ONTARIO POWER GENERATION

Report for Submission to the Nuclear Generation Projects Committee

November 18, 2008

DARLINGTON REFURBISHMENT PROJECT

Executive Summary

OPG commenced project planning activities for the refurbishment of the Darlington Nuclear station in late 2007. Regular updates have been provided to the Board over the course of 2008 on the progress of those activities. The purpose of this memorandum is to update the Board on current planning activities.

Currently the major refurbishment scope consists of fuel channel and feeder replacement but excludes the replacement of Steam Generators (SG's). An independent third-party review has been completed and Management is reviewing its findings to re-assess whether SG's should be included.

Management has now completed a Screening Level Assessment of the economics of refurbishing the Darlington units. The assessment found that the Levelized Unit Energy Cost (LUEC) of refurbishing and continuing to operate the Darlington units for a further 30 years is in the range of 4.5 to 6 ¢/kWh. Within this LUEC range, the Darlington Refurbishment is significantly more economically attractive than alternate base-load generation options including New Nuclear and Combined Cycle Gas Turbines (CCGT).

The Refurbishment Project is estimated at approximately [redacted] on the basis of current scope (including a contingency of [redacted] and not including escalation and interest during construction). The project estimate after including escalation and interest is approximately [redacted] If SG's are included in scope, the project cost will increase by approximately [redacted] and the LUEC range will increase by approximately 0.5 ¢/kWh.

Given the Screening Level Assessment indicates the refurbishment and continued operation of Darlington has a high likelihood to be economically viable, Management is preparing an recommendation, for review by the Nuclear Generation Projects Committee and approval by the Board of Directors, that future planning activities be capitalized consistent with the corporation's accounting rules for project capitalization.

This report is for information only and no decision is being requested.

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1. Background

The Darlington Nuclear units are currently predicted to reach the end of their service lives in 2019 and 2020.

In June 2006, the Ontario Government directed OPG to begin feasibility studies on refurbishing its existing nuclear plants. The need for refurbishment is also addressed in the Ontario Power Authority's Integrated Power System Plan (IPSP). The Ontario Power Authority, in response to a Directive from the Ontario Minister of Energy, is planning for up to 14,000 MW of nuclear generation to meet Ontario's requirements for electrical energy. While the IPSP recognizes that refurbishment decisions rest with facility owners, the IPSP reference plan does assume substantial nuclear unit refurbishments, including the Darlington units.

The goal of the refurbishment project would be to extend the service life of the units by an additional 30 years. The refurbishment would involve an outage for replacement of life-limiting components, as well as maintenance or replacement of other components which are most effectively done during the refurbishment outage period.

2. Update on the Planning Activities Phase

Regular updates have been provided to the Board over the course of 2008 on the progress of the planning activities phase. The following work has been completed in 2008:

a) Technical Scope:

- On June 12th, the CEO approved the reference outage scope as an initial planning assumption for the Darlington NGS Refurbishment project. The reference outage scope is based on a review of the expected life of the critical components and their current life cycle plans and includes the replacement of pressure tubes, calandria tubes and feeders, and calandria internal inspections. Additional regulatory work scope is expected as a result of the completion of an Integrated Safety Review (ISR), an Environmental Assessment (EA) and a detailed plant condition assessment.

- Steam generator (SG) replacement is currently excluded from the reference outage scope. Based on a preliminary internal technical assessment, there is a high confidence that the SG's will continue to perform reliably for at least 15 years post refurbishment. A preliminary economic assessment showed that, provided the steam generators could operate reliably for 15 years post-refurbishment, there was an economic advantage to retaining the existing steam generators. Due to the strategic importance of this scope item, a contract was issued to perform a third-party review on the Condition Assessment of the Steam Generators. A draft report was received on October 14th and is currently under review by OPG technical experts.

- Work has also commenced on the Fuel Channel and Feeder Replacement Study, the Fuel Handling System Condition Assessment, and the Refurbishment Activity Islanding study.

b) Plant Condition Assessment (PCA):

- Prerequisite work on an assessment on the condition of the "balance of plant" systems including the development of a Scoping and Screening guide and database, as well as staff training, has been completed.

c) Integrated Safety Review (ISR):

- An assessment of key safety factors against modern codes and standards will be reviewed. Issues identified would be assessed for inclusion in the refurbishment project scope.

- The ISR Basis Document, which is the process governing document, will be the first major ISR deliverable to be submitted to the CNSC by year-end 2008. The document has been issued for internal review and comments are being dispositioned. The CNSC has accepted the code effective date of July 31, 2008.

- In September 2008, the Darlington Refurbishment Advisory Committee endorsed Management's recommended interim position to retain natural uranium fuel as the baseline for operation post-refurbishment at DNGS. This recommendation has been assumed in the Screening Level Economic Assessment. Low Void Reactivity Fuel (LVRF) option will be considered as a contingency for planning purposes. A definitive position with respect to Low Void Reactivity Fuel (LVRF) will follow from the corporate Canadian Nuclear Utility Executive Forum (CNUEF) and CNSC team initiative on Large LOCA (Loss of Coolant Accident). Their recommended path forward is expected by the end of 2008.

- In September 2008, a session was held with Darlington and NGD Nuclear Safety staff to review potential Nuclear Safety issues to be considered by the ISR program and potential economic initiatives. This review highlighted a number of areas that will be considered by the DN Refurbishment ISR including such issues as updating the Safety Analysis (Deterministic / Probabilistic / Hazard Analysis) to meet modern requirements and including ageing effects, Severe Accident Management, Seismic and Post-Accident Monitoring, Powerhouse Steam Ventilation System, Hydrogen Mitigation, Special Safety System performance, Environmental Qualification, and Shutdown Heat Sinks. These were presented to the Darlington Refurbishment Advisory Committee. Additional follow up sessions with key station stakeholders are continuing.

d) Outage Planning:

- On June 12th, the CEO approved the initial planning assumptions including the reference schedule for the Darlington NGS Refurbishment project.

	Start	Finish	Duration (mths)
1st Unit	1-Oct-16	1-Nov-18	25
2nd Unit	1-Jul-18	1-Aug-20	25
3rd Unit	1-Apr-20	1-May-22	25
4th Unit	1-Jan-22	1-Feb-24	25
		Unit Outage Months	100
		Refurb Window =	88

- Work is underway to prepare the draft site layout for refurbishment. The Darlington Site Infrastructure Coordination committee continues to meet and identify/mitigate any major issues related to the use of land and facilities for refurbishment taking into account Operations land use and New Build proposals.

3. Summary of Screening Level Assessment

The Darlington Refurbishment Screening Level Economic Assessment has been prepared and was endorsed by the Darlington Management Advisory Committee on September 29, 2008. The key assumptions used in deriving the preliminary LUEC range were as follows:

- The scope of the refurbishment outage is based on replacement of the pressure tubes, calandria tubes and feeders;
- A refurbishment duration of 25 months per unit with a 4 month overlap of the prior unit with the subsequent unit;
- A refurbishment schedule start of October 2016 on the first unit, overall 88 month refurbishment duration for all four units, resulting in a return to service of the final unit in February 2024;

- A total refurbishment project estimate of [redacted], overnight $, including a contingency of [redacted] including escalation and interest, assuming a 2016 start. Management believes that this is a medium to high confidence estimate;
- Post refurbishment direct station costs of [redacted] per year, which is slightly higher that the current expenditures levels;
- Nuclear Support and Corporate Support costs totalling [redacted] ($2008) per year on an incremental basis [redacted] per year, fully allocated);
- Average station performance post-refurbishment of 87% capability factor (with a range of 82% to 92% used for sensitivity analyses).

The economic assessment indicates 80% confidence that the Levelized Unit Energy costs for Darlington are in the range of 4.5 ¢/kWh to 6 ¢/kWh on an incremental basis. The refurbishment project costs account for about 1/3 of the LUEC value, while post-refurbishment operating costs account for the remaining 2/3 of the LUEC value. Should the need arise to add Steam Generators to scope, this would add [redacted] o the project costs, would impact the Net Present Value of the project negatively by [redacted] and would add ½ ¢/kWh to the expected LUEC. Similarly, should there be a need to use Low Void Reactivity Fuel in future (considered a very low probability), the impact on LUEC would be an additional 0.3 to 0.5 ¢/kWh.

At this LUEC, the Darlington Refurbishment is very competitive economically with all other generation options such as New Nuclear and Combined Cycle Gas Turbines (CCGT). Further details of the Screening Level Assessment are provided in Appendix A.

4. Planning Activities Phase Costs

A summary of the planned expenditures on the Darlington Refurbishment Planning Activities Phase (Initiation Phase) for 2008 is provided in Table 1 below. Life-to-date costs to year-end 2007 are $0.4 Million, primarily for regulatory fees. The life to date expenditure (projected) of the Darlington Refurbishment Planning Activities Phase is $10.3 Million (OM&A) as of year-end 2008.

Table 1 – Life to Date Expenditures – Darlington Refurbishment Planning Activities ($ Millions)

$ Million	Cost Life-to-Date 2007	Actual YTD Sept 2008	Approved Annual Budget 2008	YE Forecast 2008	YE Projected Life to Date
Engineering studies, including Plant Condition Assessment (PCA)	0	1.7	8.5	**5**	**5**
Licensing (EA and Licensing Regulatory Support)	0.4	0.7	1.9	**1.3**	**1.7**
Integrated Safety Review (ISR)	0	0.7	3.8	**1.3**	**1.3**
Project Support & Oversight	0	1.4	4.2	**2.3**	**2.3**
Total	**$ 0.4M**	**$ 4.5M**	**$ 18.5M**	**$ 9.9M**	**$ 10.3M**

5. Future Recommendation on Capitalization of Future Planning Activities

The Screening Level Assessment indicates that the refurbishment and continued operation of Darlington has a high likelihood of being economically viable. Management is preparing a recommendation, for review by the Nuclear Generation Project Committee and then approval by the Board of Directors, that future planning activities be capitalized consistent with the corporations accounting rules for project capitalization.

APPENDIX A:
SUMMARY OF SCREENING LEVEL ASSESSMENT OF DARLINGTON REFURBISHMENT

1.0 Process Used to Prepare Screening Level Assessment

The approach used to develop the Screening Level Assessment was as follows:

- **Assemble and Validate Preliminary Assumptions**: Preliminary assumptions on refurbishment scope and costs, durations, timing, operating and maintenance costs, performance etc were assembled and reviewed with individual subject matter experts, the NGD Team and other invited subject matter experts.
- **Review Assumptions with Advisory Committee:** The Darlington Advisory Committee, made up of most of the members of the Nuclear Executive Committee as well as the CFO, the Chief Risk Officer and SVP and General Counsel, was presented with the assumptions for information and input, prior to preliminary results being generated. This provided the assessment team an opportunity to obtain Senior Executive input to the analysis.
- **Generate Preliminary Results, Review with NGD Project Team and Advisory Committee:** The preliminary results were developed and presented to the NGD team and subsequently to the Darlington Advisory Committee in order to provide further opportunities for review and input.
- **Present Assumptions and Results to the Executive Committee:** As is the case for all material to be presented to the Board of Directors and/or sub-committees of the Board, the assumptions and results of the Screening Level Assessment were presented to the Executive Committee of Management.

2.0 Assessing the Economics of Refurbishment

In order to assess the economics of the refurbishment decision on Darlington, the following key factors must be considered:

- **Refurbishment Scope, Cost, Duration and Timing**
- **Expected Life of each unit post-refurbishment**
- **Forecast annual operating costs post-refurbishment, including Operation, Maintenance and Administration costs, On-going Project (Capital & OM&A) costs, Outage costs, Fuel costs, Nuclear Waste Management and Decommissioning (Provisions) costs and Overhead (Nuclear and Corporate) costs.**
- **Forecast Performance post-refurbishment (annual capacity factor/capability factor).**
- **Economic Indices (e.g. labour and material escalation rates, appropriate discount rate)**

The above factors can be used to determine the Levelized Unit Energy Cost of the refurbishment option. In addition, to assess the Net Present Value of the decision, assumptions need to be made about the future electricity price. There are other potential incremental costs or opportunities associated with a decision to go or not to go ahead, such as changes to the present value of the decommissioning liability or incremental transmission costs, which are applicable if one were to take a societal view of the costs and benefits of the project, which may also influence the ultimate decision.

The above items are discussed in more detail in the following sections.

2.1. Refurbishment Scope, Cost and Reference Schedule

2.1.1. Refurbishment Scope

The core scope of work during the refurbishment of each Darlington unit was assumed to be limited to the replacement of fuel channels (pressure tubes and calandria tubes) and feeder pipes (up to the

feeder header). At this time, the refurbishment scope does not include replacement of the steam generators or a switch to Low Void Reactivity Fuel. These items are discussed below in more detail.

Preliminary assumptions were made about the amount (and cost) of non-core refurbishment work likely to be required on the nuclear steam supply system and the balance of plant for each unit. This work can potentially arise from a need to perform safety upgrades and/or to bring the plant in line with new regulatory requirements; however, the scope of this work will remain not well defined until the completion of the Environmental Assessment process, the Integrated Safety Review and the detailed Plant Condition Assessments.

Notionally included in the allowances for non-core refurbishment scope work are also limited provisions for advancing future life-cycle work (ie, work that would be necessary in the post-refurbishment life to ensure that the plant can continue to operate safely and reliably during that planned post-refurbishment life), where it made business sense to advance this work into the refurbishment outage, eg, because of the duration of the work or the state of the plant required to execute the work.

The outage scope also includes provisions for outage support work (unit islanding, facilities, construction island barriers, D2O management, radioactive waste management).

Steam Generators: The Darlington Refurbishment Advisory Committee, at its May 23, 2008 meeting, agreed with the recommendation of the Darlington Refurbishment Project Team that the interim scope of the upcoming refurbishment should not include steam generators. This recommendation was based on the following:

- Historically, the Darlington steam generators have performed exceptionally well with a total incapability of 0.62% (in-service to April 2008). This performance is partially due to very good chemistry control and maintenance practices. There has been no forced incapability at Darlington due to steam generators since 2000.
- A preliminary technical assessment of the Darlington steam generators by Engineering & Modifications indicated that the steam generators have greater than a high to medium probability of achieving 15 years post-refurbishment without significant deterioration in performance and a medium probability of reaching 30 years post refurbishment life.
- Refurbishment Outage execution is simplified if steam generators are not replaced which increases the confidence in achieving the planned 25 month outage duration.
- A conservative economic assessment indicates that as long as the steam generators can operate reliably until up to 15 years post-refurbishment, it makes economic sense not to replace them during the refurbishment outage even if later replacement requires a 20 month outage per unit, or if later replacement costs $100 Million more per unit, which includes the costs of defuelling, draining, drying, refuelling and commissioning.

Due to the strategic nature of this decision, an external third party was commissioned to perform a condition assessment of the steam generators and to recommend a long term (post-refurbishment) life cycle strategy and plan. The preliminary results of this assessment have been received by OPG and are being reviewed internally.

Low Void Reactivity Fuel (LVRF): The refurbishment scope does not include a switch to Low Void Reactivity Fuel (LVRF) to address Safety Margin issues. LVRF remains a contingency for planning purposes. This decision was endorsed by the Darlington Refurbishment Advisory Committee on September 29, 2008. The preferred approach is to retain natural uranium fuel as the reference basis for Darlington in the post-refurbishment period, which is consistent with current strategies. A definitive position with respect to the use of LVRF to address Safety Margin issues is expected by the end of 2008 based on on-going work under the aegis of the Canadian Nuclear Utility Executive Forum (CNUEF) and the CNSC.

Tritium Removal Facility (TRF): The TRF located at Darlington provides services to Canada's CANDU fleet (OPG, Bruce, Gentilly, Point Lepreau) and other occasional minor customers. A Heavy Water (D_2O) Management Strategy Study is underway, which will make recommendations in 2009 regarding the need for, and the likely timing of, TRF refurbishment and/or replacement. If needed, a new facility is expected to cost $500 Million. Darlington's share of the TRF costs is approximately 40%. For the Darlington Refurbishment Screening Level Assessment, replacement of the TRF is assumed to take place at the end of the current TRF life (nominally 2024), and costs are assumed to be shared among all TRF customers. TRF replacement (capital) costs are not included as part of the Darlington refurbishment scope. If Darlington were to attract the full costs of TRF replacement and operation (ie, a current-sized TRF dedicated to Darlington) additional impact on the LUEC is small (0.1 cents/kWh),

2.1.2. Refurbishment Costs

Preliminary cost estimates were developed for the refurbishment scope of work from a variety of sources, including the Pickering B assessment in 2007, industry studies, experience from previous OPG projects and engineering judgment. For the purposes of preparing sensitivity analyses, ranges were applied to these costs.

The table below summarizes the project costs which were utilized in the assessment and compares these with the costs developed for Pickering B refurbishment in 2007.

Table 1: Refurbishment Project Costs Used in the Screening Level Assessment

Cost Element	[redacted]
Retube & Refeeder (1)	
Steam Generators (SG)	
Turbine/Generator Set Upgrades	
Fuelling Machine Upgrades	
Reactor Components	
Safety & Env. Assessment Upgrades	
Plant Condition Assessments	
Unit Separation & Construction Island	
Refurbishment Waste & D2O Mgmt	
Cyclic Outage/IOP Work & Deferred Proj.	
Initial Fuel Charge	
Project Mgmt & Programmatic Support	
Total Before Risks/Contingencies*	
Total Allowances for Risks/ Contingencies	
Total	
Overall Total for4 units	

1. Prorated from the Pickering B estimate to reflect the higher no. of fuel channels at DN (480 @ DN vs. 380 @ Pick B).
2. Proj. Mgmt & Program. Support costs have increased since the Pickering B assessment, due to higher Supply Chain estimates.
3. 20% contingency based on same % used for Pickering B and applied evenly to each unit for screening level assessment. Note that the contingency has not been skewed to the first unit at this early stage of the assessment.

2.1.3. Refurbishment Reference Schedule

For the Darlington Refurbishment project, the reference schedule was established in 2 steps; the duration of a unit outage was first established followed by the decision on the timing of the unit outages.

Unit Refurbishment Duration: The duration of the refurbishment outage of the first Darlington unit was assessed to be nominally 25 months (breaker open to breaker closed). This was based primarily on the experience from the Pickering B assessment prepared in 2007 adjusted for differences at Darlington, as well as engineering judgment, experience with recent projects in OPG, and published information on the expected durations of planned or currently underway refurbishments of other CANDU units in Ontario (ie, Bruce Units 1 & 2).

In summary, the key activities and nominal expected durations were as follows (estimates will change as the schedule is developed in more detail):

Refurbishment Activity	Duration
Defuel	4 months
Replace Pressure Tubes, Calandria Tubes and Feeder Pipes (vault preparation/isolation, decontamination if required, drain/dry, feeder removal, pressure tube / calandria tube removal, pressure tube / calandria tube re-installation, feeder re-installation, new fuel load)	17 months
Unit Restoration (refill moderator and heat transport system, pressure test, system commissioning)	4 months
Total Duration	**25 months**

Timing of Unit Refurbishment Outages: The Darlington units have predicted end-of-service life dates ranging from Q1 2019 to Q1 2020 assuming 210,000 Effective Full Power Hours (EFPH) for the pressure tube life. As shown below, this represents a medium confidence (30 – 70%) estimate. The high confidence estimate (70 – 90%) of the pressure tube life is 185,000 to 190,000 EFPH which corresponds to end-of-service life dates for the Darlington units about two years earlier (see table below). There are currently programs underway to increase the confidence in a pressure tube life of 210,000 EFPH but these are not expected to result in greater clarity around pressure tube life until 2011 or later.

Forecasted Unit Nominal End-of-Service Life Dates

	Pressure tube life	
Unit	210,000 EFPH (30-70 % confidence)	185,000 – 190,000 EFPH (70-90 % confidence)
1	Q1 2019	Q2 2017
2	Q1 2019	Q2 2017
3	Q4 2019	Q1 2018
4	Q1 2020	Q2 2018

Several criteria were used to assess the optimum start dates for a Darlington refurbishment outage, including the life of major components (e.g. pressure tubes and feeders), lead times for key decisions (Environmental Assessment, Integrated Safety Review), lead times for critical path procurement activities (e.g. pressure tube tooling), project preparation and planning, market share implications for OPG and capacity available to the Ontario electricity system. The overall ranking indicated that the optimum start date for the first Darlington refurbishment outage was 2016.

The following is the current reference schedule for refurbishment, with the first unit's refurbishment starting in 2016, refurbishment outage durations of 25 months/unit with a 4 month overlap between the

end of the prior unit and the beginning of the subsequent unit, and a final unit return-to-service date of 2024:

Table 2: Reference Schedule Used in the Screening Level Assessment

Unit	Start of Refurbishment Outage	Finish of Refurbishment Outage	Duration (months)
1st	**1-Oct-2016**	1-Nov-2018	25
2nd	1-Jul-2018	1-Aug-2020	25
3rd	1-Apr-2020	1-May-2022	25
4th	1-Jan-2022	**1-Feb-2024**	25
		Unit Outage Months	100
		Refurbishment Window	88

The refurbishment reference schedule optimizes the value to OPG and the Ontario electricity consumer, considering a range of factors. A key consideration is to minimize the combined sum of idle time and forsaken life. Idle time occurs when a unit is shutdown before the refurbishment outage can begin, because limiting components have reached their ends of life, but readiness to refurbish cannot be achieved (e.g. another unit is already under refurbishment; lead time constraints have prevented the acquisition of necessary tooling). Forsaken life occurs when units are shutdown for refurbishment before they reach the limiting component end of life, in order to execute the refurbishment. Because the nominal end of life dates of the four Darlington units occur within a 1 year span, there is the potential for significant idle time and/or forsaken life which would need to be managed.

2.2. Post-Refurbishment Assumptions

To fully assess the merits of the option to proceed with the refurbishment of the Darlington plant, all future expected costs of operating the facility over its post-refurbishment life, as well as the expected operating performance of the plant and expected unit life must be forecasted.

2.2.1. Unit Life

Since the Darlington units will have been in service for approximately 60 years (not including the time out-of-service for refurbishment) by the end of their post-refurbishment lives, it is considered prudent to utilize conservative assumptions for unit lives for the economic assessment, in order to mitigate the risk that an unforeseen equipment issue could emerge which could bring about an earlier than expected end of post-refurbishment life.

The post-refurbishment life of each unit was assumed to be nominally 30 calendar years. This post-refurbishment calendar life was derived from the current design life of pressure tubes of 24 effective full power years (210,000 effective full power hours) with some recognition that, given the knowledge gained about pressure tube degradation mechanisms, future pressure tubes will likely be designed to achieve longer service lives. 30 calendar years, with an assumed 87% capability factor translates into a pressure tube life of 25.5 effective full power years (approx. 224,000 effective full power hours). This nominal life was used in the Screening Level Assessment.

Sensitivities on unit lives were run at 25 calendar years and 40 calendar years respectively.

2.2.2. Annual Station Operating, Maintenance & Projects Costs

The 2012 data from the approved 2008-2012 business plan was used to derive the expected annual OM&A for the post-refurbishment period. Annual OM&A levels were derived based on forecast changes to programs and were estimated to be nominally the same as the current 2008-2012 Business Plan averages over the post-refurbishment period.

The post-refurbishment outage costs were developed based on expected work programs and typical outage templates. These were increased during the last 10 years of post-refurbishment life. The outage costs include allowances for periodic 4-unit shutdowns for the Vacuum Building Inspections and Containment Testing.

Expenditures for ongoing sustaining projects of $28M/unit/yr was assumed, which is consistent with the nuclear project portfolio assumptions. This was modified by assuming that, in the first year post-refurbishment, 50% of the "typical' annual project costs would be incurred, ramping up to 100% by the 5th year.

The following table provides details on the assumptions used for these factors in the analysis.

Table 3: Annual OM&A, Outages & Projects Costs Used in the Screening Level Assessment

Going Forward Cost Item	2008-2012 Bus. Plan Avg. ($M/yr; 2008$)	Post-refurbishment Averages
		Median Confidence ($M/yr; 2008$)
Station Base OM&A (1)	290	293
Outages (1)	90	92
Projects (Cap & OM&A) (2,3)	78	101
Annual Direct Costs	458	486

1. Base and Outage post-refurbishment forecasts are very close to the current business plan averages. Excludes Darlington portion of TRF costs which is accounted for in the assessment model.
2. Project forecasts are based on 4/10 of the current Nuclear Portfolio. Darlington specific projects in the last 2 years of the business plan are not all defined. The 3 year projects spending average in the business plan period is $93M.
3. Periodic major projects (e.g. facilities, security) are factored into the long-term projects forecast.

2.2.3. Annual Support and Overhead Costs

Costs associated with direct and allocated support services and overheads must be included when considering the true costs of the continued operation of the Darlington plant. These overhead and support costs are divided into Nuclear and Corporate Support. Examples of nuclear support costs include costs of the Engineering and Modifications organization which are not directly charged to each plant through project work, e.g. chemistry and metallurgy support. Examples of Corporate Support costs include Head Office Finance Support, Human Resources and Real Estate Services. In addition, there are overheads such as pension obligations and insurance which are allocated to Darlington.

Experience shows that a large portion of these costs would not disappear from the company's cost structure if Darlington were to be shut down. Hence, the analysis of Darlington's economic assessment is done including fully allocated support and corporate overhead costs and also including only the portion of those costs which are considered incremental to the operation of Darlington. Table 4 below

shows the fully allocated and incremental support and overhead costs which were assumed in the Screening Level Assessment.

Table 4: Nuclear & Corporate Support Costs Used in the Screening Level Assessment

Going Forward Cost Item	Fully Allocated M$/Yr, 2008$	Incremental M$/Yr, 2008$
Nuclear Support	**175**	**145**
Corporate Support & O/Hs	**143**	**41**
Total	**318**	**186**

1. Fully Allocated Nuclear & Corporate Support costs are very close to current 2009-2013 business plan averages.
2. Incremental Support & Overhead costs refer to the derived portion of these costs that would not be expended if Darlington were to be shutdown.
3. In other words, of $318 M/yr in allocated support & overhead costs, only $186 M/yr is incremental to Darlington; remaining $132 M/yr will be incurred regardless (in the long term this could likely be reduced).
4. Overheads include costs such as obligations for past service liabilities which will be incurred regardless and are not considered incremental.

2.2.4. Station Performance Assumptions

In developing an estimate of the performance of the Darlington units in the post-refurbishment period, a number of factors were considered including historical performance. Recent capability factor performance has been excellent, in the 85%-90% range, and recent planned outage performance and forced loss rates (FLR) have also been very good.

Factors considered in forecasting a post-refurbishment performance include the following:

- Lifetime performance of the Darlington station has been 83% capability factor; last 10 years' performance has averaged 87% and last 5 years' performance has also averaged 87%.
- As part of the assessment for refurbishment, detailed plant condition assessments (PCAs) will be completed well prior to the decision on refurbishment. These PCAs should identify any major equipment issues which may potentially limit the performance of the plant post-refurbishment.
- Technical knowledge of equipment reliability issues, including component degradation mechanisms in CANDU reactors and the balance of plant, has improved dramatically over last 5 decades of the CANDU program, leading to some confidence that there will be fewer surprises in the future.

These issues were discussed in meetings with senior station personnel and in discussions with the NGD Project Team and the Advisory Committee. The consensus view arrived at was to assume a reference annual capacity factor of 87% but to analyze over a broad range as shown in Table 5 below:

Table 5: Performance Assumptions Used in the Screening Level Assessment

Performance Factor	2008-2012 BP Avg	High Confidence	Medium Confidence	Low Confidence
Gross Capability Factor (%)	91%	82%	**87%**	92%

The 87% capability factor (medium confidence) is equivalent to Darlington's average performance for last 10 years. It is considered conservative given the station's performance of 89.6% over the last 3 years and would put the station in the 4th quartile of INPO plants. The low end performance of 82% reflects the station's since-in-service performance and could result, for example, from a failure to effectively implement the Integrated Aging Management Program (IAMP) and/or an inability to maintain

a 3-year outage cycle. It would also allow 20-month outages at year 15 post-refurbishment, if necessary, to replace steam generators. The high end performance of 92% could be achieved if Darlington were to achieve and sustain 1st or 2nd quartile INPO performance, funding levels are maintained, the IAMP is effectively implemented, and Human Performance is maintained.

3.0 Results

The Levelized Unit Energy Cost (LUEC) was calculated using the above assumptions and alternative scenarios and sensitivity analyses were run on the low/high (pessimistic/optimistic) assumptions in order to assess the sensitivity of the results to the various input variables. These results are presented below.

3.1. Levelized Unit Energy Costs

The preliminary analysis indicates 80% confidence that the levelized units energy costs (LUEC) for Darlington Refurbishment of about 4.5 to 6 cents/kWh (2008$) on an incremental basis. Incremental LUECs include only the going forward costs associated with refurbishment and continued operation. Note that the refurbishment project costs account for about 1/3 of the LUEC value, while post-refurbishment operating costs account for the remaining 2/3 of the LUEC value. Should the need arise to add Steam Generators to scope, this would add $2 Billion to the project costs, would impact the Net Present Value of the project negatively by $1 Billion and would add ½ ¢/kWh to the expected LUEC. Similarly, should there be a need to use Low Void Reactivity Fuel in future (considered a very low probability), the impact on LUEC would be an additional 0.3 to 0.5 ¢/kWh.

3.2. Sensitivity of Results to Changes in Input Assumptions

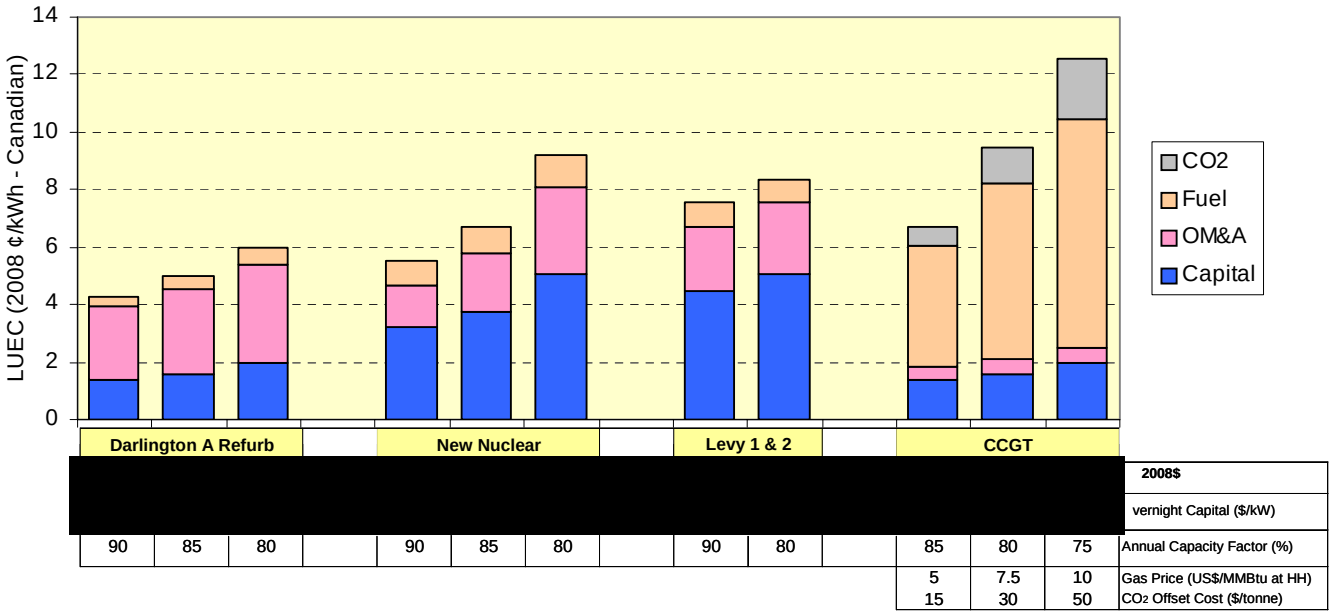
As documented in Section 2, this Screening Level Assessment includes a large number of assumptions regarding refurbishment costs and durations, going forward operating and sustaining investment costs and operating performance. For each of these factors, ranges were developed and sensitivity analyses were run at the low and high ends of these ranges for each of the key input factors. This analysis shows that the results are most sensitive to assumptions on future performance (post-refurbishment life and capability factor assumptions), future operating costs (Station Direct, Nuclear & Corporate Support costs), project costs and the discount rate.

3.3. Comparisons to Other Options

A significant input into the decision-making process on the economic viability of the Darlington Refurbishment is a comparison to the LUEC's of other options competing with this project. Figure 1 presents such a comparison.

The conclusion is that the economic viability of Darlington Refurbishment project compares well. It is at a level comparable to the low end of New Nuclear and better than the low end of combined cycle gas turbines (CCGT) for low, median or high gas process and no CO_2 adder. The LUEC for CCGT is highly uncertain due to the continuing volatility in natural gas prices and potential changes to CO_2 regulations. Estimated costs for New Nuclear have risen sharply in the past few years and are also highly uncertain. The latest estimates for Progress Energy's Levy Plant in Florida are near the high end of OPG's estimated range for New Nuclear.

Figure 1: Levelized Unit Energy Costs for Darlington Refurbishment and Comparators



4.0 Conclusions of Screening Level Assessment

The preliminary Levelized Unit Energy Cost (LUEC) assessment for Darlington Refurbishment appears to be very competitive economically with other available generation options, including New Nuclear and Combined Cycle Gas. There is merit to continuing the development of a more detailed scope, cost, and schedule for the project and to commence preliminary engineering work.