EB-2007-0707
Integrated Power System Plan
CAE (Clean Affordable Energy) Alliance Response to
Interrogatories of The City of Toronto

Issues: A 20, 24, 28, 33 & 34

Ref.: Online:

http://www.rds.oeb.gov.on.ca/webdrawer/webdrawer.dll/webdrawer/rec/73729/view/CAE_EVD_20080801.PDF (no exhibit information provided), Page 3

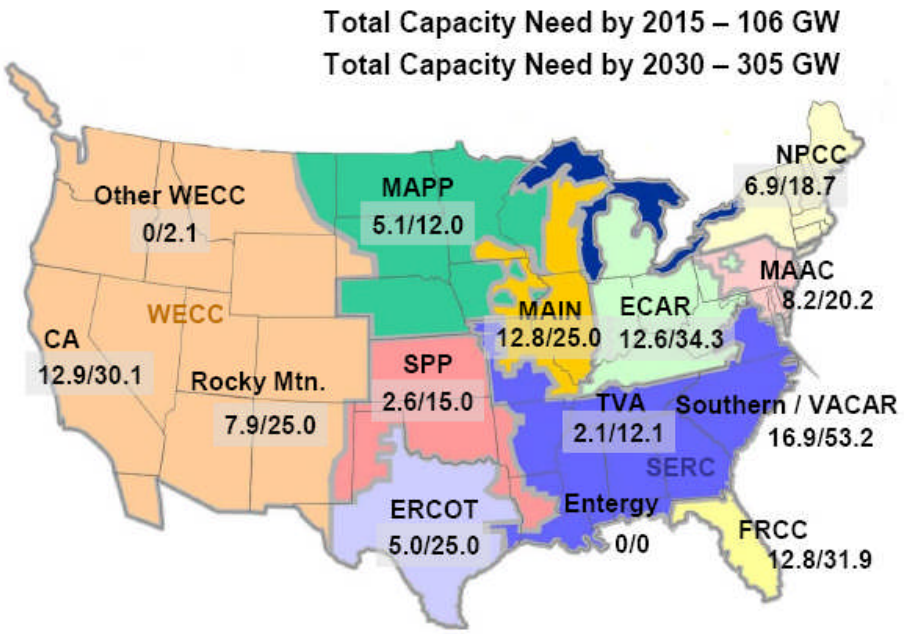
1. The evidence indicates that "the OPA did not evaluate surrounding jurisdictions that provide power to Ontario to determine future power constraints in neighbouring jurisdictions". Please provide the supporting numerical evidence for this statement.

2. To what extent did the Alliance consider and model the impact of local community based conservation, demand management, energy efficiency, distribution generation and renewable electricity programs that may mitigate future power constraints? Please provide all supporting numerical evidence, modelling and analysis.

1. Answer

■ The proposed Plan includes a reliance on imports from surrounding jurisdictions. We have noted some concerns regarding future availability of power supply from these jurisdictions due to potential power constraints in other areas. As noted, we do not believe that the OPA has fully investigated the degree to which imports can be relied on. The following chart demonstrates some of the needs in the bordering states.

Figure 3.4: Additional Capacity Needs by Region by 2015/2030 in GW



■ The National Energy Board's report "Natural Gas for Power Generation: Issues and Implications", June 2006 includes an assessment of regional power needs, including jurisdictions surrounding Ontario, and the impact of growing electricity requirements on natural gas use.

■ The export information from Manitoba to Minnesota and Wisconsin, together with demand profile of Manitoba was taken into consideration, as well as the rising energy requirements in New York state and the potential for increased exports from Quebec to New York. Rising Michigan energy requirements were also considered. (A number of articles can be accessed via the internet, as well as the State and Provincial electricity profiles and concerns.)

2. Answer

■ The OPA has modeled the acquisition of these resources. It is therefore unnecessary and outside of our resource (monetary) abilities to model the impact of CDM and renewable supplies of power. As the OPA has included imports as a mitigation measure if renewable resources and CDM do not materialize, to provide supply requirements when natural gas units were out of service for maintenance, and for meeting extreme weather conditions, we expressed our concern that the OPA has not sufficiently verified whether these imports would be available.

Issues: A19, 33&34

Ref.: Page 4

3. The evidence indicates that "natural gas cannot perform the quality of load following expected of it as replacement for coal-fired generation…" Can you please explain how you define the "quality of load following expected" of natural gas under the IPSP? Please share the evidence you have to demonstrate that natural gas cannot perform the load following expected of it under the IPSP?

3. Answer

■ On pages 55-57 of our submission to the Board, the CAE Alliance included quotes from the OPA and the IESO regarding the quality of load following required, i.e. quick response of readily dispatchable resources to match supply with demand on a minute by minute basis, with the ability to respond to constant load changes and periods of sustained increase or decrease. These characteristics are critical to the reliability of the system.
The IESO has indicated that the characteristics of replacement resources for coal-fired generation must closely resemble those being replaced. We are not alone in raising our concerns that replacement resources will not be adequate. This was raised by other Intervenors, by the IESO and OPG, and have not been sufficiently addressed.

■ Some comments on the comparison include:

"Ontario gas-fired generators typically offer load following capability over the upper 25% of their capacity range, whereas coal-fired units can typically achieve load following from minimum load up to maximum output, which represents the upper 80% of each unit's capacity range." (IESO – highlights of 10-Year Outlook, Jan/06-Dec/15)

"Ontario Power Generation raised the concern that when new gas-fired power generation is added to the Province's generation portfolio, the amount of load-following capability available in the market will decline. This decline will exacerbate the current problem with generators that are capable of ramping up and down. ..." (Ontario Energy Board – Natural Gas Electricity Interface Review)

"Both gas fired and coal-fired generation facilities are flexible and fairly responsive resources to meet various load-following requirements. The main differences are associated with their load-following capability relative to their capacity range, with coal-fired units generally covering a larger unit capacity range compared to gas-fired units." (OPA)

The effects of plant ageing, part load operation and starts and stops are not included in the OPA analysis, nor the effects of inlet temperature on combustion turbine heat rates and maintenance cost. (EB 2007-0707-Exhibit 1, Tab 32)

■ The CAE Alliance has sought the advice of an independent natural gas consultant and expert who has advised that combined cycle gas facilities are not as efficient at load following, have increased emissions and would experience higher outages if exposed to the conditions required of them. The CAE Alliance has not obtained an official report of this information, but has rather chosen to highlight this concern in the hopes that the Board will direct the OPA to answer our - and others - concerns in this regard. The OPA has obtained many other consultant reports and we are requesting that they obtain independent, expert advise to address this vital concern.

■ Included in the concerns regarding dispatchability of natural gas-fired generation is the reliance on (primarily) private power producers to generate when required for as long or short as required - something new to the Ontario system. This leaves the system vulnerable to outside influences.

Issues: A 7-9, 19, 34

Ref.: Page 8

4. On page 8 it is stated that the need for natural gas-fired generation will increase "as more wind power is added to the system". Further, it is added "[c]ombined cycle gas plants can load follow provided that the load swing is not too great". Is it possible for wind power to facilitate load planning in conjunction with power sources such as hydro power?

4. Answer

Additions of hydroelectric resources is not expected to be sufficient to "mitigate the impacts of wind variability on power quality and voltage performance", particularly in the near to mid terms. If significant northern hydro resources are added in the latter years of the Plan, they could offset the potential new wind resources which could be included, also from northern Ontario.

Issues: A 2-5

Ref.: Page 12-13

5. The evidence states that smart meters will impact electricity prices for small business to the tune of 50-100%. On page 16 it is also said that for the "average" household to see a decrease in electricity costs, there will be a "need to spend a considerable amount on new appliances". Please indicate how and from what sources these figures are derived? Can you please indicate how, and the extent to which, the Alliance considered demand management programs, such as "Peaksaver" and distributed generation programs in reaching this conclusion and provide the supporting analysis?

5. Answer

■ We believe that the information provided regarding small business price impacts is self explanatory. The load profile for winter show demonstrates that the cost of electricity during normal business hours of 9 am to 6 pm will increase approximately 50%-100%, rising from 5.2 cents/kwh to 7.3 cents/kwh during noon to 4 pm; and from 5.2 cents/kwh to 9.3 cents/kwh during the hours of 9am-noon and 4pm to 6pm. This highest cost will extend to pre-opening hours and beyond closing when staff are there but businesses are not open. Likewise, costs will increase during summer hours, from 5.2 cents/kwh to 9.3 cents/kwh from 11 am to 5pm and from 5.2 cents/kwh to 7.3 cents kwh from 9 am to 11 am and 5 pm to 6pm and beyond.
The charts show the impact of smart meters to reduce consumption. As noted, there will be miniscule reduction during peak hours for small businesses.

■ Regarding residential consumption, savings encouraged by the OPA are obtained in part by switching from electricity to natural gas for clothes drying, water heating and cooking. The cost to convert to natural gas, including gas hook up, new appliances and water heater will not likely be recovered over the life of these appliances and therefore the benefit of lowered electricity consumption costs will be outweighed by these costs to fuel switch.

■ It is our understanding that the Peaksaver program and distributed generation programs are designed to reduce overall provincial consumption, particularly at high peak times. These programs will not impact the price that individual consumers pay as a result of installed smart meters.

Issues: A 7-9, 28

Ref.: page 20

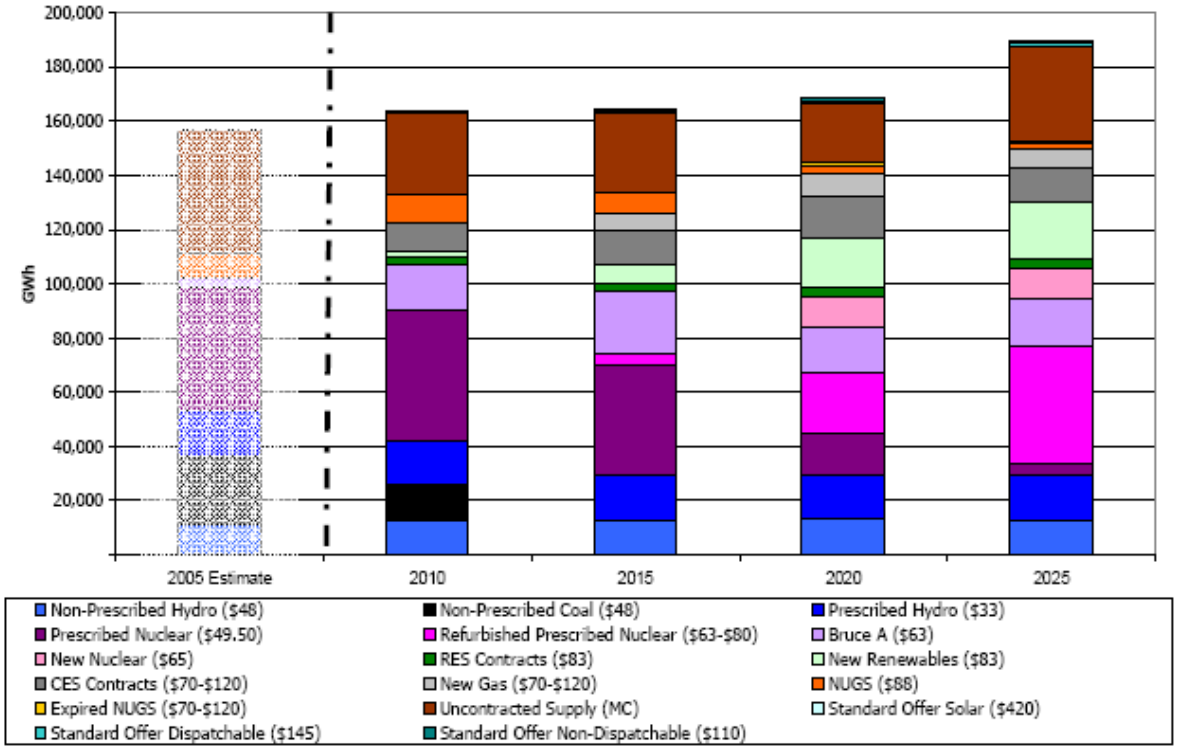
6. On page 20 it is stated that wind and solar represent "higher price power". In characterizing renewable energy sources as "higher price" would you please explain if your assessment considers, the quantitative and qualitative impacts of renewable power, including, without limitation, the costs of GHG emissions? Can you please explain if your assessment of the price of power considers public subsidies that support non-renewable energy sources such as coal and nuclear power, including tax expenditures for mining and limitations on liability for the nuclear industry, as well as direct spending? In your view, are the costs of wind and solar power generation increasing?

6. Answer

■ The description of wind and solar as "higher priced power" comes from the OPA information, as follows:

"... solar-generated power has the advantage of using a free resource, has modularity that makes it suitable for connecting close to the load, and has significant potential for technological improvement. The challenge of solar-powered generation is its environmental life-cycle impact. This impact is dominated by the process to manufacture the photovoltaic cells, which itself is energy-intensive and creates toxic by-products. The cost of electricity from photovoltaics is more than $180/MWh, higher than all other sources examined." (OPA)

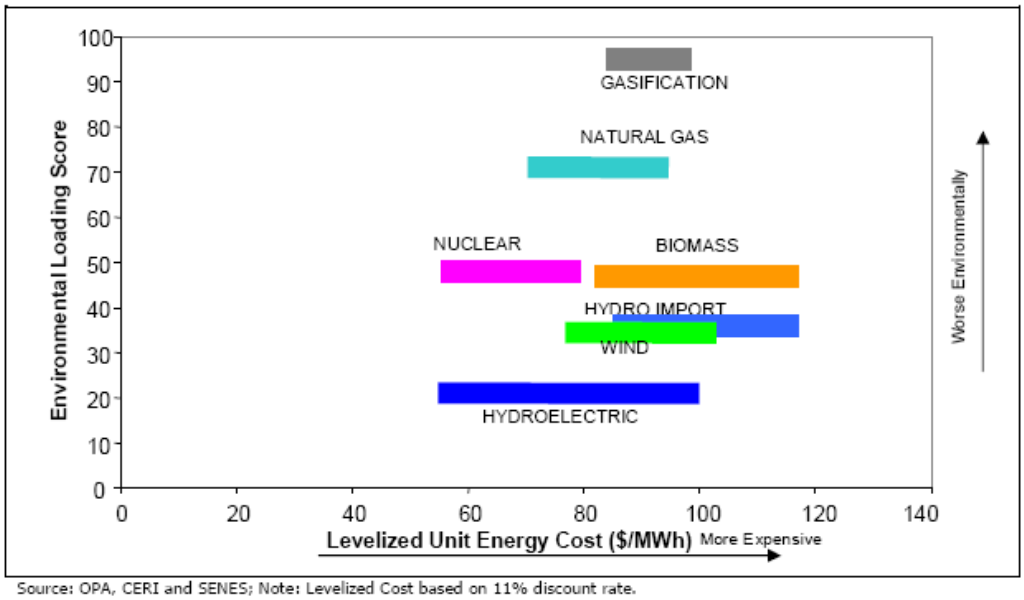
Figure 3.15 – Total Generation Produced by Various Cost Categories



Source: OPA

(Discussion Paper - Integration)

Figure 1.2.11: Combined Environmental Impacts and Cost Ranges – Base Load



Source: OPA, CERI and SENES; Note: Levelized Cost based on 11% discount rate.

■ Regarding the impact of GHG emission costs, we refer to the government cost benefit analysis prepared in order to justify coal closure. In that analysis greenhouse gas costs comprised 94% of the total estimated environmental damages with respect to coal fired generation. Even with this significant allocation of environmental costs, coal fired generation was a better choice than utilizing natural gas. This government report also noted that "Ideally, the GHG emissions being assessed should be based on a life-cycle perspective ... GHGs are associated with the production of natural gas (e.g. leakage during recovery and transport, burning of impurities) and the impact of these emissions is not captured in the damage estimates n this report." (Cost Benefit Analysis: Replacing Ontario's Coal-Fired Electricity Generation prepared for the Ontario Ministry of Energy, April 2005)

This report was based on costs much lower than current costs, as noted below.

Table 1. Levelised Cost of Electricity, $/MW (Derived from Data in the DSS report)

Coal as is	Coal with Stringent Controls	Coal Replaced With Gas @ 5.48USD @ 6.25CAD	Coal Replaced With Gas @ 7.00USD @ 7.98CAD	Coal Replaced With Gas @ 8.00USD @ 9.12CAD
$37	$51	$78	$93	$102

Using the mid point price for this year of say $7.00 US, the levelised cost of electricity from gas-fired generation would be $93 CAD/MW, 2.5 times that of the existing coal-fired generation or 1.8 times that of coal after installing stringent controls. Using a price of gas, $8.00 US, the price from gas-fired generation

becomes 2.8 times that of existing coal generation and 2.0 times that of coal after installing stringent controls.
For more information, please review the attached "Review of Ontario's Cost-Benefit Analysis, Replacing Ontario's Coal-Fired Electricity Generation", Prepared by Thomas Hughes Consulting (Corunna) Ltd.

■ Regarding public power subsidies, note the following information that describes subsidies available to the renewable and "clean" energy resource developers:
As part of the “Clean Air Incentives” noted in Ontario’s Clean Air Action Plan: Protecting Environmental and Human Health in Ontario, June 21, 2004”, “An immediate, 100 percent corporate income tax write-off and a capital tax exemption for assets acquired after November 25, 2002, and before January 1, 2008 that are used to generate electricity from clean, alternative, or renewable energy sources; A sales tax rebate on building materials purchased after November 25, 2002, and before January 1, 2008 that are incorporated into facilities that generate electricity from clean, alternative energy sources.” … “Natural gas is exempt from Ontario fuel taxes…”

■ Regarding costs for wind and solar energy, the OPA concludes that, “Technology improvements, cost improvements and favourable policies have resulted in significant increases in the annual production of photovoltaics over the past decade and this trend is expected to continue.” (OPA – Supply Resources)

■ The market and development of these renewable energy resources is increasing rapidly which is expected to drive costs down. On the other hand, the cost of raw materials and transport of the components has risen dramatically, so we are unable to provide any prediction of cost prospects for wind and/or solar.

■ Ontario however is committing to 20 year contracts at high prices for technology that could become obsolete as technology advances for both wind and solar.

Issues: A 2-5, 33

Ref.: page 24

7. The evidence indicates that "[t]here is insufficient evidence of [CDM] program success to determine with any degree of reliability what can be relied upon for planning purposes". Please provide a list of North American jurisdictions that include and rely on CDM for electricity planning purposes.

7. Answer

The CAE Alliance is unaware of a list of North American jurisdictions that include and rely on CDM for electricity planning purposes. There is widespread interest in pursuing and encouraging CDM to reduce electricity demand, which we naturally support.

Issues: A 2-5

Ref.: page 25

8. On page 25 the Alliance is critical of programs such as Peaksaver. Is it possible that CDM programs such as Peaksaver will decrease the use of natural gas and other generating sources as peaking or load following resources?

8. Answer

The CAE Alliance fully supports programs which, in the terms of the Ministerial Directive are "economically prudent and cost effect". We have questioned whether the costs of Peaksaver ($2,250,000 and counting) are worth the net demand reduction, particularly as there are other measures in place to reduce this peak demand.

Issues: A 7-9

Ref.: page 27

9. The evidence indicates that "wind resources have a 17-20% capacity factor". Provide the source of the data for using 17-20% as the average capacity factor for wind? Would you not agree that most capacity factors are cited as being over 30%? Please indicate if you distinguish between capacity factors for onshore and offshore wind, including that which might be sited on Lake Ontario?

■ "The average capacity value of the wind resource in Ontario during the summer (peak load) months is approximately 17%. The capacity value ranges from 38% to 42% during the winter months (November to February) and from 16% to 19% during the summer months (June to August). Since 87% of the hits (periods within 10% of the load peak) occur during the summer months, the overall yearly capacity value is expected to be heavily weighted toward the summer. The overall yearly capacity value is approximately 20% for all wind penetration scenarios." (Final Report to: Ontario Power Authority (OPA) Independent Electricity System Operator (IESO) Canadian Wind Energy Association (CanWEA) for Ontario Wind Integration Study)

■ Although the average capacity factor for 2007 wind production was higher, it was overall less than 30%. As we do not have installed offshore wind capacity, it is premature to provide information regarding this resource.

■ As noted, the Plan anticipates 9-11 TWhs production from additional wind generation. (See page 27 of our submission to the Board). "Wind-powered generation in Ontario more than doubled in 2007, ... output from the more than 400 MW of installed wind generation in Ontario totalled 1.04 terawatt hours (TWh) compared to 0.44 TWh in 2006." (IESO) At that rate it would take about 4500-5500MW of wind capacity to produce 9-11TWh.

Issues: A 19, 20, 23, 31

Ref.: Page 31

10. The evidence indicates that "[r]eplacing coal-fired generation with natural gas-fired generation will have marginal, if any, environmental benefit, but at great cost to the Ontario economy". Has your analysis related to the cost of coal generation and the purported customer efficiencies included the costs/liabilities associated with greenhouse gas emissions that are likely to arise under any/all of the federal domestic emissions trading system and Ontario's participation in the cap and trade systems under the Western Climate Initiative and/or the Ontario-Québec Memorandum of Understanding? If so, how and what GHG prices/costs were assumed?

■ Please see answer to Question 6, and the Review of the Cost Benefit Analysis, at the end of this Response. It must be noted that a federal emissions program will of necessity include the impacts of GHG emissions from natural gas processing transport. Please note the following regarding the comparison of natural gas and coal GHG emissions, which will have a bearing on natural gas costs going forward.

CO2 Emissions from Fossil Fuels by Source (millions of tonnes)

	TOTAL	Coal	Oil	Gas
Canada	550.9	110.7	268.8	171.3
United States	5800	2109.8	2447.9	1211.7
China	4768.6	3897.4	778.6	92.5
India	1102.8	734.2	314.4	54.2
EU-25	3891.4	1210.6	1674.7	961.6
World	26583.3	10624.0	10596.3	5254.3

CO2 Emissions from Fossil Fuels
(By Country and By Fuel As % of Total CO2 Emissions)

	TOTAL	Coal	Oil	Gas
Canada	2.1	0.4	1.0	0.7
United States	21.8	7.9	9.2	4.6
China	17.9	14.7	2.9	0.3
India	4.2	2.8	1.2	0.2
EU - 25	14.6	4.6	6.3	3.6
All Others	39.4	9.6	19.4	10.6
World	**100%**	**40%**	**40%**	**20%**

CO2 Emissions From Fossil Fuels
(By Country and By Fuel As % of World's Emissions by Fuel)

	Coal	Oil	Gas
Canada	1.0	2.5	3.2
United States	19.8	23.0	23
China	36.6	7.3	1.8
India	6.9	3.0	1.0
EU - 25	11.4	15.7	18.3
All Others	24.3	48.5	52.7
World	**100%**	**100%**	**100%**

source: IEA "CO2 Emissions from Fuel Combustion" (2006 edition)

■ Some jurisdictions are looking into better reporting for methane emissions associated with natural gas.

The U.S. Environmental Protection Agency (EPA) reports approximately 19,300 scf/mile/year of natural gas is lost during natural gas pipeline transportation.

Environment Canada reports 1,000 kt CO_2 eq for coal mining; 28,000 kt CO_2 for natural gas mining, plus an additional 27,400 kt CO_2 eq associated with venting and flaring. (2004 Sectoral Greenhouse Gas Emission Summary)

TransCanada Pipelines Ltd. reported 2,148.5 kt CO2 eq emissions at the Kenora Compressor Station from the compression/recompression of natural gas coming into the Province.

■ Fugitive releases (e.g. venting and flaring from oil production, methane leaks from pipelines) contributed to greenhouse gas emissions. The current estimates show an increase of 24.1 Mt between 1990 and 2006, a growth of about 57%. Much of this increase is the result of greater traffic through energy pipelines. (Environment Canada)

Issues: A 19, 20

Ref.: Page 32

11. The evidence indicates that "[c]oal closure and subsequent replacement with natural gas fired generation will cause electricity prices to rise to 60%-70% higher than they are now". Please provide the supporting evidence for these percentages and the underlying assumptions on carbon related costs that were used to support same?

11. Answer

■ This information was obtained from "Can Ontario Shutdown Coal and Keep the Lights On?", Benjamin Tal, CIBC World Markets, July, 2007

"... electricity prices in Ontario dance very closely to the tune of natural gas. ... On average, a one percentage point increase in natural gas prices leads to 0.5 percentage point increase in electricity prices in Ontario. And that's in an environment in which natural gas accounts for only 15% of Ontario's electricity supply. The heavy reliance on natural gas as the dominant source of new supply will bring this share to 30% by 2015 — doubling Ontario's electricity price sensitivity to swings in natural gas prices. ... So the combination of increased reliance on natural gas as a source of new electricity and higher natural gas prices is a sure recipe for higher electricity prices in Ontario. In fact, based on our assumption that natural gas prices will reach $12-$14/mnBtu by 2015, and assuming natural gas-electricity price elasticity of 0.7-0.8, we estimate that by the time the last coal-fired plant is closed, electricity prices in Ontario will be 60%-70% higher than they are now, or roughly 6.5% per year."

■ This information concurs with the information provided in our submission to the Board, at pages 16-18and pages 30-37.

■ See our response to Questions 6 and 10 regarding GHG emissions impacts.

Issues: A 19, 20, 23, 31

Ref.: Page 35

12. The evidence states that even considering environmental costs, "coal fired generation was a better choice than utilizing natural gas". Can you please provide the full economic costs of using coal and natural gas and the evidence you have to support your figures? Please explain, is carbon capture and storage a viable option for Ontario's continued use of coal in light of impending carbon cap and trade requirements? What geological reservoirs does Ontario have that compare to the Western Canadian Sedimentary Basin or even those that are believed may be available to Nova Scotia? In your view, if carbon storage reservoirs are not readily available to Ontario, how would GHG emissions from coal be effectively controlled and what is the cost associated with the measures you identify? If biomass is to be co-combusted with coal, what is the maximum amount that could be co-combusted? Is it a uniform figure for all facilities? Are GHG limitation requirements and the price of carbon emissions likely to increase or decrease in your view? Would GHG emission reductions achieved by biomass co-combustion not eventually be considered inadequate?

12. Answer

■ See our response to Questions 6, 10, 11.

■ For information regarding opportunities for carbon sequestration in Ontario, please review the document, "CO2 Sequestration Opportunities for Ontario", Natural Resources Canada Presentation, at http://www.nrcan.gc.ca/es/etb/cetc/combustion/co2network/pdfs/sequest_ontario_feb2006.pdf

■ Burning biomass with coal is an effective method for controlling GHG emissions. Ontario Power Generation has information on their website regarding the successes achieved to date. European countries utilize this method, burning up to 30% coal with biomass successfully.

■ There are other promising alternatives such as the use of algae for CO2 mitigation.

Issues: A 7-9, 20-21

Ref.: Page 48

13. The evidence states that "… cleaner sources of electricity production, such as wind, solar and hydroelectric… will be insufficient to replace the hours of power generation and the generating characteristics of coal-fired power…" Can you please provide the quantitative analysis to support the view that generation from renewable sources will necessarily be insufficient?

13. Answer

Some of the information provided in the following few questions includes information included in the CAE Alliance submission to the Board. We are reproducing it here for ease of reference.

■ As we have noted, wind and solar can displace coal fired generation, but not replace due to generating characteristics required. Countries that have included significant amounts of renewable energy remain dependant on traditional resources. "The cumulative wind power capacity operating in the EU now exceeds 48,000 MW." However, "In an average wind year, it will produce approx. 100TWh of electricity, equal to 3.3% of total EU electricity consumption." (from Presentation to the European Working Group on Renewable & Environmental Technologies Berlin - March 13, 2007 - Canadian Trade Commissioner Service)

■ "The United Kingdom has seen growth in co-firing biomass in coal-fired power plants. Denmark, Germany and Spain are often cited for their installed, and rapidly growing, renewable electricity generation capacities. While these countries have made large capacity additions with new renewables, their systems are also heavily reliant on conventional sources of energy, such as thermal (fossil fuels), large hydroelectric and nuclear resources. These electrical systems are also highly interconnected with their neighbouring transmission grids, providing these systems with the type of resiliency and robustness that would mitigate the interconnection issues typically associated with new renewable generation technologies. Germany is often cited as a model country for its growth in renewable energies. ... Germany's supply mix is dominated by coal and nuclear resources. While Germany is among the world leaders in installed renewable generation capacity, these resources still represent a minute fraction of Germany's total installed generation capacity." (OPA)

■ A review of the supply resources provided by the OPA demonstrates lack of resources to produce required TWhs. (This is verified by the OPA inclusion of significant amounts of natural gas fired generation.) There are insufficient hydroelectric resources planned/available to replace coal-fired generation.

Issues: A 19, 20 and 31 & 32

Ref.: Page 49

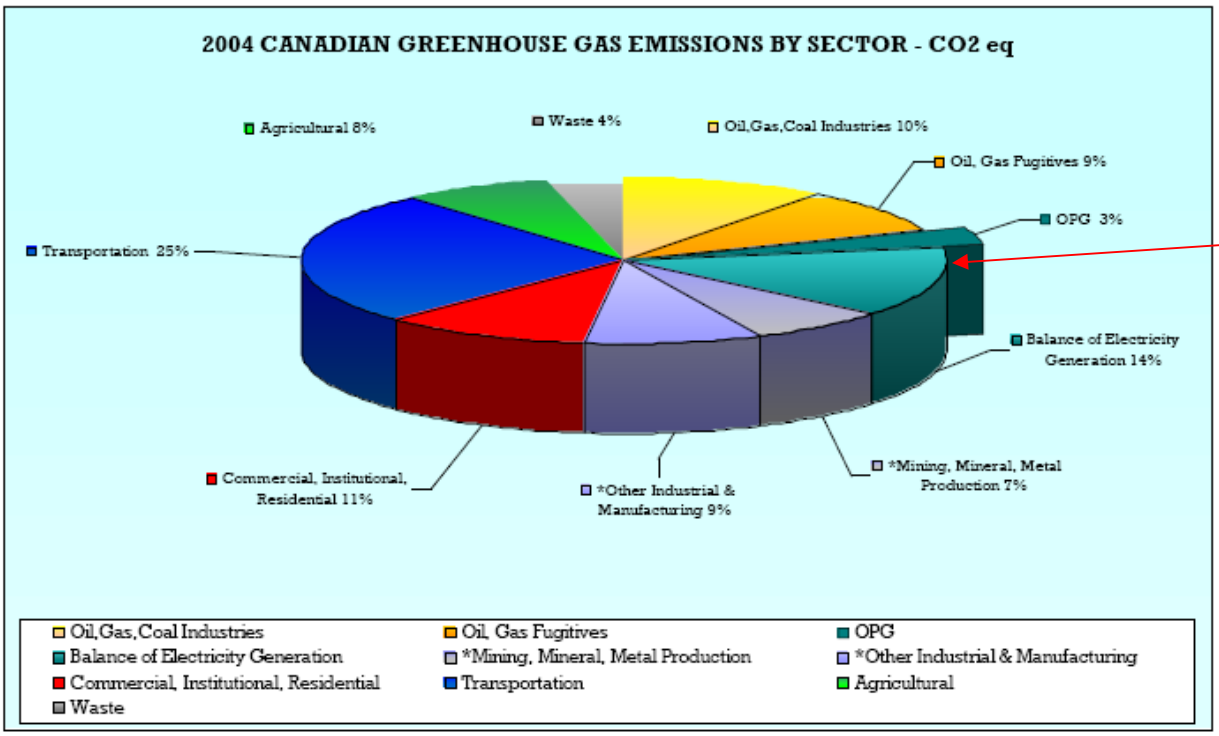
14. The evidence states that "the closure of coal fired generation in Ontario will not create drastic, nor significant reductions in greenhouse gas emissions". What share of Ontario's total GHG emissions do Ontario-based coal plants currently represent? What is the single largest point source of GHG emissions in Canada?

14. Answer

■ Ontario coal-fired generating plants produce less than 13% of provincial greenhouse gas emissions.

■ The largest source of GHG emissions in Ontario is the transportation sector, at 32% contribution.

■ As shown on the following chart, Ontario coal-fired generation contributes less than 3% to Canadian greenhouse gas emissions.



"Environment Canada, Summary of Canada's 2004 Greenhouse Gas Inventory"
*Includes both combustion emissions and process emissions

- Total Canadian Greenhouse Gases 758.0 MT
- OPG (coal) Greenhouse Gas Emissions 26.5 MT
- % OPG (coal) of all Canadian GHG emissions approx. 3%

(includes Lakeview Generating Station, since removed from service)

■ The largest point source of GHGs in Canada is the Sundance Generating Plant. The largest sector for emissions in Canada is the transportation sector, followed by the oil and gas industries.

Issues: A 19, 20, 31 &32

Ref.: Page 52

15. The evidence states that "[w]hen lifecycle emissions are taken into consideration, natural gas GHG emissions are about 25% less than coal". Can you please clarify, was the life cycle analysis also applied to coal? Can you kindly provide the lifecycle analysis you have used for coal and gas including the GHG cost assumptions?

■ A switch to natural gas-fired generation will reduce Ontario emissions by a mere 5% at best, and could actually increase. (Natural gas generation would reduce those emissions to about 7%.)

■ Natural gas emits about 55% - 63% the CO2 of coal generation **at point of combustion**. (63.06% according to - "Carbon Dioxide Emissions from the Generation of Electric Power in the United States", July 2000, staff of the U.S. Department of Energy and the U.S. Environmental Protection Agency; 56.67% according to Natural Resources Canada). Therefore, replacing coal fired generation with natural gas would

reduce total Ontario greenhouse gas emissions by only 5.4% (45% of coal's contribution to Ontario total emissions).

■ However, this figure represents emissions from the power generation process alone. There are additional, significant emissions associated with production, flaring, processing and transport of natural gas. A life cycle assessment of methane (unburned natural gas), which is 23 times more potent as a greenhouse gas than CO2 - from extraction through the pipeline, valves, fittings, compressor stations to power generation - would nulify the benefit of natural gas useage over coal.

Table2: Direct and indirect GHG emission factors for Electricity generation, by fuel type	
Fuel Type	Direct CO_2 emissions
Coal	1.20 kg CO_2-eq./kWh
Fuel Oil	1.10 kg CO_2-eq./kWh
Natural Gas	0.68 kg CO_2-eq./kWh
Nuclear	0.0052 kg CO_2-eq./kWh
Hydroelectricity	0.0024 kg CO_2 -eq./kWh
Source: NRCan Office of Energy Efficiency, June 2005	

■ The chart below identifies the global warming potential of a gas fired facility with consideration given to life cycle emissions, including a conservative estimate of 1.4% fugitive emissions.

GWP Contribution For Each System Component

Process step	GWP value (g CO_2-equivalent /kWh)	Percent contribution to GWP (%)
Power plant operation	372.2	74.6
Natural gas production & distribution	124.5	24.9
Construction & decommissioning	2.0	0.4
Ammonia production & distribution	0.4	0.1
Total	499.1	100.0

Source: Life Cycle Assessment of a Natural Gas Combined-Cycle Power Generation System , U.S. Department of Energy Laboratory

■ This chart indicates that production and distribution represents about 1/3 (33.35%) of the total global warming potential of the overall life cycle of natural gas fired power production. Therefore, we must assess natural gas climate change potential as point of combustion emissions, plus an additional 33.35%.

■ Considering the significant amount of new gas fired generation proposed for Ontario, and the future supply concerns, "…liquefied Natural Gas (LNG) is expected to play a critical role in addressing the forecast supply gap." (Navigant Consulting Report to OPA) There are greenhouse gas implications of using LNG. LNG entails an energy loss of 15% - 30% in the transport, liquefaction and regasification processes.

■ The Ministry of Energy has not taken into consideration the carbon intensity of generating facilities. Some existing natural gas fired power plants produce higher emissions/MWh. (Check the CARMA website - compare the CO2 intensity.)

■ Some new natural gas fired power plants in Ontario will utilize both oil and natural gas for power production. Some will be single cycle peaking plants. The emissions associated with both these forms of power production are higher than combined cycle natural gas plants.

Issues 2-5, 7-9, 15-19, 20-23, 33-34

Ref. page 58

16. The evidence states that "It is impossible, at this point in time, to replace coal fired generation with anything but another fossil fuel". Kindly provide the independent analysis you have undertaken to support this claim?

16. Answer

This information is explained throughout our submission to the Board, as well as this Response to the City's questions. It is explained throughout the OPA documentation, as well as the IESO's requirements regarding replacement generation characteristics.

The City of Toronto has spent hundreds of thousands of dollars funding lobbyists for the coal closure. May we respectfully encourage the City to incur the expense to independently verify the environmental impacts of the existing coal plants on the City of Toronto (GTA); the impacts of significant natural gas resources on the ozone levels (both the government's assessment and the OPA conclude that ozone will be worsened from the use of natural gas-fired generation in the City); and the economic impacts to the City of Toronto's many businesses and industries from the higher energy costs associated with natural gas-fired generation, as we have summarized in our information.

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

Updated March, 2006

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 $4,496000)(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 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 it's 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	LGS			NANTIKOKE			TOTAL
Units	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)