40% of the total office area in Ontario is located in Toronto, then based on OEE data, we can calculate that approximately 4,904 GWh are consumed annually for office lighting in Toronto. If 80% of this lighting is provided by fluorescent systems, and 70% of that lighting uses T12 lamps with electromagnetic ballasts, a retrofit program could shave close to 300 MW from the peak system demand. Conservatively assuming that every kW of lighting reduction results in a decrease in cooling loads of 0.2 kW, and grossing up the total by 9% to allow for distribution and transmission losses that are eliminated, results in a total reduction in system demand of 384MW. This is roughly equivalent to the capacity that would be produced by the first phase of the proposed Portlands project (330MW).

- ✓ Using comprehensive energy audits and inspections, combined with incentives equal to the installed or full avoided costs, Ontario Hydro captured the majority of available savings. ***Residential customers in Espanola implemented 82% of identified savings, while Commercial customers achieved 50% of recommended demand and energy savings.*** Unfortunately, Ontario Hydro's DSM programs ended before planned follow ups had been completed.

- ✓ In Hood River, Oregon, 85% of homes were audited and with a range of financial supports, ***81% of the more than 14,000 measures recommended were implemented.*** Measured savings were over 2,600 kWh and 1.76 kW per home.

- ✓ In Jasper, Alberta, 67% of homes and 86% of businesses were audited under an intensive program offered by Alberta Power. 61% of the businesses audited under the program proceeded with efficiency retrofits.

These examples illustrate that it is possible, at least on a pilot project scale, to economically achieve far higher rates of implementation than are typically shown by current "best practice" DSM initiatives. In reports commenting on the project, *Ontario Hydro staff indicated that their goal was to learn how this type of initiative could be transferred to other markets – including Toronto*. If this same intensive, focused program could be transferred to other markets the potential could be enormous (see sidebar).

The example in the sidebar is not presented as a proposal to solve Toronto's electricity supply problems. Rather it is an illustration of both the potential that DSM can offer and the value of developing better information on that potential. The reality is that today we don't know what percentage of office lights in downtown Toronto, or elsewhere in Ontario, are efficient. We don't know how many are equipped with local switches or occupancy sensors to allow occupants to turn lights off when unneeded. Nor do we know whether daily decisions to replace lights, maintain cooling systems, or buy new office equipment are choosing efficient options.

Conclusions

The OPA Supply Mix Report assumes that CDM, in all forms, could contribute between 1,800 and 4,300 MW to the supply/demand "gap". This is a quite conservative estimate of the range that might correspond to the IESO/Navigant forecast. The economic, achievable potential described above could be much greater. Planned and new initiatives such as Smart Metering and recent changes to allow Net Metering could further increase this potential.

The DSM potential for fuel substitution (800 MW), demand reductions (3,000MW), co-generation (16,500 MW), and efficiency improvements (4,300 MW) could clearly more than fill that gap if we implemented all of the economic and achievable opportunities identified. Table 1 shown above illustrates that attaining even a portion of the estimated economical and achievable potential over the next 14 years could delay the projected "gap" in Ontario's electricity supply/demand picture out beyond 2020 (when the gap is now projected to reach 10,200 MW).

In other words, if we are able to achieve even half of the DSM that has been judged to be the <u>*economic*</u> *and* <u>*achievable*</u> *over the next 14 years, there would be no supply/demand gap until beyond 2020 – and hence no need to rush to a commitment to large expensive generation facilities.*

Finally, as we have noted earlier, and as has been so important in the past when projected supply/demand "gaps" have not materialized, there are many other factors at work that could push the gap further into the future:, factors that have underestimated or omitted altogether in the *Supply Mix Advice.* These include:

- ongoing improvements in the electricity productivity of Ontario industry due to structural shifts and a move to higher value output in the electricity intensive industries,
- a slowing down of the growth of commercial and institutional floor area,
- aggressive peak reduction indicatives through a combination of technology and price signals,
- a deliberate encouragement of shifting off electricity for water (and space) heating,
- increased cogeneration,
- a moderated growth in the peak due to air conditioning saturation, and
- a deliberate and successful effort to implement a conservation culture that achieves higher than normal levels of economic electricity efficiency.

If and especially *when* a supply/demand gap develops in Ontario depend greatly on dynamics of the demand for electricity in Ontario that are less well understood now than they were fifteen years ago. There is an urgent need to assemble the databases and the analytical capacity needed to understand the dynamics of the demand for electricity. This is needed so that the demand-side resource, which has barely been tapped, can be exploited systematically and strategically, so that the risks of committing resources to long lead time power supply projects can be properly assessed, and to facilitate the timely and orderly development of our wind and other renewable electricity resources.