Conservation
and
Alternative Electrical Energy Sources
(Version 4)

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Abstract

Electrical energy conservation provides more opportunity than any other energy source in terms of: investment; operating cost; impact on the environment, our health, and climate change; renewability; sustainability; local employment; and benefit to future generations. The risk is that we may not be able to achieve all of the available potential. Alternative energy sources are not capable of providing the required quantity of electricity and benefits. It will be necessary to hedge the conservation projections with traditional generation technologies to bridge to future electricity energy production sources with the necessary capabilities.

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Conservation and Alternative Electrical Energy Sources

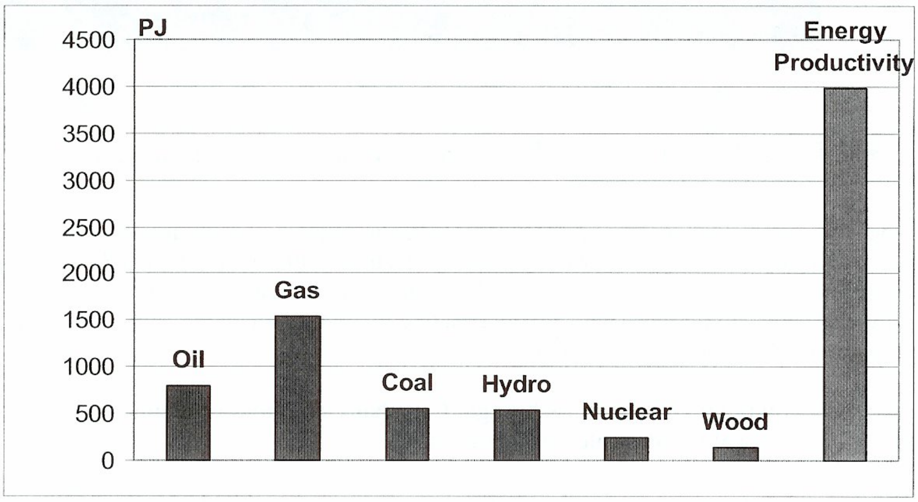
Introduction

Of all the electrical energy sources to meet demand, conservation (see definition below) is by far the most effective in terms of: investment; operating cost; impact on the environment, our health, and climate change; renewability; sustainability; local employment; and benefit to future generations. No other approach to the problem offers the benefits to the same overwhelming degree. Why then is it not really foremost in our efforts, both at the individual and organizational (government and commercial) levels?

At the individual level, is it because there is so much need for involvement from all of us? Do we think that conservation involves deprivation and extensive effort? Do we believe that there is not sufficient individual benefit to warrant this personal involvement? Is it too easy to let government and commercial organizations solve the problems for us? Do these considerations inhibit effective action at the government and commercial levels?

To gain an indication of the potential for conservation, a look at the total energy productivity of the Canadian economy is instructive. A report prepared by Torrie Smith Associates for the David Suzuki Foundation shows that from 1970 to 1998 increases in energy productivity have avoided 200-300 megatons of greenhouse gas emissions, representing 30-40% of 2002 levels.[1] Figure 1 shows the contribution by various energy sources to new energy demands over this period.

Figure 1 – New Primary Energy in Canada, 1998 versus 1970
(PJ = petajoules)



Source: David Suzuki Foundation

Here is a quote from the report in connection with this achievement.

> *Not only has growth [in energy productivity] outstripped all the supply side resources combined, but it now makes a larger contribution than any other single supply source, including oil, and is* ***sixteen times*** *bigger than Canada's entire nuclear program, which got started about the same time. With almost no government assistance, in the absence of well organized institutional and financial infrastructure for its delivery, and against heavily subsidized and highly organized competition from oil, gas and nuclear power, the demand side has still managed to outperform the supply side of the energy economy since 1970.*
>
> *The question arises: How much more could we get from this resource if we* ***tried****?*

This is the reason why organizations like the David Suzuki Foundation, Torrie Smith Associates and the Pembina Institute[2] place so much emphasis on conservation in addressing our electrical energy needs. They believe that conservation can eliminate Ontario's reliance on coal and nuclear generation plants. Note that conservation addresses the demand side as opposed to the conventional response, which is to consider that the best solutions must come from the supply side of the equation.

Conservation is indeed a source of electrical energy just like any generation plant. This is because with projected demand in terms of present levels and growth, our response has to be to either: build more generation plants and grid delivery capability; or reduce demand through conservation. Every watt-hour of energy saved means less generation capacity and grid infrastructure to supply the demand.

This document also considers what role alternative energy sources can play in Ontario's electricity future.

Definitions

To avoid confusion it is important to establish the meaning of a number of terms. All are within the context of electrical energy.

Energy Conservation

For simplicity and ease of reference, conservation in the context of this document means all measures that reduce demand on our electricity system. As such it embraces energy efficiency measures as described next. As well, it overlaps the area of small scale, distributed wind and solar generation facilities.

Energy Efficiency

Energy efficiency can be viewed somewhat differently from conservation. It can be defined as activities to make commercial/industrial: processes and products less dependent upon electrical energy content; and products that inherently reduce end user electricity consumption, such as building materials. Conservation is sometimes limited to the reduction in electricity use by other means such as reduction in electricity demand by actions by end users, for example by turning off lights. For the purposes of this document both are considered to be within the definition of energy conservation.

Alternative Energy

Alternative electrical energy sources are generally those that do not use fossil fuels. Generally, it indicates energies that are non-traditional and have low environmental impact.[3] Because nuclear fission technology is a traditional electricity generation source, and has high environmental impact due to nuclear waste disposal, it will not be treated as an alternative energy source in this analysis. Arguably nuclear fusion plants can be considered as an alternative energy source. They remain a distant future source of electricity, are hardly traditional because of the major technological advances required and have substantially lower environmental impact compared to fission generators. Because fusion reactors are not an available generation means for the foreseeable future, they are not considered further in this analysis. Conservation could be considered an alternative source, because it does not depend on fossil fuels and has a low environmental impact. However it is hardly non-traditional. On balance, it is excluded because a strong sense of alternative energy is that it is from new sources.

Renewable Energy

Renewable energy sources effectively use natural resources such as sunlight, wind, rain, tides and geothermal heat, which are naturally replenished. Renewable energy technologies include solar power, wind power, hydroelectricity/micro hydro, and biomass.[4] Biomass refers to living and recently dead biological material that can be used as fuel. It excludes organic material which has been transformed by geological processes into substances such as coal or petroleum.[5] Although conservation is not typically thought of in this sense, it certainly meets the spirit of the renewable concept and is considered as such in this document. Industrial wind power using fossil fuelled plants as backup cannot be considered as renewable.[6] However, industrial wind power using hydro as backup is considered renewable on the basis of hydro being renewable. As defined below small scale wind is a renewable energy source.

New Renewable Energy

New renewable sources are those that exclude hydro.

Sustainable Energy

Sustainable sources are those which are not expected to be depleted in a timeframe relevant to the human race, and which therefore contribute to the sustainability of all species. Sustainable energy sources are most often regarded as including all renewable sources, such as solar power, wind power, wave power, geothermal power, tidal power and others. Nuclear power (fusion) meets this definition of sustainability.[7] It is taken that nuclear fission does not due to potential limitations of available fuel sources.

Small Scale Wind

Small scale wind facilities are those that serve a single household, a small community or single or small group of non-residential buildings or facilities. The latter could include hospitals, schools, emergency services, and businesses and government establishments. The wind power installation should be complemented with solar generation and electricity storage capability, which is feasible at this level. The user of this arrangement could be independent of the electricity grid but would most likely be grid connected to assure reliability of supply at all times. This arrangement avoids the many drawbacks of the random, highly fluctuating nature of industrial wind, where electricity storage at the scale required is not feasible for the foreseeable future. Small scale wind can be therefore classified as renewable, sustainable, having low environmental impact and providing climate change benefits. The major disadvantage is the relatively low amount of benefit and electricity supplied compared to other measures.

Small Scale Solar

For the foreseeable future this is seen as providing the same capabilities as that for small scale wind.

Comparison of Energy Sources

Comparison Using Major Criteria Excluding Costs

For proper evaluation, it is important to put currently available alternative energy sources into perspective with respect to traditional means and conservation. Table 1 provides a summary of the comparison of selected energy sources using the following important criteria:

- *Electrical Generation Capability* – This is the ability of the energy source to produce meaningful amounts of electricity, regardless of the amount of generation capacity implemented. No new renewables meet this test as shown later in Table 2.
- *Low Environmental Impact* – This is intended to take into account environmental impacts separate from climate change considerations, such as disposal of nuclear waste for nuclear fission plants, and the results of building large dams for hydro (effects on flooding and fish spawning).
- *Climate Change Benefits* – This focuses on greenhouse gas emissions considerations.
- *Alternative Source* – This is as defined above.
- *Sustainability* – This is as defined above.
- *Renewability* – This is as defined above.

Table 1 – Comparison of Selected Energy Sources

Fuel Source	Electricity Generation Capability	Low Environ-mental Impact	Climate Change Benefits	Alternative Source	Sustainable Source	Re-newable Source	New Re-newable Source
Coal,Gas, Oil	High	No	No	No	No	No	No
Hydro	High	No	Yes	No	Yes	Yes	No
Nuclear (fission)	High	No	Yes	No	No	No	No
Industrial Scale Wind With Fossil Fuel Backup	Low	No	No	No	No	No	No
Industrial Scale Wind with Hydro Backup	Low	No	No	No	Yes	Yes	No
Small Scale Wind	Low	Yes	Yes	Yes	Yes	Yes	Yes
Small Scale Solar	Low	Yes	Yes	Yes	Yes	Yes	Yes
Biomass	Low	No	No	Yes	No	Yes	Yes
Conserva-tion	High	Yes	Yes	No	Yes	Yes	No

For the purposes of electricity generation, Table 1 says:

- The only effective non-traditional sources are small scale wind and solar, and biomass. Industrial wind power is not because of the almost 100% traditional generation backup required.[8]
- The only sources with low environmental impact are small scale wind and solar, and conservation.
- Generation means that have high climate change benefits are hydro, nuclear, small scale wind and solar, and conservation.
- The only effective alternative energy sources are small scale wind and solar, and biomass.

- Sustainable sources include only hydro, nuclear, industrial scale wind with hydro backup, small scale wind and solar, and conservation. Biomass does not qualify because of extensive use of wood for fuel and cropland impact for biofuels.[9]
- Effective renewables include only hydro, industrial scale wind with hydro backup, small scale wind and solar, biomass and conservation. A credible source in the UK has called for industrial wind power to be re-classified as non-renewable.[10]

Biomass is the most difficult to categorize because of the wide variety of technologies that have been developed to utilize this resource, each with their own impacts. Environmental impact considerations include the use of land mass to grow energy crops. Climate change considerations include emissions from the combustion of biomass and biomass-derived fuels. Further study is required to properly assess the electricity generation column using waste materials.

Industrial scale wind has some merit only under conditions of hydro backup (or shadowing) by which it gains sustainability and renewable status from the hydro backup. Environmental impact includes the effect on wildlife, the natural environment of rural and protected areas, and the effects on surrounding human habitation.

In explanation of Electricity Generation Capability and Climate Change benefits columns, Table 2 illustrates the amounts involved for plants with the same equivalent capacity of the Wolfe Island wind plant, that is, 198 MW. Note that the wind scenario requires 376 MW of installed capacity to produce the same amount of electricity as 198 MW of all the other options.

Table 2 – Electricity Production and Emissions Saved by Various Generation Means (Using the Wolfe Island Wind Plant as a Basis)

Generation Means	Installed Capacity MW	Electricity Produced MWh/year[11]	Wind %[12]	Emissions tons/year[13]	Increase in Emissions over Gas Turbine Alone[14]	Wind % Contribution to Emissions Reductions
Coal Plant	198	1,470,000		1,470,000		
Gas Turbine replacing Coal Plant	198	1,470,000		589,000		
Wind Plant replacing Coal with Gas Turbine Backup	198 (Wind) 178 (GT)[15] 376 (Total)	347,000 (Wind) 1,127,000 (GT)	23.5%	619,000	30,000	(3.4%) of Gas Turbine (2.0%) of Nuclear, Hydro or Conservation
Hydro, Nuclear Plant	198	1,470,000		0		
Equivalent Conservation	198	1,470,000 (saved)		0		

In the above calculations it has been assumed that: wind backup would be a combination of CCGT (Combined Cycle Gas Turbine, which is more efficient than OCGT) and OCGT (Open Cycle Gas Turbine); and in the case of just gas turbine alone replacing coal, CCGT is used.

The other columns in Table 2 show the negative contribution to emissions savings that the wind power presence makes. Most analyses of the emissions savings due to wind ignore the effect of the backup/shadowing generation capacity and attribute all the savings to wind. In fact it is the backup/shadowing capacity that is producing the benefits. This table is important in understanding the next section, Ranking of Selected Energy Sources. Not factored into these calculations is the consideration that a 10% reduction in gas turbine efficiency results in 20-30% increase in emissions, depending on the gas turbine type.[16]

Ranking of Selected Energy Sources

Table 3 shows the ranking of energy sources for the most benefit considering low environmental impact, climate change benefits, sustainability, and renewability with each being given equal weight and valued as 1 or 0. The relative size of beneficial impact/amount of electricity produced is the last category and has a value of 2 or 0. A value of 2 is given for those sources with significant positive impacts and 0 for relatively small impacts.

If this scoring seems extreme it is because the benefit impacts and electricity production capability differences are in the order of many times (in some cases 10 times) the amounts, as shown in the previous section. The nature, importance and size of the issues involved (environmental impact, climate change, sustainability and renewability) are that very large impacts are required to make a difference. The "every little bit helps" argument does not apply.

In general, the ratings used in Table 3 could be refined somewhat to provide more precise results. It is unlikely that this would substantially change the ratings and rankings as a result. It seems reasonable to say that environmental impact, climate change benefits, sustainability, renewability should all be weighted approximately equally. It is also reasonable to assume the size of beneficial impact/electricity produced should be weighted more heavily. Otherwise small scale wind and solar would have a higher overall score than hydro, which does not seem reasonable.

Table 3 – Ranking of Energy Sources to Deliver Beneficial Impacts

Rank	Fuel Source	Low Environ-mental Impact	Climate Change Benefits	Sustainable	Renewable	Size of Beneficial Impact/ Electricity Produced	Score (out of 6)
1	Conservation	1	1	1	1	2	6
2	Hydro		1	1	1	2	5
3	Small Scale Wind	1	1	1	1		4
3	Small Scale Solar	1	1	1	1		4
4	Nuclear Fission		1			2	3
5	Industrial Scale Wind with Hydro Backup			1	1		2
5	Coal, Gas, Oil					2	2
6	Biomass				1		1
7	Industrial Scale Wind With Fossil Fuel Backup						0

Costs have not been factored into the above table for a number or reasons. One is that all the traditional generation means easily beat alterative energy sources on costs. The other is the need to put a cost value on the various categories of measurement used. It is unlikely that an exercise in costing these would change the ratings and rankings.

Table 3 can be summarized as follows:

- The clear winner is conservation
- Hydro is a close second but the opportunity in Ontario for significant additional hydro resources are limited. It is probably 1,500 MW.[17] In any event in Ontario it beats out small scale wind and solar on the basis of the size of the electricity produced. As discussed above, even assigning an intermediate value of 1 in the "Size" column to small scale wind and solar would make these equal to new hydro. This would require installing wind and solar capability on hundreds of thousands homes in Ontario. However, this is not out of the question, but would take a large provincial government program, including significant incentives.
- Small scale wind and solar outrank nuclear fission plants for the reasons shown. Nuclear fission plants remain the strong next choice because of its very large electricity generation capability. Today 40% of the electricity energy in Ontario is produced by nuclear plants.[18] Without these plants Ontario would be burning coal.
- Industrial scale wind with hydro backup, biomass and the fossil fuels (coal, oil and gas) rank equally in fifth place, even though the fossil fuel generation capability is quite large by comparison. Hydro backup for industrial scale wind power in Ontario may not be feasible because of the limits to our hydro resources and hydro's base generation role, which may not allow it to be diverted to wind backup. The plans for Ontario are for large increases in gas turbine generation, which is a strong indication of the likelihood of this being the wind backup of choice.
- Fossil fuel generation beats out industrial scale wind with fossil fuel backup, because of the need for almost 100% backup requirements for wind, which would be fossil fuel based. Clean coal plants could deliver the same benefits of wind backup using clean coal technology. Similarly gas turbine can reduce emissions over coal by about 50% and deliver the same benefits when used as wind backup. In short there are no emissions reductions benefits by the introduction of wind into the generation portfolio. Specifically the Royal Society and Royal Academy of Engineering have expressed concerns over setting targets for renewable energy sources as

percentages of total generation capacities, and states that a target set in terms of maximum mass of CO_2 emitted from electricity generation would be more appropriate.[19,20]
- Alternative energy sources are not capable of significant impacts and should not be looked to for commercialization for the foreseeable future. Continued research and development support would be a better use of funding in these areas. Solutions might lie in these areas in the future, and solar energy looks to be the best bet.

The main problem with conservation is that despite its very high potential it requires significant effort on the part of governments to organize the proper policies to gain maximum leverage, and on the part of everyone to take action and to change their way of doing things. As a result an electrical energy policy that depended on such gains to be made is risky. That is not to say that it should not be viewed as the number one strategy, but that it should not be depended upon without sufficient allowance of other approaches to meet any shortfalls in conservation results.

One of the conclusions that results from the analysis shown in Table 2, is that it is inescapable that nuclear energy has a significant role to play to offset the risks that significant conservation targets are not met. This is an “inconvenient truth” of another sort that will not be welcomed by some. In this connection there are some additional considerations that should be borne in mind in connection with the current situation:

- The only real alternative to nuclear power, in terms of the ability to produce the massive amounts of electricity required world-wide, for the foreseeable future is fossil fuel generation plants, and these will be mostly coal. Gas turbines are making some inroads into this equation.
- We need to bridge to the next generation of electricity production (and energy production in general), whether it be a hydrogen based system (especially a decentralized, distributed system), nuclear fusion (centralized generation facility), extensive solar (both centralized and decentralized), or probably some combination, or other means. The time frame to make this advance is probably measured in terms of human generations, say 50 years.[21]

In summary, we will have to make the choice between the two alternatives of nuclear fission and fossil fuel plants along with our best efforts on conservation to reduce emissions to the minimum possible. The greater the success in the area of conservation will mean the greater the reductions in emissions. The most likely outcome will be some combination of all three.

This is unavoidable and we would be well served to get on with this electricity supply and demand program as best we can and devote otherwise wasted resources to other important matters facing mankind. Examples of these are: better care of the planet’s surface; overhauling of our food and transportation systems; improvement of human rights, health and education; reducing poverty; and settlement of international disputes. In the Western democracies, we should also focus on making improvements in our social, justice, government and political systems, which are falling into disrepair and should be made into an example to the rest of the world.

This leads to a consideration of the broader aspects of sustainability, which are addressed in Appendix A.

Electricity Conservation Potential for Canada

The report prepared by Torrie Smith Associates for the David Suzuki Foundation projects the demand for electricity in Canada can be reduced as shown in Table 4.[22] This reduction has to come from conservation measures.

Table 4 – Projected Reduction in Electricity Demand and Emissions for Canada Through Conservation

	2004	2012	2030
Total Demand for Grid Electricity – PJ (petajoules)	1,915 PJ	1,526 PJ	1,242 PJ
Total Demand for Grid Electricity – TWh (terawatt-hours)[23]	532 TWh	424 TWh	345 TWh
Percent Reduction in Electricity Demand	0%	20%	35%
Total Emissions	114 megatons	43 megatons	16 megatons
Percent Reduction in Emissions	0%	62%	86%

Source: David Suzuki Foundation

Does all this look too good to be true? It may well be. The 2030 generation portfolio contains no nuclear and coal generation. The reduction in electricity demand looks remarkable, and the reduction in emissions, incredible. In support, a report by the Pembina Institute projects electricity savings of 23% compared to current levels by 2020 for Ontario.[24] Table 5 shows the generation source by fuel type for Canada in 2030 to meet demand.

Table 5 – Fuel Source to Meet Electricity Demand for Canada in 2030

	Fuel Source	Percent
Hydro	1,335 PJ	84%
Gas	132 PJ	8%
Wind	65 PJ	4%
Other New Renewables	62 PJ	4%
Total	1,594 PJ	100%
Reserve	352 PJ	22%
Demand	1,242 PJ	

Source: David Suzuki Foundation

The Capacity Factor used for wind power is 29%, based on 7,000 MW of installed wind capacity.[25] This represents an overoptimistic production based on experience in Europe where Capacity Factors in mature implementations are 19-22%.[26] In spite of this, the contribution from wind to the total electricity energy supply is only 4%. The associated investment is CDN$14 billion.

The contribution to reduction in emissions by wind is small based on this consideration alone, which ignores the impact of the almost 100% backup required for wind power at the wind penetration levels of 10% represented by the energy production in Table 4.[27,28] If the backup is gas turbine then the emissions from this offset the reductions at point of generation from wind. If the backup is hydro then there is no emissions reduction because hydro does not produce emissions. At the very least, the projected emissions reductions are over-stated by this consideration.

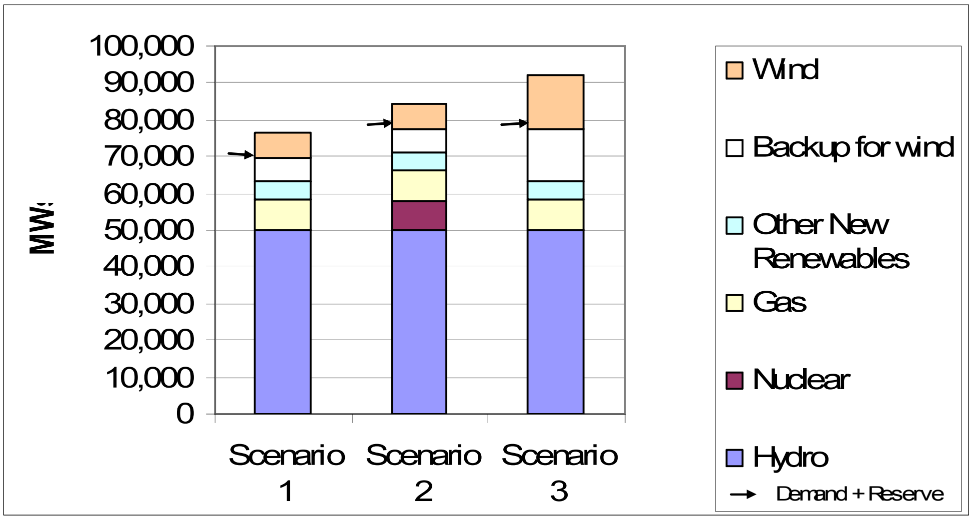
For Ontario 27% of the electricity will have to be imported from other provinces, probably from hydro plants in Quebec and Manitoba. Assuming all these imports are hydro, Ontario will be dependent upon other provinces for 60% of its hydro generated electricity.[29]

All considered, this is a very good and detailed report on the potential provided by conservation. It should likely be considered a maximum amount available in the time frame shown. In the event that these projected conservation levels are not achieved as scheduled, or if the imports from other provinces are not possible, there must be some generation capacity that is capable of providing significant amounts of electrical energy, without attendant emissions, to fill the gap.

Assuming that only one-half of the reductions are achieved this means that an additional generation capacity of 8,000 MW must be available.[30] Nuclear plants produce no emissions in operation, and this is close to the current nuclear capacity of 11,000 MW.

Finally, using 8,000 MW of wind power as an alternative to nuclear generation, requires an almost equal amount of other conventional generation to back it up. There would be an increase in emissions over the two previous scenarios. Figure 2 illustrates this.

Figure 2 – Electricity Capacity Scenarios for Canada in 2030

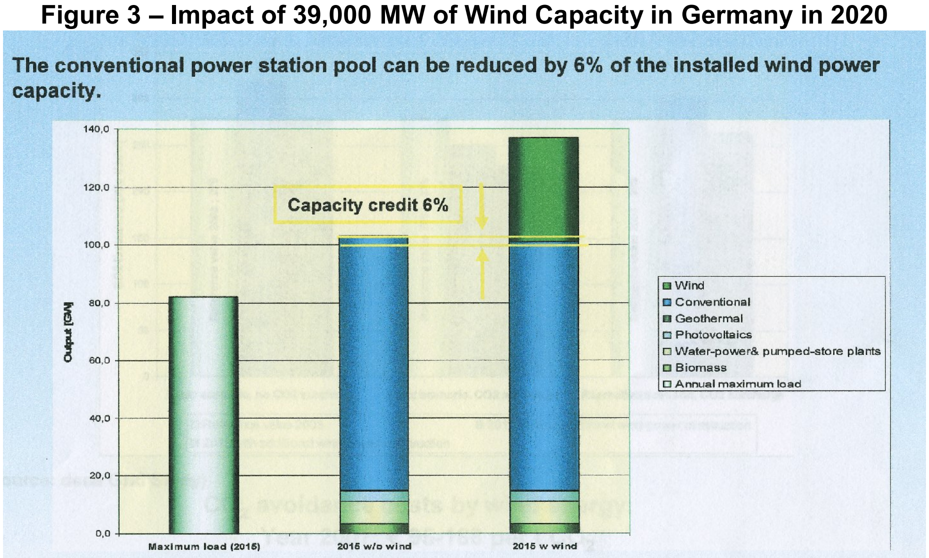


The description of the scenarios in Figure 1 is as follows:

- *Scenario 1* – This represents the Torrie Smith Associates report (prepared for the David Suzuki Foundation). The projected total of demand plus reserves of all generation means for Canada in 2030 is 70,000 MW.[31] This includes a 22% reserve. As this report did not take wind backup into account it has been added giving a new total of almost 77,000 MW.
- *Scenario 2* – This represents the case where only one-half of the conservation is achieved by 2030 and the shortfall is covered with nuclear fission plants. In this case 85,000 MW of capacity is required.
- *Scenario 3* – This represents the case where only one-half of the conservation is achieved by 2030 and the shortfall is covered with industrial wind plants. As shown above, an additional 8,000 MW of wind capacity is required giving a total of 15,000 MW of wind. This could replace only 6% of other capacity, or 900 MW. The total installed generation capacity now balloons to 92,000 MW because of the additional wind backup required. The investment in wind is now CDN$30 billion, most of which is redundant capacity.

If this seems hard to believe, Figure 3 shows the outlook for Germany in 2020 with 39,000 MW of wind planned and represents the effect of continually increasing wind power capacity.[32]

Figure 3 – Impact of 39,000 MW of Wind Capacity in Germany in 2020



Source: deENet, Energie mit System [33]

Conservation Activities World-Wide

Introduction

This section provides a sampling of conservation activities in other jurisdictions to represent approaches and achievements. It appears that the main source of non-price oriented campaigns is in the US, and in particular in California. Europe has long practiced conservation, in part as a natural result of very high electricity prices.

There are examples of conservation in response to a significant event as occurred in Ontario in the summer of 2003. The demand savings achieved during the recovery phase were over 15% and represent what is possible.[34]

In terms of global warming impact, the examples shown are not necessarily solutions but examples of how leadership and innovation, in many cases without major government programs and incentives, can have notable effect. They represent a starting point.

United States

California

California has been actively practicing conservation since the 1970s. It has been developing public education and policy initiatives that have achieved remarkable success. In the process it has fostered an infrastructure of contractors, energy service companies, vendors and retailers, providing valuable local employment opportunities. For comparison purposes California has about three times the population of Ontario, but the electrical energy consumption is only about twice that of Ontario. A summary of their achievements is as follows:

- Since the mid 1970s, per capita consumption of electricity in California has been held flat, while the total US per capita consumption rose by 50%. Ontario's has risen by 33% in the same period.
- As a result California has avoided the construction of 20 large power plants.
- The state's energy efficiency standards for appliances and buildings have helped save more than $15.8 billion in electricity and natural gas costs.
- In 2001-2002 avoided 8 million tons of CO2 emissions, equal to the production of Ontario's largest coal power plant.
- During the electricity squeeze in early 2001 when the Independent System Operator was forced to impose rolling blackouts, the National Electric Reliability Council projected that the state would experience 260 hours of blackouts during the summer. Through conservation measures learned over the previous decades, Californians were able to reduce peak electricity consumption from 3,200 to 5,600 MW over the four summer months averting a major crisis, and avoiding billions of dollars of economic cost. This represents up to a 10% reduction in average monthly peak demand and a 7.5% reduction in electricity usage.[35]

Has California run out of conservation options? A recent study shows that a doubling of existing spending on energy conservation programs will capture another 3,500 MW of demand savings over a decade, the equivalent of seven conventional power plants, with net benefits to the state of over $8 billion.[36] One factor that will help this is that performance of conservation technologies continue to improve and cost less. Also, it is reasonable to assume, like in other areas of human activity, that we can learn by doing and thus find new and better ways to achieve results.

Vermont

Efficiency Vermont is the US's first statewide provider of energy efficiency services. It is an independent, non-profit organization under contract to the Vermont Public Service Board that provides technical assistance and financial incentives to Vermonters to help them reduce their energy costs with energy-efficient equipment and lighting and with energy-efficient approaches to construction and renovation. It has implemented conservation measures in about 68,000 businesses and households throughout the state. In 2002 savings of $26 million over the lifetime of the investment are achieved over and above the $17 million it cost to achieve the savings.[37]

Other US Programs

The following is a sampling taken from a report by the Pembina Institute, which contains additional conservation programs. [38]

1. Northwest Energy Efficiency Alliance Building Operator Certification

The Regional Building Operator Certification (BOC) program aims to achieve energy efficiency through improved building operations. BOC is a professional development program that teaches facility managers, building operators, maintenance personal and others who monitor commercial building controls how to reduce energy and resource consumption in the facilities they operate. Building operators and managers who successfully complete a training series earn certification.

Studies show that electricity use in Northwest commercial and government buildings could be cut by 15 percent or more if building operators managed and maintained their structures and building systems more effectively. The program was initiated by the Northwest Energy Efficiency Alliance (NEEA) and is delivered by industry through a voluntary, competency-based certification process.

The annual program costs include US$1.8 million for delivery, $140,000 for administration, and $233,000 for evaluation. The cumulative computed impact for the period 1997-2000 per student participating in the program was estimated to be 177,500 kWh (compared with an initial planning value of 25,000 kWh per year). Total annual energy savings of the whole program were estimated at 172 GWh at the end of the period between 1997 and 2000. A demand reduction of 19 MW was estimated to be achieved by 2001. The program demonstrated a benefit-cost ratio of 7.8.

2. New York Standard Performance Contracting Program
The New York State Energy Research and Development Authority (NYSERDA) offers a commercial and industrial performance program which aims to encourage contractors to implement cost-effective electrical efficiency improvements or summer demand reductions for eligible customers.

Cumulative funding for the program to date has been US$81 million. As of September, 2002, annual savings of 232 GWh and a demand reduction of 51 MW were achieved. When fully implemented in 5 years, the projects are expected to reduce electricity use by 489 GWh per year, including a reduction of the summer peak demand by more than over 100 megawatts. By way of comparison, to implement 51 MW of industrial wind plants would cost $100 million (excluding backup costs) and would generate 89 GWh of electricity.[39]

3. New York Energy Efficiency Services Technical Assistance
This program is a part of the New York State Energy Research and Development Authority's (NYSERDA) Business and Institutional Program. The program provides technical assistance in the following areas:

- Energy feasibility studies – to identify capital improvements
- Energy operations management – to improve electrical energy efficiency of facility operations
- Rate analysis and aggregation – to prepare customers to negotiate energy prices and services with independent marketers

The total budget is $24.6 million of which $6.7 million has been spent. Savings of 195.5 GWh have been achieved, with a demand reduction of 52 MW. The program is targeting annual savings of 560 GWh and a demand reduction of 149 MW.

On the user side, according to a survey of NYSERDA's clients, two-thirds of them have implemented recommendations made by Technical Assistance contractors. Each dollar spent on engineering services has resulted in $14 in capital improvements and $4 per year in energy savings.

Table 6 summarizes the information from these two programs.

Table 6 – Comparison of New York Programs to the Equivalent Industrial Wind Plant Capacity

Alternatives	Funding Required	MW Saved/Produced	GWh Saved/Produced
NY Performance Contracting Program	$81 million	51	232
NY Technical Assistance Program	$7 million	52	196
Industrial Wind Plant	$100 million	6[40]	89

4. Texas LoanSTAR Revolving Loan Fund
This revolving loan fund was legislatively mandated to be funded at a minimum of US$95 million at all times. It aims to provide financing for energy efficiency projects to institutions of higher education, school districts, non-profit hospitals and local governments. Projects can include energy efficient lighting systems; high efficiency heating, ventilation and air

conditioning systems; computerized energy management control systems; boiler efficiency improvements; energy recovery systems; and building shell improvements.

Between 1989 and the end of 2000, the program had achieved annual energy savings of $100 million. The program has a 20-year target of $500 million of annual energy savings. Actual energy savings have exceeded targeted savings by 5% on average.

5. California Express Efficiency Program
The Express Efficiency program pays rebates to distributors and small to medium sized nonresidential customers for equipping facilities with selected electricity efficiency measures. The total budget for the program is US$23.8 million. The program target for 2002 was savings of 284 GWh of electricity per year and 82 GWh of thermal energy savings along with an electrical demand reduction of 56 MW.

6. Massachusetts Commercial and Institution Retrofits
Massachusetts Electric Co. has several programs for large businesses. For small business they pay 80% of the cost of the installation of a company's energy saving improvements and finance the remaining 20%, interest free, for up to 24 months.

Germany

From 2001 to 2005, Procter & Gamble in Germany increased production by 45%, but reduced the energy needed to run machines, and to heat, cool and ventilate buildings rose by only 12%, and carbon emissions remained at the 2001 level.

In a conservation project in Ludwigshafen, 500 dwellings were retrofitted to adhere to low-energy standards, reducing the annual energy demand for heating for those buildings by a factor of six. This is not necessarily an electricity project but is included as illustration of potential.[41] Almost 700,000 homes in Ontario are still heated using electricity.[42]

China

China has launched a $100 billion electricity conservation program including a major emphasis on new building codes.[43] This represents announced spending of about $77 per person, and probably only a good start. If we were to spend an equivalent amount in Ontario it would be $1 billion. Compare this to the $10 billion Ontario is going to spend on industrial wind power over the next 10-15 years.

Brazil

Brazil is 100% hydro. In 2001 a drought caused severe shortages and a mandatory reduction in electricity use was implanted. This included a major media campaign, millions of compact fluorescent light bulbs, and unplugging of appliances. The target was achieved.[44]

Canada

Ontario
We have a good example of local leadership. The Hastings and Prince Edward Public School Board has cut utility costs by $1 million (roughly 30%) and has reduced greenhouse gas emissions by 8,050 tons per year. This was realized by replacing washroom pieces to conserve water, upgrading heating and cooling systems and switching to more efficient lighting. The Board is hoping to boost savings to $1.6 million per year.[45]

Finally the following are links to important sources for conservation in Ontario:

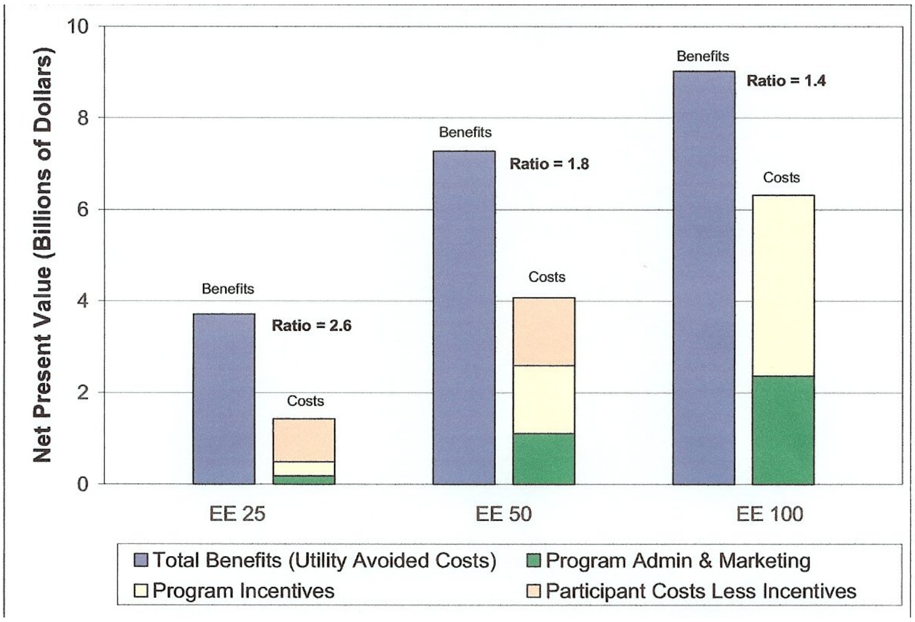
1. Conservation Bureau http://www.conservationbureau.on.ca/
2. Ontario's Chief Conservation Officer 2007 Annual Report. See page 22 for conservation programs and activities http://www.conservationbureau.on.ca/Storage/18/2340_AR2007_26Oct07(Final).pdf
3. Canada's home retrofit programs http://www.energy.gov.on.ca/index.cfm?fuseaction=conservation.homeretrofit

Ask yourself is Ontario doing as much as we can?

Cost Benefits of Conservation

Figure 3 shows the benefits and costs for electrical energy efficiency programs.[46] Note the use of the term energy efficiency rather than the broader term used in this document of energy conservation, limiting the effect to a narrower view. Further information on demand response measures to round out the more complete conservation view is provided below. The EE stands for the percentage of the incentives assumed by the utility. EE 25 means that the utility provides 25% of the required investment, and participants provide the balance. As can be seen the benefits in terms of utility avoided costs are substantial compared to the costs even under the conditions where the total program incentives (EE 100) are provided by the utility.

Figure 3 – Benefits and Costs of Electrical Energy Efficiency Progams



Source: Ontario Power Authority

To round out the effects of conservation programs the Pembina Institute provides an analysis that shows end user savings are slightly higher than their investment costs, with the residential sector showing a net loss of about $6 per person per year. This analysis assumes no government incentives. The user savings are not reflected in Figure 3. In summary, Figure 3 is a conservative proxy for the overall cost benefit of conservation programs. It is further important to note that these cost analyses do not consider the overall societal benefits to health and the environmental.[47] For example the Ontario Medical Association estimates that the total annual health costs associated with poor air quality in Ontario, to which, the current electricity supply mix is a major contributor, at $9.9 billion per year.[48]

As noted above in the description of conservation activities in Vermont, in 2002 savings of $26 million over the lifetime of the investment are achieved over and above the $17 million it cost to achieve the savings.

Reports considering costs alone include:

- A 2005 staff paper of the California Energy Commission highlighted the economic benefits of the State's demand management (conservation) programs, relative to the costs of supply options. The report concluded that energy efficiency (EE) program costs (averaging 2.9 cents/kwh for 2000-2004) are more economic relative to base load generation (5.8 cents/ kWh), intermediate generation (11.8 cents/kWh), and peaking generation (16.7 cents/ kWh).[49]
- The David Suzuki Foundation reports that the cost of saving electricity is 4.5 cents per KWh versus the cost of electricity generation at 6.2 cents per KWh.[50]

Of all the generation means discussed only conservation provides net savings. The savings are substantial and are in the order of two times the investment. Among the other generation means, the traditional generation plants have less operating costs per MWh than the alternative energy sources. Capital costs vary amongst the traditional generation plants but are about equal at approximately $2 million per MW for nuclear and coal plants and less than half that for gas turbine plants. The capital costs for industrial wind plants is the same as nuclear and coal.

Conclusions

If we take it seriously, at the individual, government and commercial levels, electricity conservation could eliminate our dependence upon fossil fuel and nuclear generation plants in Ontario. This is due in part to our comparatively large existing hydro generation resource.

Currently available alternative energy sources are not equal to the task of providing meaningful contributions in electricity production, reduction in emissions and sustainability in light of the size of the issues involved.

There are risks inherent in depending on the level of conservation required. In view of the lead time for plant implementation it would be prudent to provide for additional traditional generation plants that have the greatest impact on emissions reduction to bridge us to the next generation of electricity generation technologies, which are in the order of 50 years in the future.[51]

The environmental effects and economics of conservation are extremely attractive compared to all other approaches to meeting our electricity requirements. If we are truly concerned about climate change, and if we truly want to have a major impact on reducing emissions, we have to focus heavily on conservation.

Appendix A

Sustainability

Introduction

Sustainability has been previously defined in this document within the context of energy sources. It is recognized that sustainability has wider implications and context and this appendix attempts to deal with them. This appendix depends on the concepts contained in Wikipedia and other noted sources and remains very much a work-in-process.

It can be claimed that there is no generally agreed definition of sustainability. The following are some versions, descriptions or concepts:

- A characteristic of a process or state that can be maintained at a certain level indefinitely
- A measure of how long human ecological systems can be expected to be usefully productive
- Meets the needs of the present without compromising the ability of future generations to meet their own needs
- Climate neutrality is not an unreasonable partial proxy metric for overall sustainability
- Parallel care and respect for the ecosystem and the people within

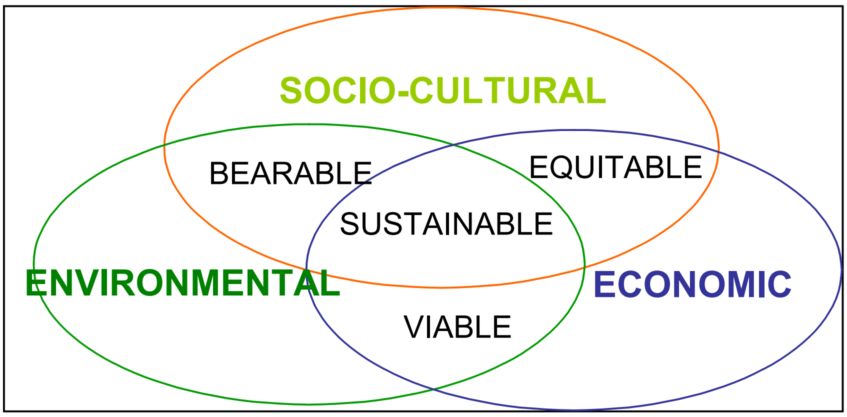
Conceptual Issues

Sustainability is often looked at as a consideration of environmental and economic concerns. This is represented by the bottom two ovals in Figure A1. In this connection there are two types of capital – natural capital and man-made capital. A case can easily be made that we should not deplete natural capital for man-made capital. So for what purpose are we conserving natural capital? Is the society supported by this capital just and decent, worthy of preservation? The work of sustaining a society raises the question of the moral worth of that society.

The last point in the introduction on parallel care and respect for the ecosystem and the people within (other than just economic care) takes sustainability out of the realm of just looking at it from the point of view of ensuring an ecosystem that provides for the sustainability of the human species. In Figure A1 this is represented by the top oval – Socio-Cultural considerations – which are concerned with the fundamental rights of individuals. This views the concept of sustainability as much more than environmental protection in another guise. It is a positive concept that has as much to do with achieving well-being for people and ecosystems as with reducing ecological stress or environmental impacts.

The complexity is increased again by the fact that values vary greatly in detail within and between cultures. The introduction of social values to sustainability goals implies a much more complex and contentious debate, and those focused on ecological impacts might tend to overlook non-ecological considerations. In summary sustainability can be looked at as the effective merging of all these considerations as shown in Figure A1.

Figure A1 - Sustainability



Source: Federation Environnment Durable[52]

Further details for each of these areas can be found at
http://www.sustainability.ca/
http://www.edu.gov.mb.ca/k12/esd/about.html

A final but important concept is that sustainability should focus on achieving desired outcomes as opposed to intermediate considerations, which may or may not support such outcomes.

Common Principles

Despite differences, a number of common principles are embedded in most charters or action programs to achieve sustainable development, sustainability or sustainable prosperity:

- Dealing transparently and systemically with risk, uncertainty and irreversibility.
- Ensuring appropriate valuation, appreciation and restoration of nature.
- Integration of environmental, social, human and economic goals in policies and activities.
- Equal opportunity and community participation.
- Conservation of biodiversity and ecological integrity.
- Ensuring inter-generational equity.
- Recognizing the global integration of localities.
- A commitment to best practice.
- No net loss of human capital or natural capital.
- The principle of continuous improvement.
- The need for good governance

Population Growth

With the world population continuing to grow, there is increasing pressure on arable land, water, energy, and biological resources to provide enough food and other needs while supporting viable ecosystems. The world population is projected to grow from the current 6 billion and peak at 9.2 billion in 2075. With expanding population and increasing consumption, the problems will worsen.

We must solve the major problems with respect to population growth and increasing consumption or face the same consequences as other societies that have failed to do so.

Change Resistance

Although there is general acknowledgement of the problems, there is a strong resistance to adopting meaningful sustainability practices.

It has been suggested that if we adopted a problem solving process that fit the problem, we would make the astonishing discovery that the crux of the problem is not what it thought it was. It is not the proper practices or *technical side* of the problem after all. Any number of these practices would be adequate. Instead the real issue is why is it so difficult to persuade people, corporations, and nations to adopt the proper practices needed to live sustainably? Thus the heart of the matter is the change resistance or *social side* of the problem. Generally speaking, people’s values are in the right place. The problem is to enact them.

Government and individual failure to act with substantive solutions is widely attributed to personal motivation and inertia. There is a strong tendency to look to solutions that can be provided by others.

Precautionary Principle

The precautionary principle states that if there is a risk that an action could cause harm, and there is a lack of scientific consensus on the matter, the burden of proof is on those who would support taking the action.

When competing "experts" recommend diametrically opposing paths of action regarding resources, carrying capacity, sustainability, and the future, we serve the cause of sustainability by choosing the conservative path, which is defined as the path that would leave society in the less precarious position if the chosen path turns out to be the wrong path.

End Notes

Web links have been supplied for convenience. As web sites do change, those shown may not be current. It is possible that a web search might be required in some cases.

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[1] David Suzuki Foundation, "Kyoto and Beyond: the low emission path to innovation and efficiency", 2002, prepared by Torrie Smith Associates, pages 22-23 http://www.davidsuzuki.org/files/Kyoto_Beyond_LR.pdf

[2] The Pembina Institute, "Power for the Future: towards a sustainable electricity system for Ontario", 2004, http://pubs.pembina.org/reports/energyreport-fullreport_a.pdf

[3] Wikipedia, http://en.wikipedia.org/wiki/Alternative_energy

[4] Wikipedia, http://en.wikipedia.org/wiki/Renewable_energy

[5] Wikipedia, http://en.wikipedia.org/wiki/Biomass

[6] APPEC, Industrial Wind Power: Production, Emissions Reduction and Costs, 2008, [link to APPEC document]

[7] Wikipedia, http://en.wikipedia.org/wiki/Sustainable_energy

[8] APPEC, "Industrial Wind Power: Production, Emissions Reductions and Costs", 2008, [link to APPEC document "Industrial Wind Power"]

[9] Bradley Robert L. Jr., President of the Institute for Energy Research, " Renewable Energy: Not Cheap, Not Green", 1997, http://www.cato.org/pubs/pas/pa-280.html

[10] O'Carroll, M. J., "Response to DTI Energy Review", 2006, http://www.berr.gov.uk/files/file31230.pdf

[11] Capacity Factors used are 20% for wind and 85% for other plants.

[12] Wind percent of the total is higher than its Capacity Factor would indicate because the other generation Capacity Factor is taken to be 85%.

[13] For gas turbine alone, CCGT is assumed. For the combination of wind and gas turbine, 50% CCGT and 50% OCGT is assumed.

[14] This assumes a 10% reduction in efficiency of the backup generation due to having to follow the wind variations. A 10% reduction in efficiency produces emissions greater than gas turbine alone of 30,000 tons/year. (This still ignores the consideration that a 10% reduction in efficiency produces a 20-30% increase in emissions. See Renewable Energy Foundation, Reduction in Carbon Dioxide Emissions: Estimating the Potential from Wind-Power, 2004, page 16, http://www.ref.org.uk/Files/david.white.wind.co2.saving.12.04.pdf)

[15] Wind requires 90% of other generation capacity in a constant backup or "shadowing" role due to the highly frequent and random variation in wind output. (see E.ON Netz, Wind Report 2005, page 9 at http://www.eon-netz.com/Ressources/downloads/EON_Netz_Windreport2005_eng.pdf). Therefore 90% of 198 MW or 178 MW of gas turbine will be necessary at planned penetrations of wind for Ontario.

[16] Renewable Energy Foundation, "Reduction in Carbon Dioxide Emissions: Estimating the Potential from Wind-Power", 2004, pages 15-16, http://www.ref.org.uk/Files/david.white.wind.co2.saving.12.04.pdf

[17] Ontario Power Authority (OPA), "Supply Mix Advice", 2005, Section 2.8.3.3 page 251, http://www.powerauthority.on.ca/Storage/18/1352_Part_2-8_Porfolios.pdf

[18] Ontario Power Authority, "Integrated Power Supply Plan", 2007, Exhibit D, Tab 9, Schedule 1, page 8 of 32, http://www.powerauthority.on.ca/Storage/53/4875_D-9-1_corrected_071019.pdf

[19] Royal Society, "Response to the House of Lords Select Committee on Science and Technology", 2003, http://www.publications.parliament.uk/pa/ld200304/ldselect/ldsctech/126/126we41.htm

[20] Royal Academy of Engineering, “Developing a sustainable energy strategy”, 2006, page 65, (also see page 23, note 6 regarding Germany’s first feed in law) http://www.raeng.org.uk/news/publications/list/reports/Energy_Seminars_Report.pdf

[21] Scientific American, “Plan B for Energy”, September 2005.

[22] David Suzuki Foundation, “Kyoto and Beyond: the low emission path to innovation and efficiency”, 2002, prepared by Torrie Smith Associates, page 111, http://www.davidsuzuki.org/files/Kyoto_Beyond_LR.pdf

[23] Answers.com, 1 watt-hour = 3,600 joules and 1 petajoule = 1,000 terajoules http://www.answers.com/topic/watt-hour?cat=technology

[24] Pembina Institute, “Power for the Future: towards a sustainable electricity system for Ontario”, 2004, Executive Summary, Table E2, http://pubs.pembina.org/reports/energyreport-fullreport_a.pdf

[25] 65 PJ = 65x1,000/3,600 TWh = 18 TWh. The effective capacity used for wind power is therefore 18x1,000,000/(24x365) MWs = 2,055 MW. The Capacity Factor used for wind power is therefore 2,055/7,000x100% = 29%. The source for installed wind capacity is David Suzuki Foundation, Kyoto and Beyond: the low emission path to innovation and efficiency, 2002, prepared by Torrie Smith Associates, page 108, http://www.davidsuzuki.org/files/Kyoto_Beyond_LR.pdf

[26] Renewable Energy Foundation, “Renewable Energy Data Technology Analyses: Wind 2006”, 2007, slide 20 of 25 http://www.ref.org.uk/Files/wind.overview.2007.(ii).pdf

[27] E.ON Netz, “Wind Report 2005”, (see Summary section), http://www.eon-netz.com/Ressources/downloads/EON_Netz_Windreport2005_eng.pdf

[28] E.ON, website file:///E:/My%20Documents/Wind%20Power/Germany/eon%20says%2095%25%20backup%20required.htm

[29] David Suzuki Foundation, “Kyoto and Beyond: the low emission path to innovation and efficiency”, 2002, prepared by Torrie Smith Associates, page 106 http://www.davidsuzuki.org/files/Kyoto_Beyond_LR.pdf

[30] The resulting reduction in supply from conservation is 2,026-1,594 PJ = 432 PJ. This represents 432x1,000/3600 TWh = 120 TWh. The generation capacity required if one-half of this is not met by conservation is (1/2x120x1,000,000/24x365)/0.85 MW = 8,000 MW. The 0.85 factor is the likely Capacity Factor of the necessary generation capacity.

[31] The total generation capacity in 2030 represented by 1,594 PJ of electrical energy or 1,594x1,000/3,600 TWh = 443 TWh is (443x1,000,000/24x365)/0.72 MW = 70,000 MW, assuming an overall Capacity Factor of 72%.

[32] APPEC, “Industrial Wind Power: Production, Emissions Reduction and Costs”, 2008, [link to APPEC document]

[33] deENet, Energie mit System (a consortium of 90 research institutions and service providers in Germany), “System studies and best practices – Germany: Results from the dena Grid Study”, http://www.deenet.org/ See presentation at http://www.ewea.org/fileadmin/ewea_documents/documents/events/2006_grid/Martin_Hoppe.pdf

[34] Meier, Alan, International Energy Agency, “International Examples of Efforts to Save Electricity in a Hurry”, http://www.aceee.org/conf/05ee/05eer_ameier.pdf

[35] David Suzuki Foundation, “Bright Future: Avoiding Blackouts in Ontario, 2003”. This report provides good coverage of conservation, but its treatment of industrial scale new renewable energy sources as a solution is typical of environmental organizations. For example it takes the conventional, simplistic view of supporting mandated levels of new renewables, in other words too quickly attempting to pick a technological solution without understanding the full implications of the choice. A better approach is to focus on the desired end result, reductions in emission levels, low environmental impact, sustainability and renewability, and make logical decisions taking all the factors into account. The coverage of small scale new renewable technologies on page 22 is notable. http://www.davidsuzuki.org/files/Climate/Ontario/brightfuture.pdf

[36] David Suzuki Foundation, "Bright Future: Avoiding Blackouts in Ontario, 2003", page 19, http://www.davidsuzuki.org/files/Climate/Ontario/brightfuture.pdf

[37] David Suzuki Foundation, "Bright Future: Avoiding Blackouts in Ontario, 2003", page 27, http://www.davidsuzuki.org/files/Climate/Ontario/brightfuture.pdf

[38] The Pembina Institute, "Power for the Future: towards a sustainable electricity system for Ontario", 2004, Appendix 3. http://pubs.pembina.org/reports/energyreport-fullreport_a.pdf

[39] Capital costs of 51 MW of industrial wind power would be $2 million per MW or $102 million. Assuming a Capacity Factor of 20%, the electricity production would be 51MWx24x365x0,2 =89,352 MWh or 89 Gwh.

[40] Assuming 12% Capacity Credit, 51 MW can replace 51x.12=6 MW of other generation capacity.

[41] Scientific American, "An Efficient Solution", September 2005.

[42] Ontario Home Builders Association, "Reducing Electricity Consumption in Houses", 2006, http://www.homesontario.com/pdfs/OHBA_ECC_Report.pdf

[43] The Toronto Star, February 27, 2006

[44] Meier, Alan, International Energy Agency, "International Examples of Efforts to Save Electricity in a Hurry", http://www.aceee.org/conf/05ee/05eer_ameier.pdf

[45] County Weekly News, "Suzuki says message is grim", November 11, 2005.

[46] Ontario Power Authority, "Supply Mix Advice", 2005, Section 2.5, page 129, http://www.powerauthority.on.ca/Storage/18/1349_Part_2-5_What_are_the_Challenges.pdf

[47] The Pembina Institute, "Power for the Future: towards a sustainable electricity system for Ontario", 2004, page 43, http://pubs.pembina.org/reports/energyreport-fullreport_a.pdf

[48] The Pembina Institute, "Power for the Future: towards a sustainable electricity system for Ontario", 2004, page 18, http://pubs.pembina.org/reports/energyreport-fullreport_a.pdf

[49] Ontario Power Authority, "Supply Mix Advice, 2005", Section 2.4, page 107, http://www.powerauthority.on.ca/Storage/18/1348_Part_2-4__What_are_Other_Jurisdictions_Doing.pdf

[50] David Suzuki Foundation,"Bright Future: Avoiding Blackouts" in Ontario, 2003, page 3, http://www.davidsuzuki.org/files/Climate/Ontario/brightfuture.pdf

[51] Scientific American, "Plan B for Energy", September 2005.

[52] Fédération Environnement Durable, http://www.environnementdurable.net/devdur1.htm