

A REVIEW:

ONTARIO'S COST-BENEFIT ANALYSIS

**REPLACING ONTARIO'S COAL-FIRED
ELECTRICITY GENERATION**

Prepared for

Clean Affordable Energy Alliance

Prepared by

Thomas Hughes Consulting (Corunna) Ltd

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I. EXECUTIVE SUMMARY

The fact that the DSS Cost Benefit Analysis (hence forth referred to as “the DSS Report”) was issued in April 2005, long after the Provincial Government had decided the fate of Coal-Fired Generation, immediately raises the question of the real purpose for this “after the fact” report. One of the opening statements in the DSS Report sets the stage, “The Ontario government had made a public commitment to closing the provinces coal-fired generation (CFG) stations by 2007” (page1 of report)

Prior to the commissioning of the DSS cost benefit analysis, the Association of Major Power Consumers of Ontario (AMPCO) provided the Legislative Assembly of Ontario with a detailed analysis of the economic impacts of higher electricity prices resulting from the closure of the coal-fired generating stations. This input was totally ignored in the analysis.

As a result, the analysis is a very simplistic approach to a complex issue and is skewed in favor of the Provincial Government’s predetermined goal. Such an incomplete analysis would never be accepted in the business world as the basis for making major decisions. These comments are not meant to question the integrity of the Consultants or the results they produced, but rather the constraints they were given. In fact, DSS pointed out certain limitations and uncertainties in their conclusions and made recommendations for further analysis.

In considering the Coal-Fired generation as “a whole”, the real impacts at different locations are distorted, and the value of existing capital assets is being needlessly thrown away. For example, The DSS Report states (page2) that the emissions from Atikokan and Thunder Bay CFG stations are so small that they were not included in the health and environmental analysis! On this basis, there is absolutely no justification to close these two stations.

In another example, without challenging the Health and Environmental Damage numbers in the report, simply separating out Lambton units 3 and 4, shows that keeping these in operation is more beneficial overall, than replacement with natural gas fired generation. If today’s natural gas prices are substituted for the low numbers used in the DSS Report, the “total cost” of generation from natural gas, including the Health and Environmental Damage numbers, is 68% higher than retaining LGS 3 and 4, and will cost the electricity consumers an extra \$400 million/year.

Based on data in the DSS Report, the “best case” scenario is really a Nuclear/LGS units 3&4 case, rather than the “recommended” Nuclear/Gas case.

\$3 billion/year Health Damages is the dominant factor influencing the results of the DSS analysis. 95% of these damages are attributed to the value of premature deaths as a result of pollution. These “deaths “ are statistical numbers, not actual deaths, and are determined by methods having high degrees of margin for error.

To gain a glimpse of what a full cost-benefit analysis might look like, simply including the \$10 billion/year in economic damages projected by AMPCO more than offset the \$3 billion/year in health damages.

By ignoring the calls for a complete cost-benefit analysis and turning a blind eye to some of the recommendations in their own consultants report, one can only conclude that the Government’s decision to close down the Coal-Fired Generating Stations is simply political and not based on economics.

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1. INTRODUCTION

1.1 Background

The following report was prepared by Thomas Hughes Consulting (Corunna) Ltd for the Clean Affordable Energy Alliance.

When the present Ontario Government came to power in 2003 it made a commitment to close the province's Coal Fired Generating (CFG) stations by 2007. The Clean Affordable Energy Alliance (1), believes this decision was politically motivated, made in haste, and without a full cost benefit analysis. The Association of Major Power Consumers in Ontario (AMPCO) (2) and The Frazer Institute (3) are among the many individuals and organizations that have also expressed concerns regarding this decision. In August 2004, AMPCO made a submission to the Legislative Committee, detailing the negative economic impact that would result from closure of the CFG'S. The Ontario Ministry of Energy commissioned DSS Management Consultants to prepare an "after the fact" Cost Benefit Analysis which was completed in April 2005 (4). During a meeting with the former Minister of Energy in October 2004, the Clean Affordable Energy Alliance requested a copy of the Cost-Benefit Analysis that the Government used to justify closing the CFG's. In December 2005, the Clean Affordable Energy Alliance received a copy of the DSS Report from the Ministry of Energy as a basis for their justification. The DSS Report compares the status quo of continuing to operate the CFG facilities as is, with three alternate cases; All Gas, A mix of Nuclear and Gas, and Stringent Controls on the CFG's.

This report documents the findings from a review of the scope, assumptions, methodology and conclusions in the DSS report.

1.2 Purpose and Scope

The purpose of this review is to understand what factors were and were not considered in the DSS analysis, the methodologies used, and the validity of the conclusions.

The scope also includes additional conclusions that could be drawn from the data provided in the DSS report, and conclusions as a result of adding additional factors for consideration.

1.3 Methodology

The spreadsheets used to conduct the economic analysis in the DSS Report were re-created from data in the report.

Following a review of the data in the DSS Report, changes to the natural gas price assumptions and nuclear refurbishment costs were made while retaining the DSS attributed health and environmental damages.

Since Lambton Units 3&4 have been fitted with more environmental controls than any other coal-fired unit, the data for LGS 3&4 was extracted and compared to the costs for a proportional amount of generation in the All Gas and Nuclear/Gas cases.

Some of the literature cited in the DSS report, from which the health costs were derived, was reviewed. Observations and comments from this review are noted.

Economic considerations from the AMPCO submission were added to the DSS cost results for a more complete cost-benefit analysis.

2. DSS COST BENEFIT ANALYSIS SCOPE

The analysis compared the Total Cost of Generation for four different scenarios.

Base Case : (the status quo, continue to operate the Coal-Fired generating facilities)

All Gas : (replacement of all CFG's with new gas fired facilities)

Nuclear/Gas : (replacement of all CFG's with a combination of refurbished nuclear and new gas fired facilities)

Stringent Controls : (continue operating the CFG's and install the best available emissions control technology)

The Total Cost of Generation is the sum of :

Financial Costs

- Capital
- Operating and Maintenance
- Fuel

Health Costs

- Premature Deaths
- Hospital Admissions
- Emergency Room Visits
- Minor Illnesses

Environmental Costs

- Green House Gas Emissions/Permits
- Crop Damages
- Materials Soiling

These costs are summarized below in Table 2.

**Table 2 Annualised Financial Costs and Health and Environmental Damages
(per DSS, all values in \$ millions)**

	Base Case	All Gas	Nuclear/Gas	Stringent Controls
Financial Costs	\$985	\$2,076	\$1,529	\$1,367
Health Damages	\$3,020	\$388	\$365	\$1,079
Environment Damages	\$371	\$141	\$48	\$356
Total Cost of Generation	\$4,376	\$2,605	\$1,942	\$2,802

3. REVIEW AND ANALYSIS

3.1 Overview Observations

There are major cost omissions for the All Gas and Nuclear/Gas cases. These include:

- Economic and health damages due to higher electricity prices, estimated to be around \$10 Billion/year in the AMPCO submission to the Legislative Assembly.
- Nuclear Plant decommissioning, fuel disposal costs, and the cost the public will bear for the environmental and safety risks associated with Nuclear Plants.
- Costs for major infrastructure changes required to the electricity grid, as a result of closing the CFG's.
- The impact of higher natural gas prices resulting from increased demand to fuel the gas-fired generation.

Page 2 of the DSS Report states “ Atikokan and Thunder Bay CFG stations contribute a small percentage of the total CFG emissions....and are located in an air shed with few of the sensitive receptors...for these reasons, air pollution emissions and associated health and environmental damages for these two northern stations were not included in this analysis”. In other words, there is absolutely no justification for closing Atikokan and Thunder Bay stations on the basis of this report.

The overriding factor influencing the results of the DSS analysis is the \$3 billion annualized health damages attributed to the CFG's.

CFG's contribute approximately 6% of the total pollution in Ontario. If \$3.0 billion really is the annualized health damages associated with the CFG's, then the total health damages for all pollution would be \$50 billion, 60% more than the total health care budget for the province. The issue here, is that almost all of the \$3 billion is derived from the estimated value of a statistical life that is applied to the theoretical number of premature deaths resulting from pollution. Some insight into uncertainty of these numbers can be gained from statements in the DSS Report. “Expressing the results (of computer models) in terms of expected numbers of premature deaths is a simple way to communicate **the change in risk** of premature mortality...” (page iv of Executive Summary). i.e. The premature deaths often referred to, are **not actual deaths**, but statistical numbers derived from computer models. “In actual fact, **it is impossible to identify which specific deaths that occur over a given time are actually attributable to pollution.** Air pollution is a contributory factor in a multitude of deaths and is almost never the overriding or irrefutable single cause of death.” (page v of Executive Summary)

Limitations of the DSS Report are documented in the Recommendations for Further Analysis. These are :

- Health and environmental damages associated with nuclear power generation have not been included.....and should be in the future.
- Extending the results of this analysis to examine promising intermediate alternatives (e.g. different

proportions of nuclear, gas, coal and renewables) would provide useful information for making policy decisions

- The effects of delays in bringing new capacity on line need to be examined (new capacity in the analysis is assumed to be brought on line within a tight timeframe)
- Scenarios using varying market assumptions, particularly with regards to the likely reaction of the market to a reduction in generation capacity following closure of the coal-fired generation facilities.

3.2 Further Analysis of DSS Data

In the DSS analysis, all Coal-Fired Units were considered as a total entity. The result is that the benefits of the emissions controls on Lambton’s units 3&4 are masked by the overall emissions considered in the study. If LGS units 3&4 generating capacity and emissions are compared to the same amount of gas-fired generating capacity, as is the government’s plan, the gas-fired option is more costly (see Table 3.2). The reason for this is while LGS 3&4 generate 24.4 % of the total CFG capacity, and emit 24.4% of the CO₂; they are only responsible for 8.1% of health related emissions. In other words, hidden in the DSS Report Data is the confirmation that the controls technology on LGS Units 3&4 is doing what it is supposed to do, and there is absolutely no reason to replace these units with gas-fired generation. The allocation of emissions is shown in the Appendix.

**Table 3.2 Replacement of LGS 3&4 with Gas Fired generation
Annualised Financial Costs and Health and Environmental Damages
(\$ millions)**

	Coal	Gas
Financial Costs	\$240	\$507
Health Damages	\$245	\$95
Env. Damages	\$90	\$34
Total Cost of Generation	\$575	\$637

The amount of gas-fired generation in the “favored” Nuclear/Gas case is the same amount of generation as that used for LGS units 3&4 in the analysis. Since the cost to keep these units running is less than the cost to replace them with gas, it stands to reason that **the DSS “Best Case Scenario” is really Nuclear/LGS units 3&4.** (Note: DSS recommended that other scenarios such as this should be analyzed)

3.3 Sensitivity Analysis of DSS results

3.3.1 Impact of higher Natural Gas Prices

The natural gas price used by DSS in the analysis is \$6.5 Canadian/MMBtu. This is considerable lower than recent prices of \$13 to \$18 Canadian/MMBtu, which reflect the highly volatile and uncertain gas prices going forward. The result of using a gas price of \$13.0/MMBtu is shown in Table 3.3.1

**Table 3.3.1 Annualised Financial Costs and Health and Environmental Damages
(Natural Gas price \$13.0 Canadian/MMBtu)
(\$ millions)**

	Base Case	All Gas	Nuclear/Gas	Stringent Controls
Financial Costs	\$985	\$3,432	\$2,001	\$1,367
Health Damages	\$3,020	\$388	\$365	\$1,079
Environment Damages	\$37	\$141	\$48	\$356
Total Cost of Generation	\$4,376	\$3,961	\$2,414	\$2,802

In this case the All Gas option is now approaching the status quo coal-fired option and the Nuclear/Gas option is only marginally “better” than the stringent controls option

The case to replace Lambton Units 3&4 with gas-fired generation, with gas at \$13.0/MMBtu is shown in Table 3.3

**Table 3.3.2 Replacement of LGS 3&4 with Gas Fired generation
(Natural Gas price \$13.0 Canadian/MMBtu)
Annualised Financial Costs and Health and Environmental Damages
(\$ millions)**

	Coal	Gas
Financial Costs	\$240	\$837
Health Damages	\$245	\$95
Env. Damages	\$90	\$34
Total Cost of Generation	\$575	\$967

As can be seen from Table 3.3.2 it will cost \$392 million more per year to run the replacement gas fired generation for LGS 3&4, even after accounting for all the attributed Health and Environmental Damages. The benefit of keeping these units running has been reported previously by Energy Probe(5) and others.

3.3.2 Impact of “More Realistic” Nuclear Refurbishment Costs

The cost used for refurbishing the Nuclear Units is \$1300/KW and \$1400/KW, considerably lower than the recent \$2,000+/KW experience. Using \$2,000/KW and \$13.0 gas, the Total Cost of Generation for the Nuclear/Gas case is approx \$2.6 Billion versus the \$2.8 Billion for the Stringent Controls case. The latter being a virtually “risk free” case versus the considerable technical and economic risks for the Nuclear case.

3.4 Health Damages

The dominant effect on Health Damages is the economic damages associated with premature mortality; approximately 95% of the annualized \$3.020 billion reported.

3.4.1 DSS Reservations

The DSS Report states (page iv of Executive Summary). “Expressing the results (of computer models) in terms of expected numbers of premature deaths is a simple way to communicate **the change in risk** of premature mortality...”. i.e. The premature deaths often referred to, are **not actual deaths**, but statistical numbers derived from computer models. (Page v of Executive Summary), “In actual fact, **it is impossible to identify which specific deaths that occur over a given time are actually attributable to pollution**. Air pollution is a contributory factor in a multitude of deaths and is almost never the overriding or irrefutable single cause of death.”

While DSS have used what is considered to be respected research on which to base their findings, it is fairly safe to say that the research is limited and the results can have large margins of error as indicated by comments in the DSS Report.

Page 19 (Premature Mortality) “...the number of cohort (long term) studies available in the scientific literature is more **limited**....considerable effort has been expended to confirm and refine the risk factors from these (limited) studies....

Page 71 (Pollution) Model Limitations

“...**errors** in predicted long term concentrations are in the range of +/- **10 to 40** percent....**air pollution modelers tend to use assumptions that will more likely overestimate...air pollution changes**”

The authors of the research themselves (Krupnick et al.2000) (6), raised three significant issues arising from the results of their research.

3.4.2 Methodology used to determine the Economic Damages Related to Mortality

The methodology takes the increased chance of premature death due to pollution (as a result of air modeling and it’s limitations), and then asks a group of people what they are willing to pay (WTP) to reduce this risk. The value of a statistical life (VSL) is then derived by dividing the WTP by the change in risk.

In reviewing the original research report that was used as a basis for the DSS report, (Krupnick et al (2000), the following “anomaly” is apparent. In situations where people are willing to pay more for a higher reduction in risk, the Value of a Statistical Life comes out to be lower (\$772,000 to \$1,452,000), than for those willing to pay less for a smaller risk reduction (\$2,272,000 to \$4,496,000)(all in 1999 dollars). There is no doubt that the math is correct, the “discrepancy” being the result of a nonlinear relationship between increasing risk and willingness to pay. This indicates the very high variability of results from this kind of statistical analysis. The value of a statistical life used in the DSS report is \$4,180,000.

The risk of premature death derived in the DSS report is 650/14,000,000 (number of deaths divided by the population at risk) or 4.6/100,000. The willingness to pay to eliminate this risk was prorated from the numbers obtained by Krupnick et al. and calculated to be \$192. However since the coal-fired generation stations only contribute 6% of the total pollution in Ontario, after paying their Willingness To Pay amount (approx \$192/year), people are still exposed to 94% of the overall risk. If it was explained to people in this way, it quite likely that many, if not all, would think that their \$192 per year is a waste of money.

These and other questions about the methodology used in the research should be pursued with the authors, but this is outside the scope of this report.

3.4.3 Omissions in Health Damages

The AMPCO submission indicates that there will be between 85,000 and 145,000 job losses as a result of higher electricity prices. There is no doubt that as a result there will be considerable mental anguish for those involved and their families, probably including a number of suicides. No attempt has been made to quantify these health damages. Considering up to 145,000 job losses versus the 668 premature deaths, one could conclude that the health damages are likely to be offsetting.

The considerable increases in electricity and natural gas prices will make it more difficult for many of the elderly on fixed incomes to afford to run air conditioning in the summer and heat in the winter, with a resulting increase in the number of premature deaths. While the government has made some indication that some form of subsidy may be available for the needy, this amount should be included in the analysis. It is difficult to imagine that any subsidy (to prevent these deaths) will come anywhere near \$ 4.2 million (the value of one statistical life) times the number of people in need.

3.5 OTHER ECONOMIC DAMAGES

Any cost-benefit analysis should include **all of the known factors** to provide a credible result, especially an analysis that will have such far reaching consequences on the economy and life of its residents for generations to come.

There is absolutely no doubt that closing Ontario’s CFG’s will result in higher electricity prices. Therefore, the impact of higher electricity prices should have been included in the scope of the DSS report. AMPCO’s submission to the Ontario Legislative Assembly included a detailed economic analysis of the impact of higher electricity prices. These impacts include:

- A decrease in Ontario's GDP of between 1.2% and 2.0%, approx \$6 to \$10 billion depending upon the magnitude of the electricity price increase. Electricity prices over the last year would indicate that the impact would be closer to \$10 billion.
- Job losses of 85,000 to 145,000
- Reduction in the Federal Budget Balance of \$1.6 to \$2.7 billion
- Reduction in the Provincial Budget Balances of \$0.6 to \$0.9 billion

In addition to the above, the increased demand for natural gas will put upward pressure on prices with further negative impact on the overall economy.

Taking an approximate midpoint of the sum of the above impacts and including it in the DSS analysis we see a completely different result. The economic damages, as a result of higher electricity prices, are now the most dominant factor by far. See Table 3.3.3.

**Table 3.3.3 Annualised Financial Costs and Health and Environmental Damages
(per DSS, with damages resulting from higher electricity prices)
(all values in \$ millions)**

	Base Case	All Gas	Nuclear/Gas	Stringent Controls
Financial Costs	\$985	\$2,076	\$1,529	\$1,367
Higher Elec.Cost Damage	\$0	\$10,000	\$10,000	\$0
Health Damages	\$3,020	\$388	\$365	\$1,079
Environment Damages	\$371	\$141	\$48	\$356
Total Cost of Generation	\$4,376	\$12,605	\$11,942	\$2,802

4. SUMMARY OF FINDINGS

The DSS analysis falls short of the kind of cost benefit analysis required to address the issue of closing the coal-fired generating stations in Ontario. This was as a result of the limited scope defined by the Ministry of Energy.

A key recommendation in the DSS Report is “that the range of scenarios should be expanded..”

The overriding factor affecting the results of the DSS analysis is the estimated Health Damages.

The Health Damages were estimated using less than precise methods.

The natural gas prices used in the analysis was approximately half of that of recent and forecast prices.

DSS’s own information shows that there is no basis for shutting down Atikokan and Thunder Bay generating stations.

DSS’s own information also shows that keeping Lambton units 3&4 operating versus replacing with gas-fired generation is a better option, by as much as \$400 million/year, even after including all of the estimated Health and Environmental damages.

The overall “best case” using the DSS reported results would be a Nuclear/LGS 3&4 case.

When adding the economic damages estimated by AMPCO these become the overriding factor and make the case for retaining all of the coal-fired generation.

By excluding the damages to the economy, the Government is really saying that economics don’t matter and the economic damages should be added to the value of a statistical life. This then becomes \$4.2 million plus \$10 billion (economic damages)/668 (premature deaths) = \$19.2 million per statistical life.

5. CONCLUSIONS

The DSS analysis is an incomplete cost benefit analysis. The scope was constrained by the Ministry of Energy and the results were driven by the allocated Health Damages.

Even so, information in the DSS Report indicates there are no reasons to shut down Atikokan and Thunder Bay Generating Stations, or Units 3&4 at Lambton Generating Station.

If damages to Ontario’s economy, as a result of closing the CFG’s are included, these become the dominating factor and indicate that the coal-fired stations should remain in service.

By ignoring the calls for a complete cost-benefit analysis and turning a blind eye to some of the recommendations in their own consultants report, one can only conclude that the decision to close down the Coal-Fired Generating Stations has little to do with the overall economic benefit to Ontario.

5 REFERENCES

1. Clean Affordable Energy Alliance, www.caealliance.com
2. AMPCO (August 2004) : Submission to the Legislative Committee on Bill 100 – Electricity Restructuring Act, 2004, An act to amend the Electricity Act, 1998 and the Ontario Energy Board Act, 1998 and to make consequential amendments to other Acts
3. Frazer Institute (Jan 2005) :Pain Without Gain, Shutting Down Coal-Fired Plants Would Hurt Ontario.
4. DSS Management Consultants (April 2005): Cost Benefit Analysis: Replacing Ontario's Coal-Fired Electricity Generation
5. Energy Probe (Oct 2005) : Letter to the Ontario Clean Air Alliance.
6. (Krupnick et. al. Sept. 2000) Age, Health and Willingness to Pay for Mortality Risk Reduction : A contingent Survey of Ontario Residents

A APPENDIX

Table A.1 Coal Fired Generating Plants Emissions Parameters

Facility Units	LGS			NANTIKOKE			TOTAL
	1&2	3&4	3&4 %Total	1,2,3&4	5&6	7&8	
Rated Output (MW)	970	996		1960	980	980	
Ann Gen. (TWh/yr)	2	6.5	24.4	7.7	4.9	5.5	26.6
Ann Utilization	24%	74%		45%	57%	64%	
Emissions Controls	LNB,ESP	FGD,LNB SCR,ESP		LNB,ESP	LNB,OFA ESP	LNB,SCR ESP	
Nox (Mg/yr)	2200	1950	9.5	9240	5513	1650	20562
So2 (Mg/yr)	10560	6097	7.4	28105	17885	20075	82729
Pm10(Mg/yr)	380	665	14.8	1463	931	1045	4499

LGS 3&4 Wtd. Ave 8.1% Total Coal Fired Emissions

LGS 3&4 CO2 emissions 24% of total coal fired CO2 (same proportion as generation)