

# Electrical Energy Consumption: The Human Side of the Problem

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## **From the old path to the new**

All forms of unceasing growth in consumption are unsustainable in the long run. Fig.1, based upon Ontario's consumption of electrical energy shows two epochs that would be unsustainable if the increases were allowed to continue. Below the actual data in the graph, there are two lines representing 0.9 percent increases per annum to indicate likely population growth. Even these are unsustainable in the long term.

Fig.1 Logarithm of Ontario's electrical consumption in terawatt-hours from 1985 to 2003. The upper two straight lines indicate constant annual percentage increases extrapolated from the data. The point X, indicated as MacN-R, represents the level of consumption that the 1993 MacNeill-Runnalls Report showed could be achieved through economization in consumption. The MacN-R level has been extended as a straight line to indicate consumption rising at the rate of rise of population. The lower point, +, indicates 50 percent of the 1989 consumption, in keeping with typical consumption in the more industrially developed European nations, which is at or below 50 percent of per capita Ontario consumption. The line extrapolating that result to 2012 is also based upon a 0.9 percent annual population increase. The dashed and dotted lines are suggested scenarios for Ontario's future that should result from actions and recommendations of the present Parliamentary Committee.

In fig.1, the four percent per annum increase in consumption during the 1980s was bound to come to an end and, very fortunately for us, it changed very significantly. Nevertheless, the roughly 1.6 percent increase since 1993 is also unsustainable, on a longer timescale.

The principal theme of this brief is that about half of Ontario's current annual increase is due to human factors, and that the technology already exists to permit a steep downward trend toward the MacNeill-Runnalls line (fig.1). Furthermore, several factors in Ontario's energy future will allow us to drop below the MacNeill-Runnalls line and continue downward toward the 50 percent line (fig.1). In the more distant future, as solar energy becomes increasingly economic, and households and businesses will depend less and less on the grid, we may expect that consumption, as measured by what the grid supplies, will continue on downward. Thus a point should be reachable by 2012, which is below the MacNeill-Runnalls extrapolation to 2012, and this corresponds to an average consumption of under 13 GW (average), below the 1985 level. I believe we could go much further than this. The 50 percent extrapolation to 2012 in fig.1 corresponds to only 9.7 GW (average), which could be supplied entirely from renewable energy.

This brief takes as its first assumption that Ontarians don't want to have their standard of living reduced. Secondly, the drop from current levels to the MacNeill-Runnalls line cannot take place under *laissez-faire*.

Lastly, I posit that it is the prime job of this Parliamentary Committee to set in motion all those processes that will enable Ontarians to reduce their consumption painlessly from the present levels to the MacNeill Runnalls line and below. Since most, if not all the technologies exist to achieve this, the problem is largely a human one, not predominantly technical.

### **Recommendation 1**

The most important task of the present Parliamentary Committee is to set in place structures within the Ontario Government that will focus on the human side of electrical economy, so as to ensure a rapid reduction of the baseload over the next fifteen years.

### **How to begin implementing Recommendation 1**

With one main exception, no government in Canada in the past 51 years has dared or even wanted to interfere in the matter of human habits. Such interference would have been regarded as undemocratic at best and offensive at worst. The major exception has been the federal campaign to reduce smoking and the dangers of smoking to non-smokers. Most people agree that the anti-smoking campaign has been successful, even though there are still many smokers around.

Wastage of energy is a very different matter from endangering health through smoking, but both problems have some common factors that enable us to learn from the success of the anti-smoking campaign. Because electrical energy consumption of Ontario is so very high compared with that of any European country enjoying a standard of living comparable to ours, we should surely be attending to the matter of wastage before considering expanding supply. Benign interference is thus fully justifiable today. Moreover, it is highly necessary. An increase of Ontario's baseload should not be tolerated for even one more year.

### **Recommendation 2**

That the Ontario Government should take steps forthwith that will have the effect of holding Ontario's level of consumption at or below its present level, even if this should require several novel measures in combination.

### **Recommendation 3**

That the Government of Ontario should publicly announce its intention to bring in changes that will have the effect of reducing electrical consumption greatly over a period of time, and that it intends to have it remain indefinitely at a much lower level than at present, without sacrificing the standard of living in Ontario.

### **Interconnections**

Today all the world's major problems are interrelated. Electrical generation and consumption of electrical power are directly or indirectly related to population, climate change, the design of neighbourhoods where people dwell in small or large numbers, building design, plaza design, transportation in all its forms, and a host of other factors. In all of these, human habits and attitudes play a role. Nevertheless, the problems of electrical supply and demand have hitherto been treated as largely technological, so that the human-habit factor has tended to be overlooked or taken as a given, something that is unalterable — we cannot, must not, or dare not attempt to change it.

The habits of thought and action of the last fifty years in North America are, however, no longer appropriate to the coming age, and this will be the main focus of this brief.

The ramifications of power generation are so broad that I submit a further recommendation, based upon the interrelationship of energy and climate-change concerns within this Province. Since electrical generation is a major factor in energy matters, the recommendation is appropriate here.

### **Recommendation 4**

That the Government of Ontario set up a Supervisory Committee (or a Superministry) — if such does not already exist — to oversee the related questions pertaining to energy consumption, electrical generation, town planning, building, transportation, forestry and reforestation, and, above all, the human factors pertaining to change as we advance through the 21st century.

### **First steps to reducing consumption**

Changing human bad habits is one of the most difficult of tasks and requires persuasion, education, information and, ultimately, the proffering of benefits — taking this route will require a great deal of forethought, to be followed by a certain amount of effort, but it will be worthwhile. Success will have been achieved when there has developed a consciousness on the part of most citizens that they are part of the problem and also part of the solution, that individual behaviour does matter because of collectivity. Even though society can tolerate one highly wasteful individual, it cannot tolerate the concept that each person thinks himself/herself that privileged one! What is needed therefore is a series of measures that are not offensive but will have the effect of inducing change of attitudes in a population that was brought up to a way of life in which wastefulness was the norm and was not thought about. It hasn't even been recognized as wastage by most people.

To achieve the new consciousness and decide on specific measures to reduce wastage, full participation of Ontario's population is desirable in a democratic exercise.

### **Recommendation 5**

That the Ontario Government set up a round table to consider measures that would have the effect of reducing Ontario's electrical consumption.

Matter for the agenda of the round table is discussed in the section "Some suggestions for the round table" and immediately below under "Pricing electricity." Pricing, is so important that it deserves separate attention here. It happens that the Minister of Energy, the Hon. Dwight Duncan, has already let it be known that his pricing policy is likely to be compatible with what is being put forward here. But it may nevertheless be necessary for Ontario to go further in its pricing policies than is currently planned.

### **Pricing Electricity**

Pricing policy needs to fulfil all the following criteria:

- Discouragement of wastage;

- No electrical power subsidy, direct or indirect;

- Servicing of stranded debt to be incorporated into the price of generation.

While discussion of these points fits within the agenda of the recommended round table, some action is probably appropriate before any round-table conclusions would be forthcoming. Indeed, Mr Duncan's recent statements (The Toronto Star, Thursday 19 August 2004) suggest that his intentions are to price electricity much as is independently suggested here.

The continuation of any subsidy violates NAFTA, and can cause resentment of Ontario taxpayers when electrical power is exported. Ontario taxpayers do not want to subsidize exported electrical power. The above pricing agenda will be necessary to attract green energy into the grid, and does not exclude possible policies for inducement to economize. Lastly, an electrical generation price high enough to induce users to economize need not be punitive, as financial rewards could be offered simultaneously to those who economize. A high enough unit energy price for electrical power allows the creation of powerful incentives to economize. Consider, for example, a scheme in which the first 25 percent of the previous year's electrical consumption is offered to consumers free. This allows consumers in principle to reduce their actual electrical power costs to arbitrarily low levels, a huge incentive to economize. Once consumption is reduced sufficiently, the higher price per kWhr ceases to be crucial. By then, also, a reduction in the Province's electrical load will have been achieved.

## **Replacing electrical generation from coal**

Doubtless many of the presentations to this Committee have been centred on this one question. Some of the presentations will have stated the necessity to construct new nuclear reactors. Others will have emphasized natural gas cogeneration. Others small hydro. Others will have pointed to the huge strides made in Europe and in California with wind power. Yes, we should look much more closely at what is going on in Europe. Europeans have a standard of living similar to ours, and have been wiser about energy usage than we have.

On all of these subjects I have three warnings for the Committee.

The first is on nuclear power. There are ten objections to nuclear power that either have never been answered at all, or have not been adequately answered by its proponents (Annex). Nevertheless, the Atomic Energy of Canada Ltd (AECL) continues to receive federal subsidy, usually to the tune of \$100 million or more annually, and Natural Resources Canada (NRCan) favours nuclear power as "the only way to supply the baseload" (private communication). The influence of NRCan can be seen in the support that nuclear energy received from Mr Chretien when he was Prime Minister and from the recent report for Ontario made by Mr John Manley. The present Committee needs to look at the underlying assumptions of NRCan's position, among which *laissez-faire*, as defined in this Brief, plays a role. However, we have seen here that *laissez-faire* is no longer an option for Ontario's electrical power future. A question you may well ask is, "why is there an AECL and no more general energy agency, say, an Energy Canada agency?" Many years ago, Canada had its own wind development program of vertical axis turbines at the National Research Council. These had a technical fault that is easily remedied with present knowledge but, whether or not the fault and remedy were identified, the development that would have made the technology useful was not pursued. The small wind farm using these turbines on the Magdalen Islands was sold to private enterprise, but, when I last enquired a few years ago, the turbines were not being used. Today wind power is within the purview of NRCan, which allocates almost none of its great budget to wind, the world's fastest growing form of energy conversion. With an energy agency in this country, the additional research and development would have been done, but when the project came under a Ministry that was predisposed to favour nuclear energy, it is not surprising it died. One of the options that this present Committee might like to consider is an energy agency for Ontario.

It is possible to make almost anything work if you throw enough money at it, but that will not necessarily make it economic. Wind power was already economic at the time I and colleagues wrote our 20 August 1998 brief entitled "An Energy Strategy for Ontario", a submission to the Ontario Government's public hearings on Bill 35.

My last comment on nuclear power is that, contrary to popular belief, it does give rise indirectly to considerable greenhouse gas emissions. This is because the capital intensive construction and manufacture of the reactors themselves involve greenhouse gas emissions, and so also does the fuel preparation. The numbers have been worked out for light-water reactors by Professor Phil Smith of the Netherlands, but he tells me this work has not been repeated for CANDU.

My second warning to the Committee is that one should be suspicious of any hydroelectric project that would flood appreciable land areas. Much has been written about dams in recent times. Nearly all the large dams built in my lifetime have had highly negative side effects, the main one being flooding of large areas of valuable land above the dams. In addition there have been other side effects, such as the erosion of the Nile Delta by the Mediterranean Sea following the completion of the Aswan dam. Now, the mud of the delta is not any longer replaced by the annual floods that used to replenish the soil of the Nile valley. Many of the world's older dams, now silted

up or cracking, are due for dismantling. It remains to be seen what will be done when these reservoirs are emptied. One general comment is appropriate, however, that roughly the same energy can be extracted from a river using underwater turbines as can be had by building high dams. This entire subject needs careful study by energy specialists, especially in Ontario, since underwater turbines are to be preferred environmentally. Thus the construction of large dams in Quebec and in Manitoba may be serious retrograde steps. These large electrical energy projects would have been much less environmentally damaging if the underwater turbine technology had been exploited instead.

My last warning is about myths, which have their value and proper place, but can obstruct progress, especially at a time of change like this. I believe that NRCan's view of nuclear energy is mythical, but at the same time it can become reality if one accepts it for a long enough time. That is to say, NRCan establishes that something is necessary (this is the myth-building step), and then uses that to justify the next technological step. That next step results in a new or improved technology, which is the main one presented to the next generation of purchasers, so that they have little option but to buy it. I believe that NRCan's misplaced faith in nuclear as the only major energy option is based upon another myth, that of the unavoidably rising electrical consumption together with a rising baseload. These elements are based upon the idea that nothing will change in the way people use energy supplies, which is an assumption of continuing *laissez faire*. The myth that nuclear energy is absolutely the only way to go follows (though not very perfectly) from these underlying assumptions that are also mythical. I would suggest, by contrast, that **the baseload is in principle flexible and that we can make it very much smaller than it is, and that people are capable of learning to use power when it is most plentiful**. Very basic questions of this sort are why we need a round table. About the round table we need people of imagination and depth. The 21<sup>st</sup> century is not going to resemble the 20<sup>th</sup>.

### **Some suggestions for the round table**

The purpose of the round table will be to educate people and persuade them to economize in their use of electricity. An additional purpose of the round table will be to introduce the concept of flexible usage of electricity, that is, using electrical power predominantly when it is most freely available.

### **Incentives and disincentives**

When it comes to persuasion, this need not be only through the written and spoken word, but will need to be supplemented by incentives to economize and disincentives to continuing wasteful practices. Generally it is likely that a combination of incentives and disincentives (carrots and sticks) will be more effective than either carrots or sticks alone. A recent example comes from motor vehicle purchase, which also involves energy economy. A tax advantage is offered by the federal government to purchasers of hybrid vehicles, which are the most fuel-economic and by far the lowest-polluting choices today. However, little tax disadvantage is offered for the converse, namely, choosing one of the standard vehicles. The tax advantage, as at present, is an insufficient incentive to purchase the more expensive vehicle, on which the payback time, from fuel economy at current prices, is roughly 5-10 years.

### **Appliances, smart plugs and other devices for economizing**

An obvious purpose of the round table will be to devise strategies for accelerating the replacement of electrical appliances by the most efficient currently available. In this general field, there is much room for incentives and disincentives. Attention needs also to be given to increasing the use of smart plugs and other devices that will enable economies to be made and appliances to be shut off temporarily when the grid is overloaded. Some of these questions are technical, and may have to be left to experts, but consultations with members of the public at the round table can assist in garnering public support for desirable and necessary changes.

### **Air conditioning, heating and illumination**

These are areas where there is tremendous wastage at present. Unfortunately, the ramifications of these factors extend into the building trades and neighbourhood planning, so that, again, some expert knowledge must be injected into these discussions.

Today, air conditioning is used extravagantly in Ontario, often with undesirable effects. The air conditioners, depending on the type of air conditioning, tend to be set at too high power, and to be used when not needed. For buildings where the entire air circulating system is sealed from direct contact with the exterior atmosphere, there is huge wastage arising from conditioning spaces that are not actually in use. Families and businesses alike need to learn how to get the most out of their air-conditioning systems using the least power. These will be matters of education combined with incentive/disincentive measures and technical changes in design. For older buildings in Ontario, where the windows can be opened, as in most houses, even many modern structures, the habits of controlling air temperatures without air conditioning seem to have been largely forgotten, though these were well known fifty years ago. Quite modest amounts of electrically powered air conditioning are sufficient for most Ontario buildings, even in rather hot summer weather. Building trade practices play a major role in determining much of today's wastage through air conditioners. Such practices need strong financial disincentives. See Recommendation 1 for the need for a Committee or Superministry to connect matters such as energy and buildings.

Illumination has been another major source of wastage in Ontario. Years ago, the lighting standards for public buildings were set by the trade itself, a self-serving arrangement if ever there was one. A separate organization is required to determine lighting standards, with sound new research to back it up. Lighting should serve the needs of users, not merely suppliers of lamps. Illumination today is oversupplied where it is barely needed, and often too feeble where good

illumination is required for reading. These factors are very obvious in homes, offices and other public buildings such as hotels. Basic research is also required in matters such as fluorescent lighting, where false claims are made for fluorescent lighting in certain cases on the basis of the amount of light given out per watt of electrical power supplied. The output of lumens per watt is not the only relevant factor. Of equal or even greater importance is where the light is directed. The power used in street lighting could easily be halved in Ontario without rendering the streets any dimmer. Much power from street lighting goes at a slight upward angle to the sky, and is useless for the purposes it was installed and, instead, contributes to light pollution. In addition, street lighting could be further reduced between certain hours. Floodlighting is yet another source of wastage, and causes further light pollution. While floodlighting lends an attractive appearance to some structures at night, the hours for which such lighting is kept on need to be restricted, preferably by free will rather than by fiat. Pricing structures for electrical power could prove an incentive here as in other areas of concern.

### **Solar substitutes for electrical heating**

The use of electrical power should furthermore be discouraged in all cases where a more effective source of power is available. A prime example is hot-water heating. It is fully practical at this time to instal solar hot-water heating in all new houses except perhaps for a few buildings whose relation to the Sun's rays would make this impracticable. Nevertheless, a survey two years ago of a new neighbourhood in Richmond Hill, where the builder offered solar hot-water heating as an option, revealed that zero out of 96 new home owners had chosen to instal solar heating for their hot water. Strong carrot-and-stick measures are needed to reduce the electrical and/or natural gas consumption in this province for hot-water heating. Even stronger carrot-and-stick methods should apply to heating outdoor swimming pools. Such heating can be done entirely by solar installations, and should become mandatory before long. The sort of measures the round table could recommend would be that solar hot-water heating should henceforth be the norm, instead of the exception, with new buildings, public or private. Such matters impinge upon the building trade, which is the purview of another Ministry and is again why Recommendation 1 was put into this Brief.

Users in the new, 21<sup>st</sup> century, re-educated Ontario will need and want to know when it is or is not OK to switch on another device, or when it is urgent that they switch one or more off. During my time in this Province, the heavy loads on the electrical system have been accompanied by lower than standard voltages for the consumer. One can tell qualitatively whether the grid system is under great load simply by how the fluorescent lights come on after they are switched on, or whether the toaster takes much longer than usual to burn the breakfast. These symptoms are, however, somewhat too qualitative. The 21<sup>st</sup> century needs something more quantitative, coupled to the automatic message, "if it has reached this point, turn something off, please." When the 117-volt power reaches down to 90 volts, the message might very well be, "Please turn off as much as you possibly can." Such measures are reasonable when 10 million people are using the same system. We need a method of communication, much more precise and visible than we have. One suggestion has been a plainly visible device that tells homeowners and business managers the electrical status quo. In addition, the Ministry needs a system of special messages whereby it can ask for cooperation from the public. In Britain, after the 1973 oil crisis, the government appealed to consumers to economize. Britain's electrical consumption was about half, per capita, of Canada's at that time. The public nevertheless economized 21 percent in its electrical consumption as a result of the appeal. It is possible, therefore, for a large number of democratic people to respond positively in such situations. This is one part of the basis for the Recommendation 4, above.



### **Electrically independent households and businesses**

Already prior to 1998 the "Healthy House" at 150 Spark Hall Avenue, Toronto, was fully independent of the grid, as were other houses elsewhere in Ontario. My own house, constructed in Northumberland County in 1988 is, regrettably, dependent on OPG and Hydro One, whereas a \$23,000 photovoltaic facility, off-grid, had it been installed at the outset, would have paid for itself by next year. The round table will need to consider in detail the merits of having increasing numbers of houses off-grid, or generating solar electricity from the Sun and feeding their surplus electrical energy into the grid, as does the house next-door to #150 on Spark Hall Avenue. A new set of policies should be developed here, possibly in combination with research into large-scale solar film development.

### **Media**

The round table will need to consider the use of the media in Ontario's public education efforts, and the possible introduction of general courses on energy in schools. The federal government's anti-smoking campaign could be instructive here.

### **Research**

While it is very much the business of the Ministry of Energy to consider the necessity of funding research projects on energy, this is yet another area where the round table might come up with useful ideas.

### **Social Experimentation**

It was mentioned above that the people of Britain responded very positively to a request to economize in their use of energy, including electrical energy, following the oil crisis. In Ontario, there has never been a social experiment of that kind. What would be the result, we might ask, if the Province declared a week of economy, in which everyone was asked to economize as much as they reasonably could in electrical consumption? The result of such an experiment might indicate what was possible without any changes in technology, and without the application of incentives to economize and/or disincentives to waste. Such experimentation is postulated here as a possible way of finding out very roughly what is feasible. It would also raise public consciousness regarding conservation issues, and this might be the most important result.

In conclusion, the ideas presented here are clearly only a partial list of what should be considered, but these matters are at the core of a livable and sustainable energy future for Ontario. The future envisaged here is also one in which the likelihood of blackouts will be minimal and brown-outs can be forestalled.

## **Annex**

### **The standard objections to nuclear energy**

The possibility of a devastating accident, such as occurred at Chernobyl.

The injustice arising from existing limited liability legislation that would deprive victims of adequate compensation in the event of a severe nuclear reactor accident.

The possible release of intense radioactivities following an act of war on a nuclear station.

The production of plutonium.

The inevitable escape of some radioactive isotopes into the environment.

The impossibility of adequately protecting all nuclear power plant employees from the effects of radiation at all times.

The poor, unpromising economic performance.

The unjust imposition upon a future generation of the need to dispose of or guard spent fuel, such generation not having benefited from the electrical power that had been produced by the fuel.

The similar injustice of deferred costs of nuclear reactor decommissioning, when this must occur.

The potential for diversion of nuclear fissile materials for illicit purposes, even for making bombs.