UNDERTAKING JT2.1

Undertaking

TO FILE THE MINISTERIAL CONCURRENCE LETTER.

Response

See Attachment 1.

Ministry of Energy

Office of the Minister

4th Floor, Hearst Block
900 Bay Street
Toronto ON M7A 2E1
Tel.: 416-327-6758
Fax: 416-327-6754

Ministère de l'Énergie

Bureau du ministre

4e étage, édifice Hearst
900, rue Bay
Toronto ON M7A 2E1
Tél. : 416 327-6758
Téléc. : 416 327-6754

NOV - 7 2016

RECEIVED
NOV 10 2016
OFFICE OF THE BOARD CHAIR

Ontario

MC-2016-2226

Mr. Bernard Lord
Chair
Ontario Power Generation
1900–700 University Avenue
Toronto ON M5G 1X6

Dear Mr. ~~Lord~~ Bud,

Thank you for your submission of Ontario Power Generation's (OPG) 2016-2018 Business Plan ("the Plan"). I have reviewed the Plan and find it to be consistent with our government's expectations, subject to OPG's alignment with requirements of Treasury Board Secretariat's Executive Compensation Framework Regulation.

I support the operational and financial targets set by OPG in its business plan. I expect OPG to work closely with the Ministry of Energy to continue its commitment to deliver the efficiencies and cost savings as per the 2016-2018 Business Plan in a manner that is consistent with the continued safe and environmentally responsible operation of OPG's facilities. As the Darlington Refurbishment Project is a key priority for the government, I expect that OPG will continue to focus on delivering the project as per the schedule and budget contained in the Release Quality Estimate approved by the OPG Board and by the government. I also expect OPG to continue to minimize project risks consistent with the nuclear refurbishment principles set out in the 2013 Long-Term Energy Plan.

I expect OPG to continue to keep the government informed with regard to the company's key ongoing and emerging initiatives and progress in achieving its financial and operational performance commitments. I recognize the important role that OPG has and will continue to play in delivering value to the Province and electricity ratepayers.

In addition, in order to support the focus on cost containment, the decommissioning of Lambton Generating Station should proceed immediately.

I recognize OPG's achievement to date with overall headcount reductions, and OPG's efforts to align its pensions with those in the Public Service, and we expect OPG to continue negotiation on this issue in future rounds of collective bargaining. OPG's accrual accounting methods for recovery of Pension and Other Post-Employment Benefits costs are fair and reasonable given the long-term nature of these costs.

.../cont'd

In regard to the OPG's executive compensation, I expect OPG to work within the Treasury Board Secretariat (TBS) Executive Compensation Framework Regulation that came into force on September 6, 2016, which caps salary and performance-related payments for executives at no more than the 50th percentile of appropriate comparators. I understand OPG is revisiting the current proposal as embedded in the 2016-2018 Business Plan and encourage you to continue your work with the Ministry of Energy and the TBS to develop the framework that meets the requirements outlined in the regulation.

This letter constitutes my concurrence with OPG's Board-approved 2016-2018 Business Plan as provided for under the Memorandum of Agreement between OPG and the Shareholder dated July 17, 2015.

Sincerely,

Glenn Thibeault
Minister

c: Jeff Lyash, President and Chief Executive Officer, OPG
Serge Imbrogno, Deputy Minister, Ministry of Energy

UNDERTAKING JT2.2

Undertaking

TO EITHER PROVIDE THE REPORT DETAILING THE APPROXIMATELY 500 COMMUNITY JOBS, OR PROVIDE REASONS FOR NOT PROVIDING IT.

Response

The Technical and Economic Assessment of Pickering Extended Operations beyond 2020 (Ex. F2-2-3 Attachment 2) identified various quantitative benefits of Pickering Extended Operations including the direct deferral of 4,000 jobs along with an indication that additional indirect and induced jobs would also be affected. OPG discussions with the Ministry of Energy regarding Pickering Extended Operations that included estimated employment impacts resulting from Pickering NGS closure would have been consistent with the findings in the Technical and Economic Assessment of Pickering Extended Operations beyond 2020.

The City of Pickering also commissioned a report that was funded by OPG to understand the economic impact resulting from the closure of Pickering NGS in 2020. The final report dated June 18, 2015 is Attachment 1 to this response. The report concluded that 4,698 employment FTEs would be impacted in Ontario following the closure of Pickering NGS. This included direct, indirect and induced jobs across Durham Region and in Ontario. OPG provided data for used in this report particularly with respect to employment information and staff projections.

City of Pickering

Economic and financial impact of the retirement of Pickering Nuclear Generating Station

June 18, 2015

FINAL REPORT

Table of Contents

Executive Summary

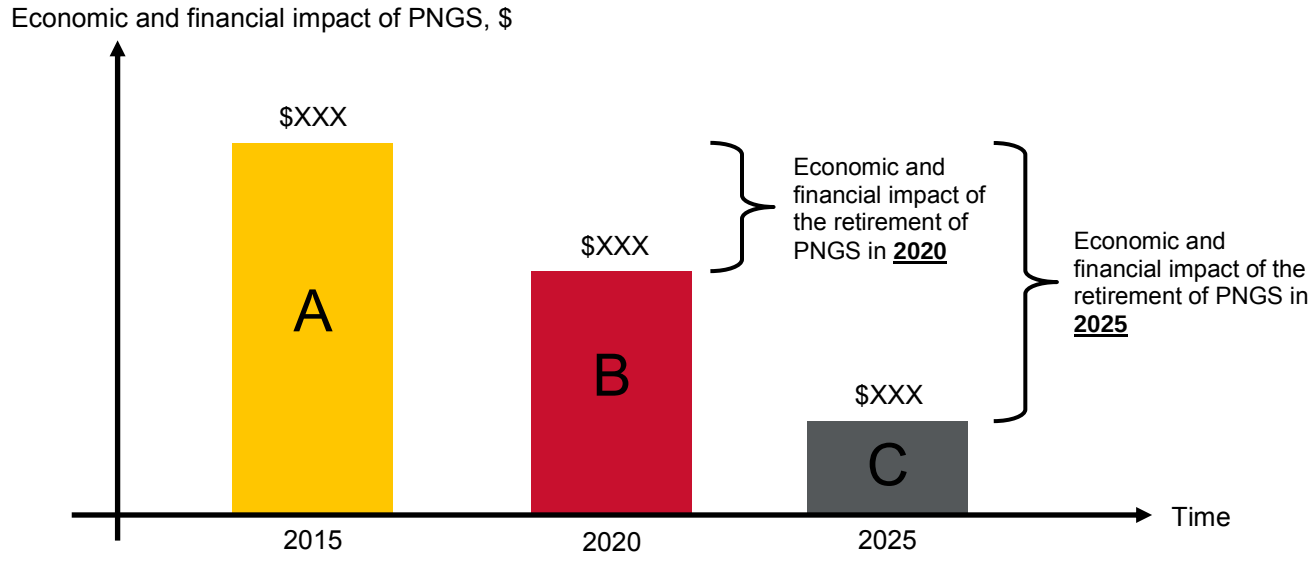
Study objectives

The Pickering Nuclear Generation Station ("PNGS") has nearly reached its useful life and is slated for decommissioning. Given that PNGS is the largest employer in the City of Pickering, the municipality engaged HDR Corporation ("HDR") to assess and estimate the economic and financial impact to Pickering and specifically Pickering residents and the Corporation of the City of Pickering of the retirement of PNGS on an objective, transparent and credible basis over the 2015 to 2025 period.

How to interpret the results?

Economic and financial impacts associated with the retirement of PNGS are estimated relative to the baseline which for the purposes of this study is the economic and financial contribution of PNGS in 2015. The figure below illustrates how the economic and financial impact of the PNGS retirement is estimated and should be interpreted.

Figure 1 – Interpretation of economic and financial impact of the retirement of PNGS



We estimate the economic and financial contribution of PNGS in 2015 (the baseline year), 2020 and 2025 to Pickering. PNGS no longer generates electricity in 2020 and prepares for the long decommissioning process that lasts several decades. For the purposes of this study:

- The economic and financial impact of the **retirement of PNGS in 2020** is equal to the economic and financial contribution of PNGS in 2020 (Area B) less the economic and financial contribution of PNGS in 2015 (Area A);
- The economic impact of the **retirement of PNGS in 2025** is equal to the economic and financial contribution of PNGS in 2025 (Area C) less the economic and financial contribution of PNGS in 2015 (Area A).

Economic and financial impact results

The table below shows the total economic impact associated with the retirement of PNGS in 2025 relative to 2015 (Area C less Area A in the diagram above). These results were estimated by HDR based on data and information collected from Ontario Power Generation ("OPG") and other sources and employing standard and accepted economic impact methodologies (see the main body of the report for a description of the methodology and specific data sources employed). To estimate the economic impact of the retirement of PNGS to City of Pickering residents and the Corporation of the City of Pickering, we first estimated the economic impact of the retirement of PNGS to Ontario and then assessed what proportion of this impact is localized in the City of Pickering to: residents, local businesses and the Corporation of the City of Pickering.

Table 1 – Total gross economic and financial impact (direct, indirect and induced) of the retirement of PNGS from 2015 to 2025

	Ontario	City of Pickering
GDP (millions)	-$789.7	-$48.8
Wages and salaries (millions)	-$367.1	-$21.4
Employment (FTEs)	-4,698	-231
Government revenues (millions)†	-$191.2	-$0.5

† Government revenue economic impacts for Ontario refer to revenues generated from all forms of taxation, for the City of Pickering they refer to Payments in lieu of Property Taxes only.

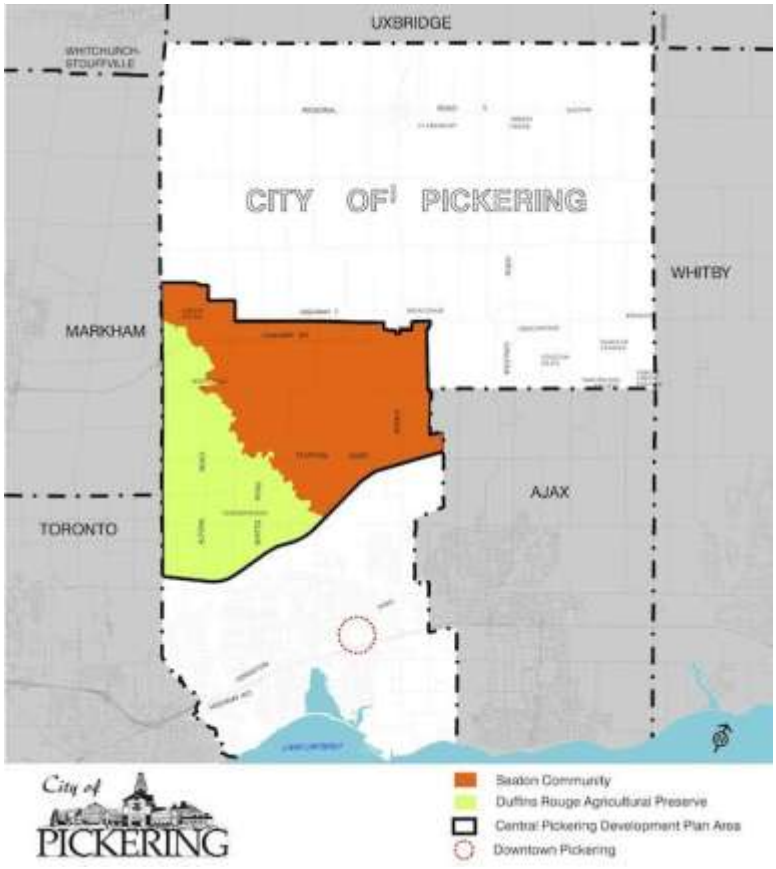
Estimates presented above are considered **gross** as opposed to **net** economic impacts because we have not considered economic impacts arising from the refurbishment of Darlington Nuclear Generating Station ("DNGS") and Bruce Nuclear Generating Station ("BNGS"). We also have not considered any potential positive economic impacts that could result from a change in energy prices arising from the retirement of PNGS. By 2025, the gross economic impact of the retirement of PNGS is expected to result in $789.7 million less in GDP to Ontario, which represents 0.1% of Ontario's economy, and $48.8 million less in GDP to Pickering. With respect to employment, by 2025, the retirement of PNGS will result in 4,698 job losses across Ontario on a gross basis and the retirement of PNGS is expected to decrease government revenues from all forms of taxation by roughly $191 million.

That said, only 8% of the employees at PNGS actually live in the City of Pickering and a majority of PNGS's non-wage expenditures occur outside the City of Pickering. We therefore estimate that 231 residents of the City Pickering, of which 203 work at PNGS (see Table 9 in the main body of the report), will lose their jobs as a result of the retirement of PNGS by 2025. While this is still a large a number, it is far less than the gross economic impact of the retirement of PNGS to Ontario. On the other hand, the average salary of individuals that lose their jobs is estimated at roughly $93,000, which is significantly greater than the average wage in Ontario. **Despite the loss of some high paying jobs, our analysis suggests that the economic**

impact of the retirement of PNGS will be distributed across the Greater Toronto Area ("GTA"), Durham Region and other parts of Ontario where employees of PNGS and employees of contractors and suppliers of PNGS live.

It is also important to assess the retirement of PNGS within some of the broader trends impacting Pickering. The development of Seaton in central Pickering will dramatically change the City's population composition and employment profile. Seaton is expected to increase Pickering's population by up to 70,000 people and generate up to 35,000 jobs. Even if PNGS was to remain commercially operating, the development of Seaton and the jobs that would be created as a result would likely decrease the importance of PNGS to Pickering's economy and labour market and help diversify Pickering's economy. **In this regard, the Province of Ontario – as the owner of substantial employment lands in Seaton – has an opportunity to play a key role in offsetting job losses from the retirement of PNGS by directing and delivering highly-skilled, well-paying jobs to the Seaton community from the outset of that development.**

Figure 2 – Map of City of Pickering with location of Seaton Community



With respect to PNGS's financial impact to the City, in 2015, PNGS made Payments in Lieu of Property Taxes of $4.9 million. The City of Pickering retains approximately 60% of these payments – approximately $3.0 million, which represents an important part of the City of Pickering's overall revenues. **Based on OPG's projections, annual Payments in Lieu of Property Taxes that are retained by the Corporation of the City of Pickering are expected to decline by roughly $0.5 million in or by 2025 and significantly more by the end of the decommissioning period.** As of the date of this report, OPG is in the process of assessing various repurposing options for the PNGS site. **There may be an opportunity for OPG to reduce a potentially significant loss of annual Payments in Lieu of Property Taxes to the City through the appropriate selection of repurposing options at the PNGS site.**

1. Introduction

Background

The Pickering Nuclear Generating Station ("PNGS") is one of the largest nuclear generating stations in the world. It produces a significant amount of Ontario's electricity and is the largest employer in the City of Pickering employing 2,700 people. PNGS commenced commercial operations in 1971. The table below provides some background information in regards to the generators/units that comprise PNGS.

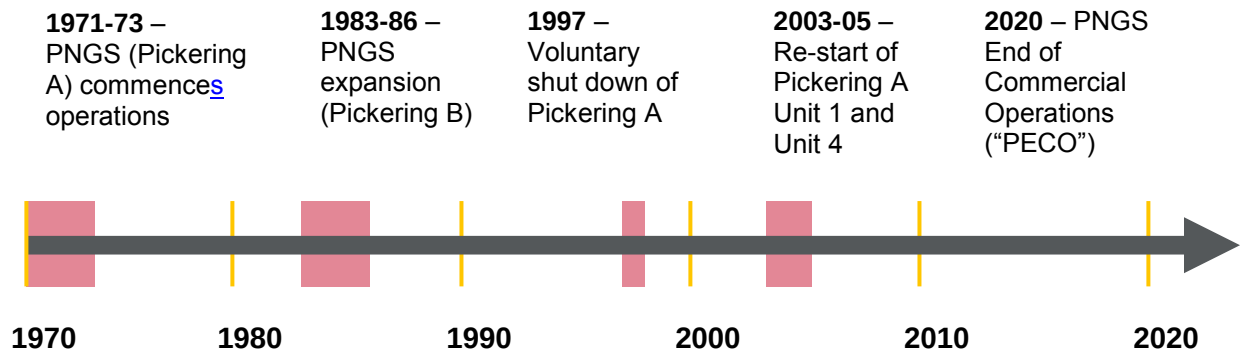
Table 2 – PNGS background information

PNGS site	Units/Generators	Commenced commercial operations	Combined energy generation capacity
Pickering A	Units 1 through 4	Between 1971 and 1973	1,000 MW
Pickering B	Units 5 through 8	Between 1983 and 1986	2,100 MW

Between 1983 and 1986, four additional reactors were added. In total, eight units comprise PNGS, but only six are currently operating.[1] PNGS has a combined energy capacity of 3,100 MW.[2] At the end of 1997, PNGS's first four units (Pickering A) were voluntarily shut down as part of Ontario Hydro's nuclear improvement program.[3] Unit 1 and Unit 4 of Pickering A returned to commercial operations in 2003 and 2005 respectively.[4] In 2010, OPG announced a large scale nuclear refurbishment strategy. The strategy called for significant investments at Bruce Nuclear Generating Stations ("BNGS") and Darlington Nuclear Generation Station ("DNGS") to extend the useful life by 30 years and further investments at PNGS to ensure the continued safe and reliable performance of PNGS for another 10 years – PNGS End of Commercial Operations ("PECO") is currently scheduled to occur around 2020.[5] Figure 3 below summarizes the timeline of key events.

[1] Pickering Nuclear Generating Station. Canadian Nuclear Safety Commission. Retrieved from http://nuclearsafety.gc.ca/eng/reactors/power-plants/nuclear-facilities/pickering-nuclear-generating-station/index.cfm.
[2] Pickering Nuclear. Ontario Power Generation. Retrieved from http://www.opg.com/generating-power/nuclear/stations/pickering-nuclear/Pages/pickering-nuclear.aspx.
[3] *Ibid.*
[4] *Ibid.*
[5] Refurbishment for Darlington, but not Pickering B. World Nuclear News. Retrieved from http://www.world-nuclear-news.org/C-Refurbishment_for_Darlington_but_not_Pickering_B-1702105.html.

Figure 3 – PNGS timeline of key events to 2020



The retirement of PNGS is expected to impact the City of Pickering given that PNGS, as noted above, is the largest employer in the City and plays an important role in helping anchor a vibrant Energy, Environmental and Engineering ("EN3") sector that has emerged in the City of Pickering.[6] Previous studies on the impact of decommissioning of nuclear generating facilities suggest that the impact can be significant particularly if the community hosting these facilities depends exclusively on them as a source of employment. It is noted that this is not the case in Pickering.

Study objectives

Given the importance of PNGS, the City of Pickering engaged HDR Corporation ("HDR") to assess and estimate the economic and financial impact of the retirement of PNGS to Pickering on an objective, transparent and credible basis over the 2015 to 2025 period. The time period selected for this study broadly reflects the operations, site preparation and decommissioning periods associated with the retirement process for nuclear generating facilities.[7] The time period for this study is associated with initial stages of the nuclear facilities decommissioning profile which is referred to as retirement in this report.

Approach

This section of our report provides a detailed description of the approach employed to complete this study. The table below outlines the steps we took as part of this study. **Users of this report should carefully review the table below to understand the scope and nature of this study.** Appendix A provides a detailed description of methodology employed to estimate the economic and financial impact of the PNGS retirement.

[6] See https://www.pickering.ca/en/business/energyenvironmentengineeringen3.asp for more information regarding Pickering's EN3 cluster.
[7] Section 3 of this report provides a more detailed description of the decommissioning process for nuclear generating facilities.

Table 3 – Overview of our approach

Phase	Tasks and activities
Phase 1 – Project initiation	• Obtained and reviewed any relevant background material and report. • Developed a draft annotated table of contents for the final report (the reporting framework). • Conducted a formal kick-off meeting at the City of Pickering to re-confirm the study objectives, review the project plan and the reporting framework.
Phase 2 – Methodology and data collection	• Developed the economic methodology of the economic/financial model and outlined the methodology in flowchart format (see Appendix A). • Collected all necessary data from the City, OPG and other relevant stakeholders to estimate the economic/financial impact of retirement of PNGS over the study period (2015 to 2025). • Met with OPG several times over the course of this project to ensure we understand the data provided and to confirm our understanding of the decommissioning profile and to address gaps in the underlying data. • Redeveloped the economic/financial methodology to address gaps in the underlying data. OPG was not able to provide us a detailed breakdown of their expenditures over the analysis period and had little information in regards to how the retirement of PNGS would impact employees. • Conducted additional research to address gaps in the data and to conform to the updated methodology. The data we collected was sent to OPG for review and approval. • Developed assumptions regarding the impact that the retirement of PNGS will have on expenditures associated with the provision of City services. • Interviewed a few key suppliers of PNGS to fully understand the direct and indirect impacts to key suppliers with respect to PECO.
Phase 3 – Financial economic impact analysis	• Developed the financial/economic model to estimate the financial/economic impact of the retirement of PNGS to Pickering based on the redeveloped methodology and data collected in Phase 2. • Tested and validated financial/economic results based on discussions with the City and OPG and comparison with other relevant studies. • Refined financial/economic results based on the above.

Phase	Tasks and activities
	• Presented preliminary findings to the City and OPG.
Phase 4 – Reporting	• Developed the draft report based on the reporting framework established in Phase 1. • Received and reviewed a consolidated list of comments from the City. • Updated and finalized the report based on comments provided by the City.

Data

The credibility of any economic impact assessment relies on using the best available data and information. All efforts were made to ensure that we met this objective as part of this project. Data obtained from third party sources to address gaps was closely and carefully scrutinized. This included reviewing data with the City and OPG. Formal approval from OPG was obtained in regards to the future number of employees and expenditures over 2015 to 2025 time period. The table below summarizes the key data sources used to estimate the financial and economic impact of the retirement of PNGS. We should note that while we think we received sufficient data from OPG to estimate the economic impact of retirement of PNGS, we would have preferred obtaining more detailed information regarding PNGS's non-wage expenditures, which we were unable to obtain for confidentiality reasons. Any additional analysis and studies on the economic and financial impact of the decommissioning of PNGS should make use of more detailed information.

Table 4 – Description of key data sources

Data	Description	Source
PNGS employment	Projections of employment at PNGS in 2015, 2020 and 2025.	OPG
PNGS wages, salaries and benefits	Projections of wages, salaries and benefits paid to PNGS staff in 2015, 2020 and 2025.	OPG
Residency of current employees at PNGS	The percentage of PNGS employees that reside in the City of Pickering.	OPG
PNGS non-wage operating and capital expenditures	Detailed breakdown of projections of non-wage operating and capital expenditures in 2015, 2020 and 2025.	OPG provided aggregate non-wage operating and capital expenditures over the analysis period, but were unable to provide a detailed breakdown. To obtain a more detailed breakdown of the expenditures we used information

Data	Description	Source
		published by the Canadian Energy Research Institute. OPG confirmed that this is an appropriate source to characterize non-wage operating and capital expenditures.
PNGS suppliers	Information regarding PNGS key suppliers – more specifically, a supplier list was obtained that showed the names of suppliers that comprise 75% of PNGS purchases.	OPG
Input-Output Tables	The Input-Output Tables show the interrelationship between industries that comprise an economy. Specifically, they show the extent of purchases from one industry to another and within each industry. They are used to estimate multiplier effects of spending in an economy.	Statistics Canada For this study, the 2010 Ontario Input-Output Tables are used, which is the latest version of the Input-Output Tables.
Various socioeconomic data	Various demographic, economic and industrial level data and information used to characterize socioeconomic characteristics in Pickering and as input into the economic impact model.	Statistics Canada – National Household Survey, Census of Populations and other relevant Statistics Canada surveys and data sources.
City of Pickering revenues and expenditures	Data and information regarding the amount and composition of City revenues and expenditures.	City of Pickering – the City's most recent publicly available financial statements were used.

Limitations

HDR relied upon the completeness, accuracy and fair presentation of all the information, data and representations obtained from various sources which were not audited or otherwise verified. These sources (collectively, the "Information"), include:

- The City of Pickering;
- OPG;

- Statistics Canada; and
- Information from other relevant studies.

The findings in this report are conditional upon such completeness, accuracy and fair presentation of the information, which has not been verified independently by HDR. HDR reserves the right at its discretion to withdraw or make revisions to this report should we be made aware of facts existing at the date of the report that were not known to us when we prepared this report. The findings are as of the date hereof and HDR is under no obligation to advise any person of any change or matter brought to its attention after such date, which would affect the findings and HDR reserves the right to change or withdraw this report. This information has been prepared solely for the use and benefit of, and pursuant to a client relationship exclusively with the City of Pickering.

Report structure

This report is structured as follows:

- Section 2 provides a high level population, economic and industrial profile of Pickering and the Region of Durham.
- Section 3 shows the economic and financial impact results associated with the retirement of PNGS. This section also includes a discussion regarding terminology and how to interpret the results.
- Appendices are contained under separate cover

2. City of Pickering population and economic profile

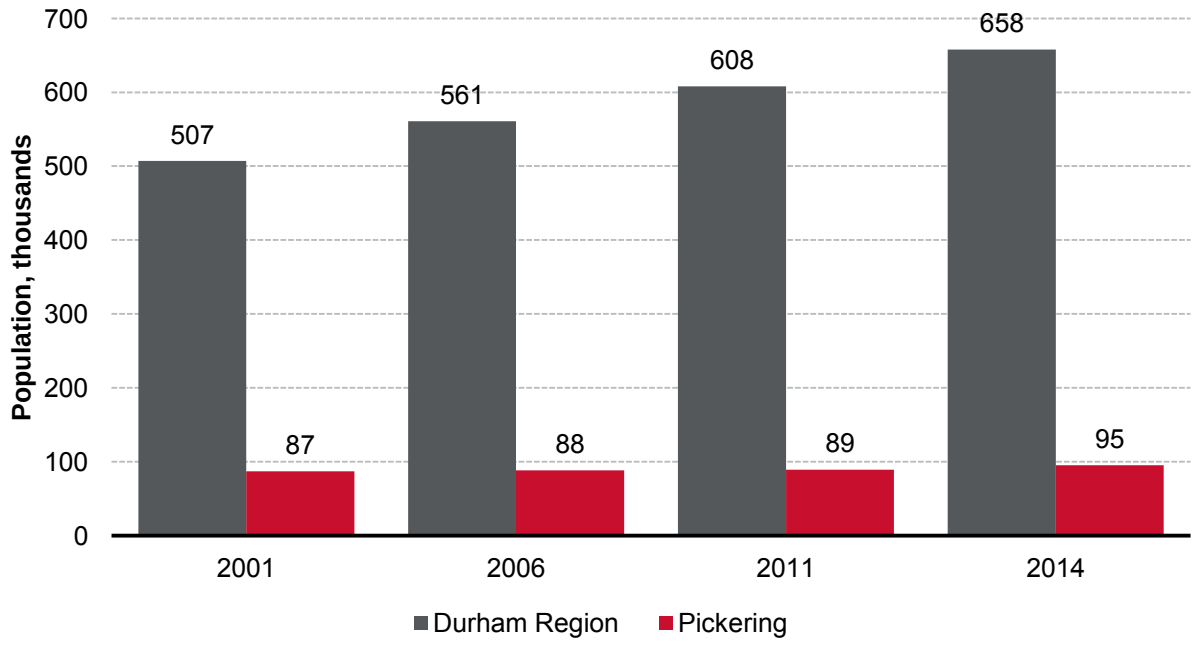
Introduction

This section of the report provides a brief population and economic overview of the City of Pickering and Durham Region as a reference point. Data and information was primarily obtained from the 2001, 2006 and 2011 Census and the 2011 National Household Survey, which is the latest available census data. Updated 2014 population data is based on estimates prepared by the Region of Durham.[8] Other data presented for 2014 is based on projections developed by the City of Pickering for planning purposes. Information from other sources is also used to assess how trends may change over this study's analysis period. We conclude with a discussion about what these trends mean for the City of Pickering in regards to the retirement of PNGS.

Population profile

The population profile below highlights key population trends and dynamics in Durham Region and Pickering. Figure 4 below shows the trend in population growth in Pickering and Durham Region.

Figure 4 – Durham Region and City of Pickering population (2001, 2006, 2011 and 2014)

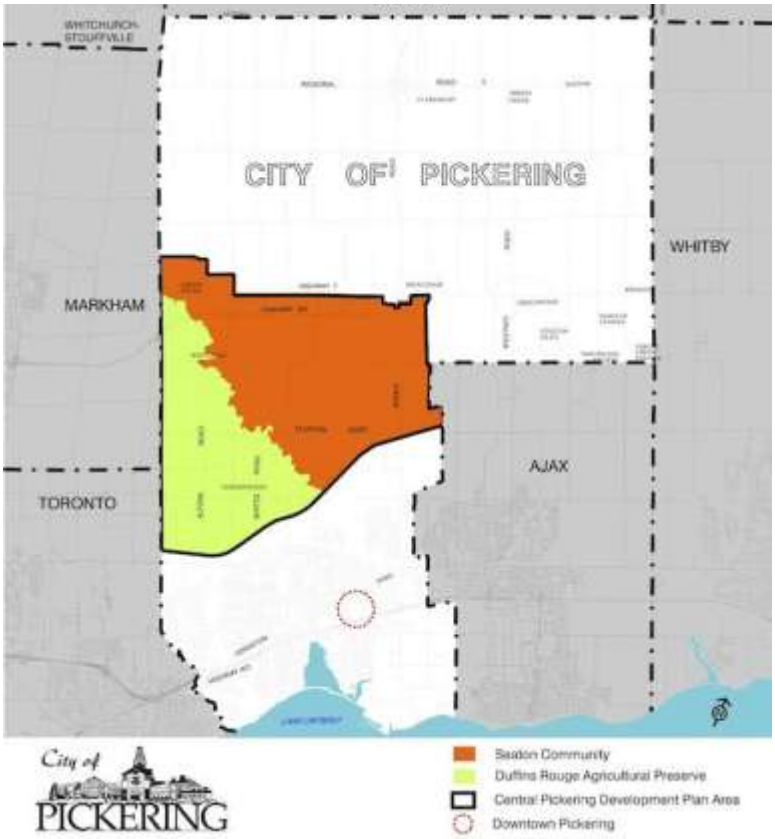


In 2014, the City of Pickering's population is estimated to be 95,200[9], which represents approximately 14% of the population in Durham Region. The relative importance of the City of

[8] Report to The Region of Durham Planning & Economic Development Committee from the Commissioner of Planning and Economic Development titled Monitoring of Growth Trends, September 23, 2014
[9] City Development Department, City of Pickering.

Pickering in terms of population to Durham Region has decreased since 2001 when the City of Pickering accounted for 17% of the population in Durham Region. This is due to faster population growth in other parts of Durham Region relative to Pickering. From 2001 to 2011, Durham Region's population grew by a Compounded Annual Growth Rate ("CAGR") of 1.8% whereas Pickering's population grew by 0.2% CAGR. More recent data from the Region of Durham Planning and Economic Development Committee, however, shows that population growth in Pickering has in fact accelerated. In 2014, Pickering's population was estimated at roughly 95,200, which means that the City of Pickering's population grew by 2.3% CAGR since 2011. Intensification in Pickering's core, new home construction in Pickering's Duffin Heights neighbourhood and more affordable housing prices in the City of Pickering relative to the City of Toronto may help explain this trend.

Figure 5 – Map of City of Pickering with location of Seaton Community



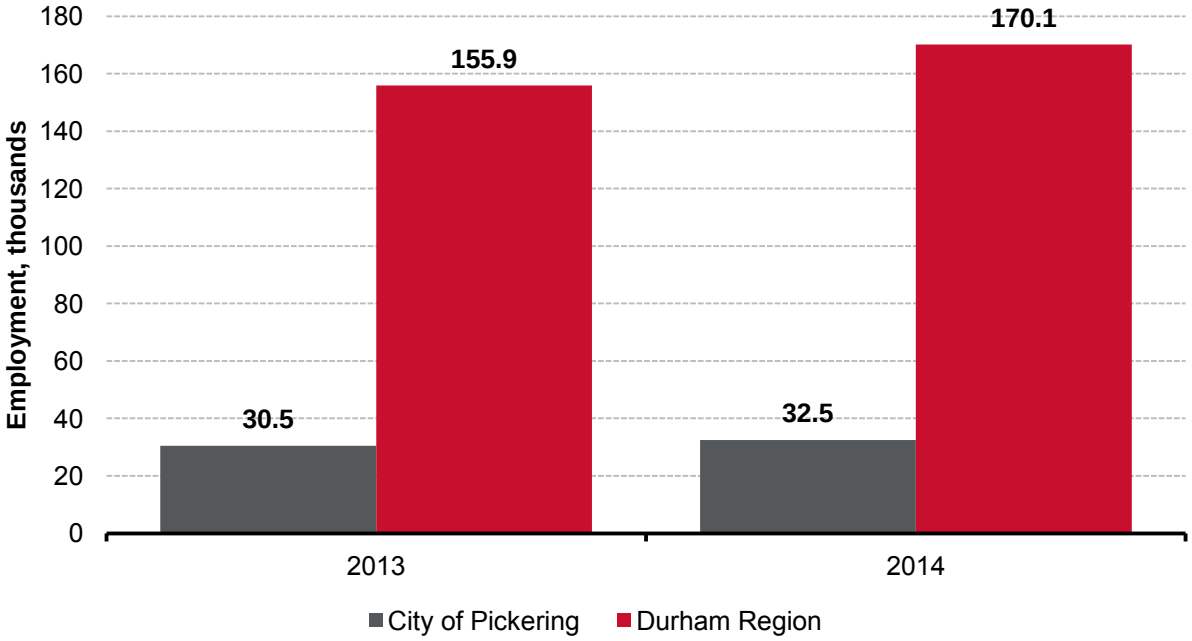
Looking forward, the City of Pickering's population will likely expand much more dramatically over the analysis period of this study and beyond. The community of Seaton, which lies within Central Pickering, will accommodate a population of up to 70,000 residents and approximately 35,000 jobs. Seaton will be one of the largest greenfield developments in Canadian history.[10] The potential construction of a new airport in northwest Pickering could increase Pickering's population and attract employment to an even greater extent.[11] Construction and development of some of the key infrastructure has already begun in the area and the City of Pickering is actively marketing and promoting the Seaton development. Needless to say, the development of Seaton and the potential development of a new airport will likely dramatically change Pickering's population and will become a more critical part of Durham Region and the Greater Toronto Area ("GTA"). These broader population trends and dynamics were considered in assessing the economic and financial impact of PECO to Pickering.

[10] Report to The Region of Durham Planning & Economic Development Committee from the Commissioner of Planning and Economic Development titled Monitoring of Growth Trends, September 23, 2014
[11] It should be noted that it is still unclear if an airport in Pickering will be developed, but the Federal Government have set aside lands for the construction of an airport – www.tc.gc.ca/eng/ontario/pickering-maps-1432.htm.

Economic profile

This section of the report highlights key economic trends impacting the City of Pickering. Census and other related data from Statistics Canada and information provided by the City of Pickering is used to assess these historical trends. Lastly, we briefly discuss implications for the financial and economic impact assessment of the retirement of PNGS. The diagram below shows the number of jobs in the City of Pickering and Durham Region in 2013 and 2014 based on data provided by the City of Pickering.

Figure 6 – Durham Region and City of Pickering number of jobs (2013 and 2014)



From 2013 to 2014, the number of jobs in the City of Pickering and Durham Region increased significantly. In the City of Pickering, the number of jobs increased from approximately 30,500 to 32,500 – a 6.7% growth rate. During the same period, jobs in Durham Region increased even more significantly by 9.1%, growing from 155,900 to roughly 170,100. In 2014, the City of Pickering accounted for nearly 20% of total employment in Durham Region. The development of Seaton and the employment that it could generate would more than double employment in the City of Pickering.

PNGS is an important contributor to the City of Pickering's and Durham Region's employment base and represents 8.3% and 1.6% of total employment respectively. This is a large percentage of total employment for any one entity to represent, particularly in the City of Pickering. If OPG employees at sites other than PNGS were also counted, then the percentage of jobs in the City of Pickering's at OPG or PNGS would be greater than 10%.[12] On the surface,

[12] It should be noted that this study only considered the economic impacts of the decommissioning of PNGS from changes in PNGS's operations in Pickering. The impact of the decommissioning of PNGS on OPG employees in the City of Pickering was not considered. OPG was unable to provide information on whether the decommissioning of PNGS would impact employment at other OPG sites in Pickering, which is why they were not considered as part of this study.

the retirement appears likely to have a significant impact to the City of Pickering in the near term. In the long run, however, the employment generated by the Seaton development would more than offset these job losses. Nevertheless, to get a more accurate picture of what the retirement of PNGS means for the City of Pickering we need to better understand the percentage of Pickering residents that work in the City.

Commuters represent a large proportion of Pickering and Durham Region residents, which complicates the estimation of the economic and financial impact of the retirement of PNGS. Isolating and estimating what the retirement of PNGS means for Pickering, which is the main objective of this study, depends partly on identifying how the retirement of PNGS will impact those individuals that live and work in Pickering. Commuters (e.g., those that live in Pickering but work elsewhere) would not be directly impacted by the retirement of PNGS. However, they could be impacted on a more indirect basis For instance if the retirement of PNGS results in decreased revenues for the City then current residents could be impacted by decreased City services or higher property taxes. The diagrams below show the place of work of Pickering's labour force in 2006 and 2011.

Figure 11 – Place of work of Pickering residents, 2006

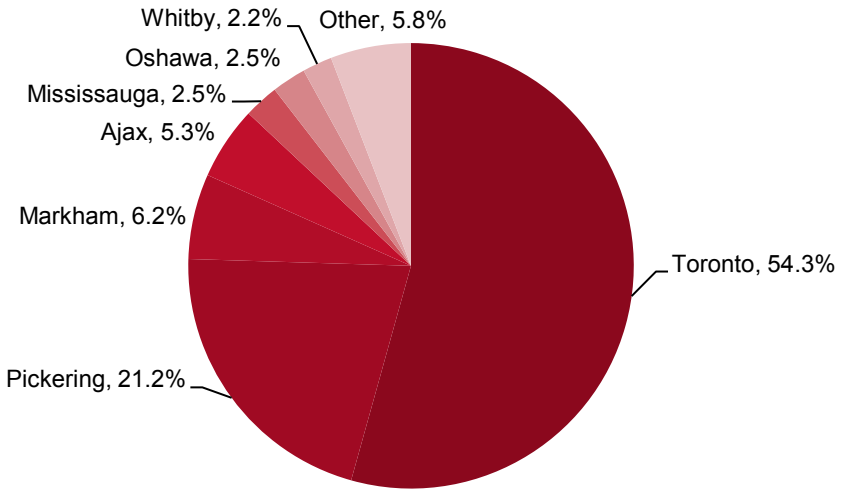
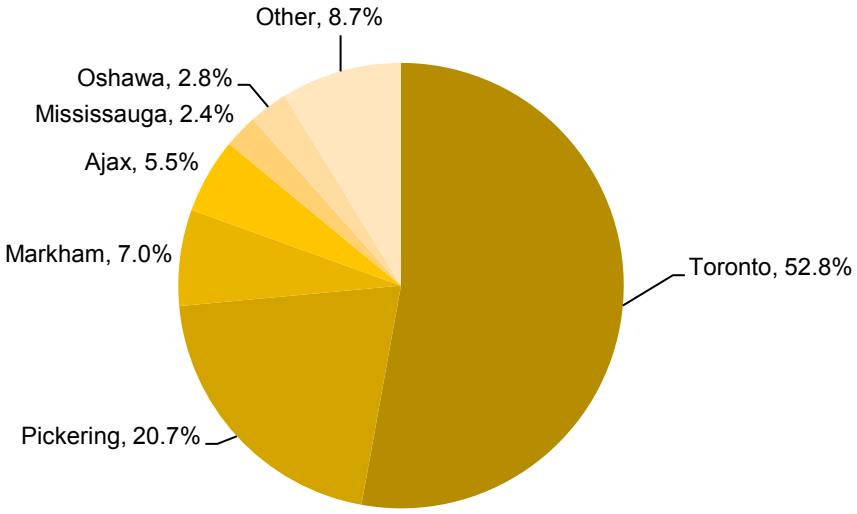


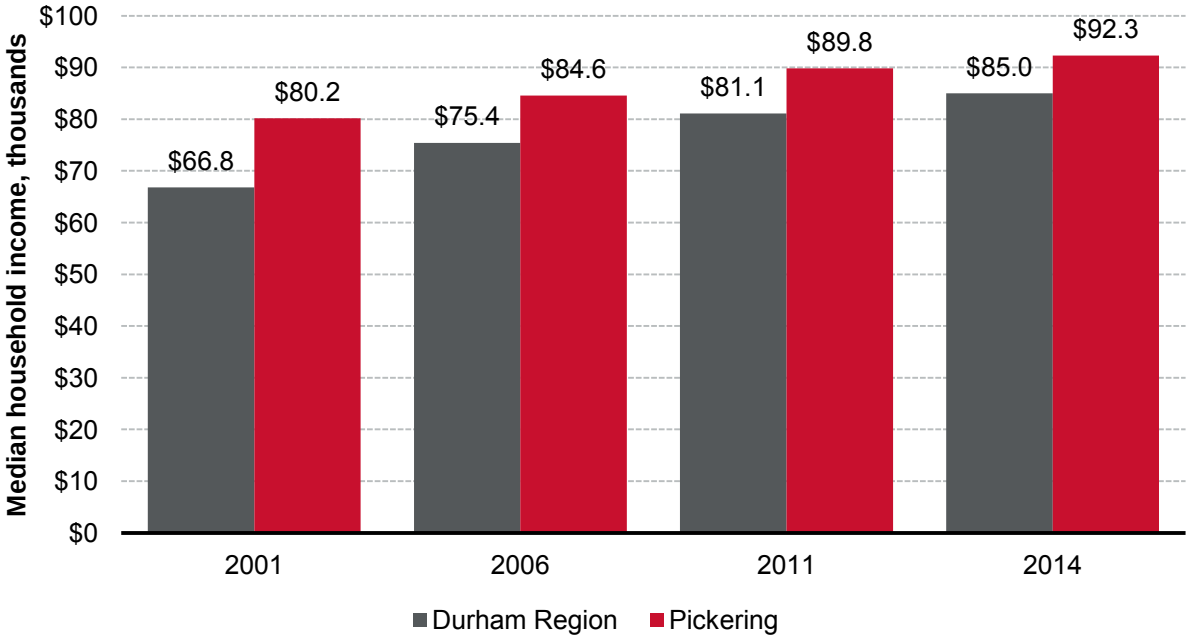
Figure 12 – Place of work of Pickering residents, 2011



From 2006 to 2011, the percentage of Pickering's population working in Pickering decreased slightly from 21.2% to 20.7%. The percentage working in Toronto decreased during this period as well, but remains the most important employment destination for Pickering residents. In 2011, the percentage of Pickering's population working in Toronto was well over two-times that in Pickering. Commuting flows are generally characterized by Pickering residents travelling west of the City for work; the percentage of Pickering's population that does so has remained relatively constant since 2006. Less than 10% of Pickering's population travelled east of the City for work in 2011. The economic impact of PECO to Pickering will at some level depend on the percentage of PNGS employees that live in Pickering. As shown above, Pickering's economy is not dependent on PNGS as a source of employment even though it represents the largest employer in the City. Indeed, nearly 80% of Pickering's population work outside of the City and they are unlikely to be significantly affected by PECO.

The discussion above suggests that the retirement of PNGS will likely have a smaller impact on residents of the City of Pickering than previously thought due to commuting flows. However, the retirement of PNGS could likely have a significant impact on average household incomes in Pickering particularly given that average incomes of employees at PNGS are nearly $100,000 – roughly double the average salaries in Ontario. The figure below shows the trend in median household incomes in Pickering and Durham Region.

Figure 13 – Median household income in Pickering and Durham Region (2001, 2006, 2011 and 2014



From 2001 to 2014, median household incomes in Durham Region increased from $66,800 to $85,000, which represents an annual growth rate of 1.9% (CAGR). Median household incomes in the City of Pickering grew at about half this rate. However, median household incomes in Pickering were still quite a bit larger than the rest of Durham Region. In 2014, the median household income in Pickering was $92,300 which is over $7,000 more than that of Durham Region's. PNGS currently employs 2,700 individuals and on average pays salaries roughly twice the average Ontario earnings and higher than the average in the City of Pickering. The loss of these high paying jobs can potentially impact the median household income in the City of Pickering.

Importance of PNGS to Pickering's economy

The high level socioeconomic assessment and outlook of Pickering suggests the following with respect to the retirement of PNGS and broader trends impacting Pickering:

- PNGS is certainly an important part of Pickering's economy and labour market and the retirement of PNGS will impact the City. However, Pickering does not depend exclusively on PNGS as a source of employment and Pickering's residents working outside of the City would not necessarily be significantly affected purely from an employment perspective.
- Certainly an important PNGS supplier community has emerged in Pickering that includes a variety of engineering, environmental services and other professional and technical

service providers.[13] Accordingly, understanding how these organizations and companies will react to the retirement of PNGS and the refurbishment of DNGS is critically important to assessing the impact of the retirement of PNGS.

- It is also important to assess the retirement within some of the broader trends impacting the City of Pickering. Development of Seaton will dramatically change the City of Pickering's population composition and employment profile. Indeed, the development of Seaton is expected to increase Pickering's population by 70,000 and generate up to 35,000 jobs.[14] Even if PNGS was to remain commercially operating, the development of Seaton and the jobs that it would result in would likely decrease the importance of PNGS to Pickering's economy and labour market over time.

The following section of this report shows the results of the financial and economic impact assessment.

[13] For a list of organizations and companies that comprise the EN3 cluster see Energy, Environment & Engineering (EN3). City of Pickering. Retrieved from http://www.pickering.ca/en/business/energyenvironmentengineeringen3.asp.
[14] New Sustainable Community Moves Forward in Durham (August 29, 2014). Government of Ontario. Retrieved from http://news.ontario.ca/mah/en/2014/04/new-sustainable-community-moves-forward-in-durham.html.

3. Economic and financial impact of the retirement of PNGS

Introduction

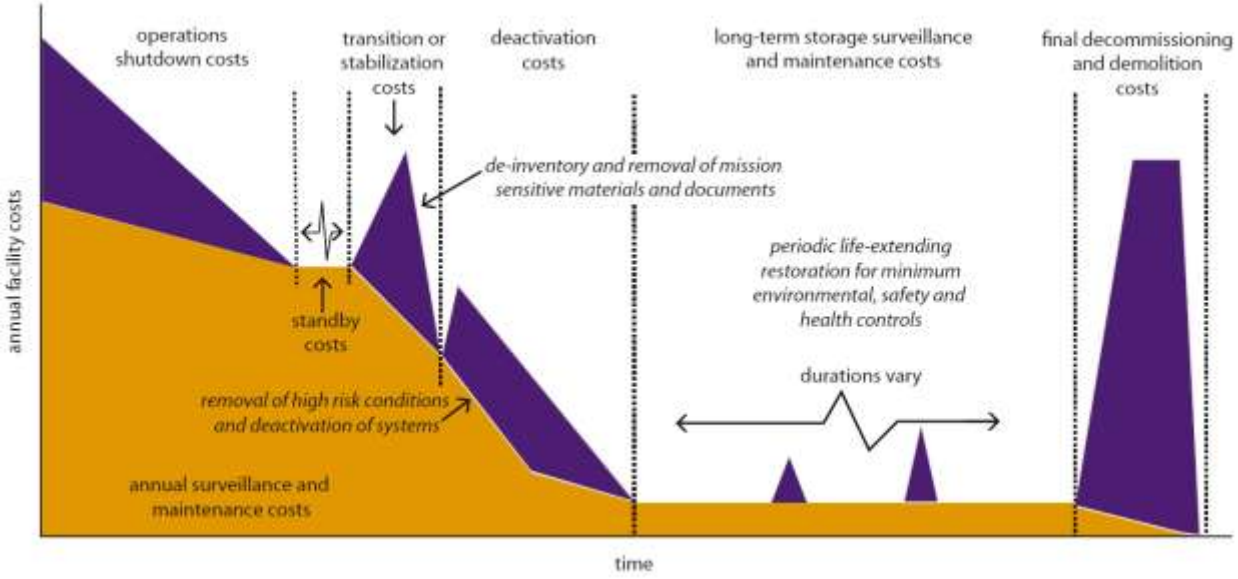
This section of the report shows our projected results of the economic and financial impact of the retirement of PNGS. For context, we first briefly describe a typical decommissioning process of a nuclear generating facility. A primer on economic impact analysis, which defines and explains key terminology, is then presented followed by the economic and financial impact results. We conclude with a summary of key findings and a discussion about what this means for the City of Pickering.

Decommissioning of nuclear generating facilities

Many nuclear generating facilities across North America were initially developed in the late 1960s and early 1970s with useful lives of 30-40 years.[15] Accordingly, many nuclear generating facilities across North America in the next several years will begin the long process of decommissioning, which can last several decades. In this respect, the City of Pickering is not unique. However, the size and scale of the decommissioning of PNGS is likely one of the largest ever. For the purposes of this study, the economic impact of the retirement of PNGS is forecasted by estimating the economic contribution of PNGS in 2015, 2020 and 2025 and then taking the 2020 and 2025 estimates and subtracting them from 2015 – the baseline year. How spending changes over time will determine the extent of the economic and financial impacts since economic impacts are driven by spending in an economy. The figure below shows an expenditure profile of a typical nuclear generating facility decommissioning process.

[15] Decommissioning Nuclear Facilities (2014). World Nuclear Association. Retrieved from http://www.world-nuclear.org/info/Nuclear-Fuel-Cycle/Nuclear-Wastes/Decommissioning-Nuclear-Facilities/.

Figure 14 – Expenditure profile of typical nuclear generating facility decommissioning process[16]



The decommissioning of nuclear generating facilities can take several decades and expenditures associated with the decommissioning of nuclear generating facilities can be quite erratic over the decommissioning time period. Initial expenditures result from preparing the site for decommissioning. During this period, annual surveillance and maintenance costs still comprise a large part of the total facility costs. The expenditure profile then typically spikes as stabilization and deactivation costs are incurred – annual maintenance and surveillance costs begin to decrease during this period. Thereafter, the facility undergoes a prolonged period of safe storage where only minor maintenance and surveillance costs are incurred. Costs jump at the end of the decommissioning period as the site is demolished and repurposed. Discussions with OPG suggested that the profile for the decommissioning of PNGS is generally consistent with this description. The time period for this study is associated with initial stages of the nuclear facilities decommissioning profile which is referred to as retirement in this report.

Economic impact analysis primer

The basic premise behind economic impact analysis is that spending in one industry generates additional spending (i.e., multiplier effects) in other industries and potentially even in the same industry. For example, the purchase of manufactured steel products (e.g., rebar) generates spending in supplying industries: steel refining, energy production, transportation, professional services; which, in turn source this supply from other industries such as coal mining, iron ore mining and several other industries. Statistics Canada produces the Input-Output Tables that quantify the inter- and intra-dependencies of industries that comprise the Canadian economy. The Input-Output Tables enable us to quantify how spending in one industry tracks through the Canadian economy and, thus, how this spending impacts the Canadian economy. Economic impacts are generally estimated for the following standard measures of economic activity:

[16] Closing and Decommissioning Nuclear Power Reactors (2012). United Nations Environment Programme. Retrieved from http://www.unep.org/yearbook/2012/pdfs/UYB_2012_CH_3.pdf.

- **Value-added or Gross Domestic Product (GDP)** – the value added to the economy or the unduplicated total value of goods and services. GDP includes only final goods to avoid double counting of products sold during an accounting period.
- **Wages and salaries** – the total value of derived from labour.
- **Employment** – the number of jobs created or supported. It is expressed as the number of equivalent full-time jobs indicated in person years.
- **Government tax revenues** – the amount of tax revenues generated. In this study, total taxes are calculated.

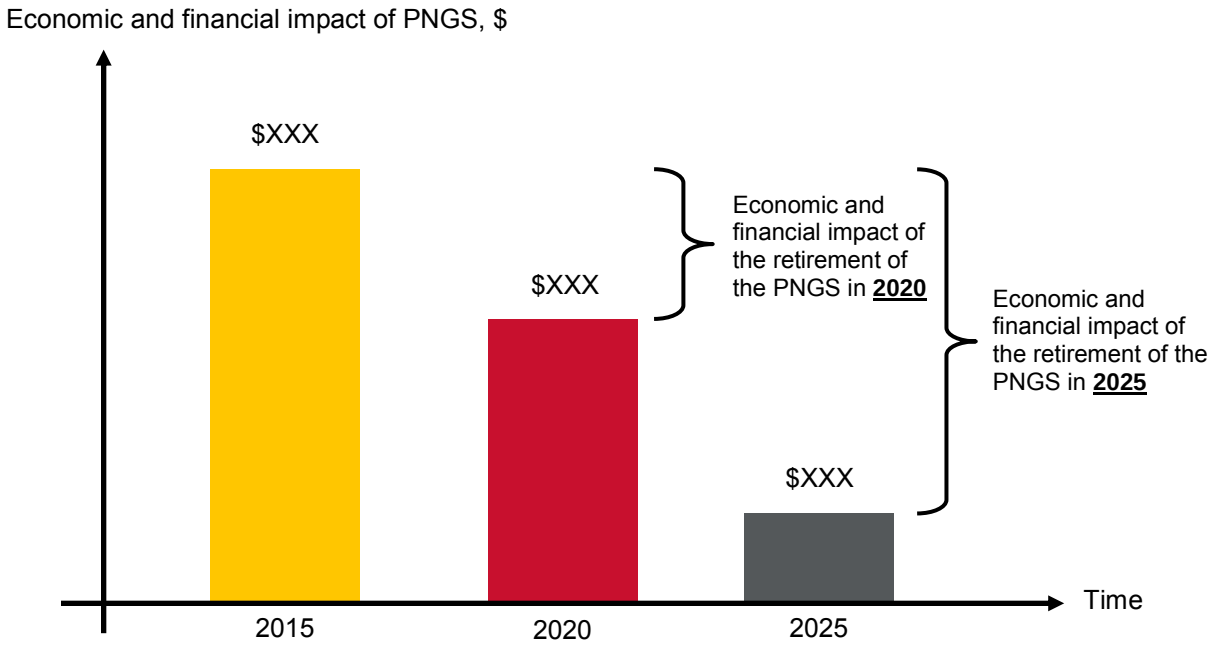
Economic impacts are typically estimated at the direct, indirect and induced levels:

- **Direct impacts** are changes that occur in "front-end" businesses that initially receive expenditures and operating revenue as a direct consequence of operations and activities conducted.
- **Indirect impacts** arise from changes in activity for suppliers of the front-end business. For example, the purchase of rebar from a steel product manufacturer requires that the steel product manufacturer purchase refined steel from a steelmaker.
- **Induced impacts** occur when employees from businesses stimulated by direct and indirect expenditures spend their income on consumer goods and services.

Interpretation of economic impacts

Economic and financial impacts associated with the decommissioning of PNGS are estimated relative to the baseline, which for the purposes of this study is the economic and financial contribution of PNGS in 2015. The figure below illustrates how the economic and financial impact of retirement PNGS is estimated and should be interpreted.

Figure 15 – Interpretation of economic and financial impact of the retirement of PNGS

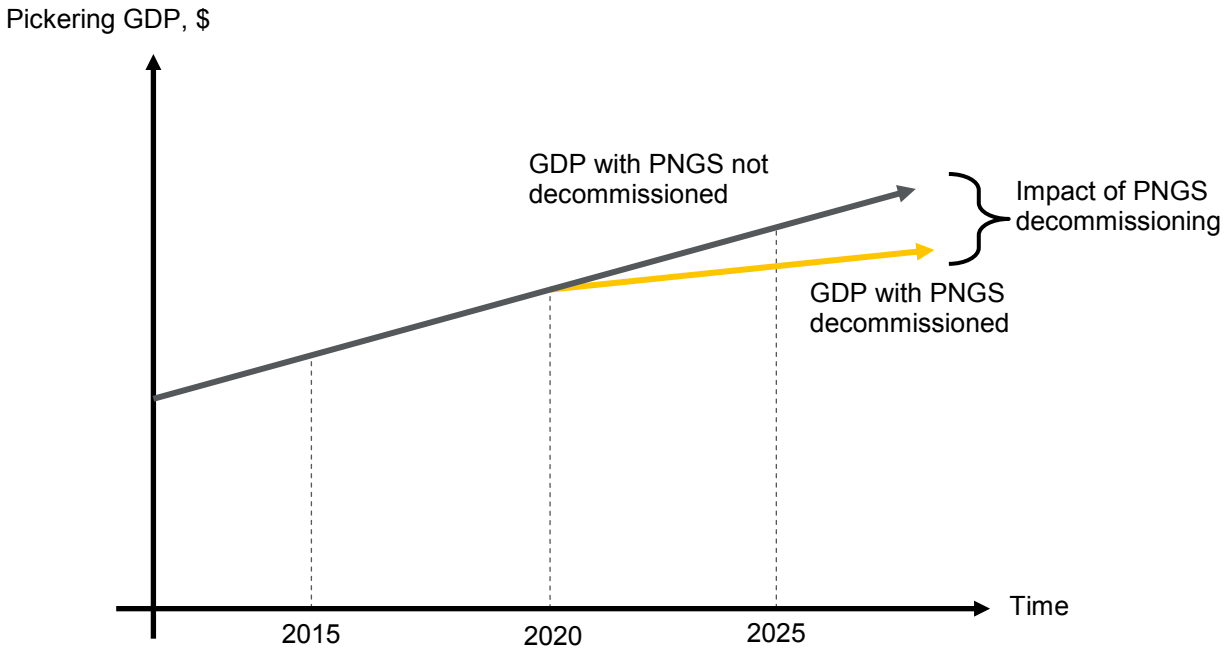


We estimate the economic and financial contribution of PNGS in 2015 (the baseline year), 2020 and 2025 to Pickering. PNGS no longer generates electricity in 2020 and begins the long decommissioning process that last several decades. For the purposes of this study:

- The economic and financial impact of the **retirement of PNGS** in 2020 is equal to the economic and financial impact of PNGS in 2020 less the economic and financial contribution of PNGS in 2015;
- The economic impact of the **retirement of PNGS** in 2025 is equal to the economic and financial impact of PNGS in 2025 less the economic and financial contribution of PNGS in 2015.

Even though PNGS is the largest employer in Pickering, decreased economic activity generated by PNGS does not mean that Pickering's economy will decrease in absolute terms. Indeed, it is entirely possible and in fact likely that Pickering's economy is still larger in 2025 than it is in 2015. That being said, the retirement of PNGS is expected to decrease the level of economic growth in the short-to-medium term in Pickering relative to the scenario where PNGS is not decommissioned. The diagram below illustrates this concept.

Figure 16 – Impact of the retirement of the PNGS decommissioning on Pickering's economy



As shown above the economic impact of the retirement of PNGS is expected to decrease the rate of economic growth in Pickering relative to a hypothetical scenario where PNGS is not decommissioned and continues to operate commercially over the analysis period.

One important caveat to note is that as part of this study we only estimated the gross economic impact of the retirement of PNGS. The economic impact associated with the refurbishment of DNGS or BNGS was not considered. We did not consider the economic impact of changes to energy costs in Ontario.

Ontario versus Pickering impacts

The tables in the following section of this report show economic impacts of the retirement of PNGS. The Statistics Canada Input-Output Tables, which are used to estimate economic impacts, are provided for Ontario and additional modelling is required to assess impacts that result from economic activity from Pickering. To do so, high level data and information regarding the residency of PNGS employees and the extent of PNGS purchases from local suppliers was obtained from OPG. We would have preferred that we obtain more detailed information from OPG in this regard, but this data was not able to be shared with us due to confidentiality reasons. Any additional analysis and studies on the economic and financial impact of the decommissioning of PNGS should make use of more detailed information.

To be specific, the tables below show the economic and financial contribution of PNGS and the economic and financial impact of the retirement of PNGS to Ontario and to residents and local businesses of the City of Pickering and to the Corporation of the City of Pickering. The methodology used in this study estimates the economic impact of the retirement of PNGS to Ontario and we then localize this impact to the City of Pickering

Economic and financial contribution of PNGS to Ontario and Pickering

This section of the report shows the economic contribution of PNGS to Ontario and Pickering for 2015, 2020 and 2025. In 2020, PNGS ceases commercial operations and begins the long process of decommissioning which lasts several decades. The table below shows the economic contribution of PNGS to Ontario and Pickering in 2015.

Table 5 – Economic and financial contribution of PNGS in 2015

	Direct impact	Indirect impact	Induced impact	Total impact
Ontario				
GDP (millions)	$667.8	$42.6	$138.9	**$849.3**
Wages and salaries (millions)	$320.7	$24.8	$66.8	**$412.1**
Employment (FTEs)	3,397	354	1,554	**5,305**
Government revenues (millions) †	$163.3	$10.0	$32.6	**$205.8**
Pickering				
GDP (millions)	$48.2	$1.4	$1.9	**$51.5**
Wages and salaries (millions)	$22.1	$0.8	$0.9	**$23.8**
Employment (FTEs)	225	12	21	**258**
Government revenues (millions) †	$3.0	$0.0	$0.0	**$3.0**

† Government revenue economic impacts for Ontario refer to revenues generated from all forms of taxation, for the City of Pickering they refer to Payments in lieu of Property Taxes only.

In 2015, expenditures undertaken by PNGS are expected to directly generate $667.8 million in GDP for Ontario. Taking into consideration indirect and induced effects, expenditures undertaken by PNGS are expected to contribute $849.3 million to Ontario's economy; approximately $51.5 million of this GDP is generated from residents and business located in the City of Pickering.

In terms of employment, PNGS's operations and expenditures are expected to directly generate approximately 3,397 employees across Ontario in 2015. This includes 2,700 employees at PNGS and 697 generated from PNGS suppliers and contractors – of these supplier and contractor jobs only a small amount are generated in Pickering, which reflects the fact that the majority of PNGS's suppliers are located outside of Pickering.[17] Further indirect impacts and induced impacts generate additional 354 and 1,554 jobs respectively across Ontario. However, only 33 of these indirect and induced jobs are expected to be generated in Pickering, which reflects that only 8% of PNGS employees actually live in Pickering.[18] The majority of individuals that work at PNGS live outside of the City.

Expenditures undertaken by PNGS are expected to generate $205.8 million in government tax revenues in 2015, which includes revenues from all forms of taxation (i.e., federal, provincial and municipal). In the same year, PNGS is expected to contribute approximately $3.0 million in Payments in Lieu of Property Taxes to the Corporation of the City of Pickering.

The table below shows the economic contribution of PNGS in 2020, which is when PNGS ceases commercial operations. Expenditures undertaken by PNGS during this period are largely a result of various activities preparing the site for decommissioning.

[17] OPG was unable to obtain a detailed breakdown of PNGS non-wage expenditures by company and relied on a list of PNGS suppliers that comprise 75% of PNGS non-wage expenditures. We checked each company on that list to determine whether they had a location in Pickering and this was used to develop assumptions regarding the extent of local purchases by PNGS. More detailed data and information regarding the actual amount of expenditures by company would have enabled a more accurate estimate.
[18] This information was provided by OPG.

Table 6 – Economic and financial contribution of PNGS in 2020

	Direct impact	Indirect impact	Induced impact	Total impact
Ontario				
GDP (millions)	$524.1	$22.4	$81.0	**$627.5**
Wages and salaries (millions)	$188.6	$13.1	$38.9	**$240.6**
Employment (FTEs)	1,994	189	905	**3,088**
Government revenues (millions)	$129.6	$5.3	$19.0	**$153.8**
Pickering				
GDP (millions)	$39.2	$0.8	$1.1	**$41.0**
Wages and salaries (millions)	$13.2	$0.4	$0.5	**$14.2**
Employment (FTEs)	134	6	12	**153**
Government revenues (millions) †	$3.0	$0.0	$0.0	**$3.0**

† Government revenue economic impacts for Ontario refer to revenues generated from all forms of taxation, for the City of Pickering they refer to Payments in lieu of Property Taxes only.

In 2020, PNGS is expected to continue to generate significant economic impacts in Pickering and across the rest of Ontario, but less than in 2015. Across Ontario, PNGS is expected to generate approximately $627.5 million in GDP in 2020. Of this, approximately $39.2 of GDP is generated from residents and business located in the City of Pickering. Including indirect and induced impacts, PNGS is expected to generate 3,088 jobs across Ontario, of which 153 are expected to by City of Pickering residents.

The table below shows the economic impact of PNGS in 2025. Expenditures undertaken during this period are mainly associated with the safe storage phase of a typical nuclear generating facility decommissioning profile.

Table 7 – Economic and financial contribution of PNGS in 2025

	Direct impact	Indirect impact	Induced impact	Total impact
Ontario				
GDP (millions)	$37.8	$6.8	$15.0	**$59.6**
Wages and salaries (millions)	$33.6	$4.2	$7.2	**$45.0**
Employment (FTEs)	378	63	166	**607**
Government revenues (millions)	$9.5	$1.6	$3.5	**$14.6**
Pickering				
GDP (millions)	$2.2	$0.2	$0.2	**$2.6**
Wages and salaries (millions)	$2.1	$0.1	$0.1	**$2.4**
Employment (FTEs)	22	2	3	**27**
Government revenues (millions) †	$2.5	$0.0	$0.0	**$2.5**

† Government revenue economic impacts for Ontario refer to revenues generated from all forms of taxation, for the City of Pickering they refer to Payments in Lieu of Property Taxes only.

In 2025, the economic impact of PNGS is expected to continue to decrease. During this period, PNGS is no longer operating commercially and expenditures undertaken by PNGS are largely a result of ongoing surveillance and monitoring costs. While its impact to Pickering declines significantly, PNGS continues to generate approximately 27 jobs for Pickering residents and 607 across Ontario when indirect and induced impacts are included.

The following section shows the economic impact of the retirement of PNGS and more specifically what this means for Pickering.

Economic impact of the retirement of PNGS to Ontario and Pickering

As shown above, the economic contribution of PNGS to Pickering and Ontario is expected to significantly decrease over the analysis period of this study. PNGS is still, however, expected to

remain an important source of employment for the City of Pickering going forward. The table below shows the economic impact of the retirement of PNGS in 2020 relative to 2015.

Table 8 – Economic and financial impact of the retirement of PNGS in 2020 (compared to 2015)

	Direct impact	Indirect impact	Induced impact	Total impact
Ontario				
GDP (millions)	-$143.7	-$20.2	-$57.9	**-$221.8**
Wages and salaries (millions)	-$132.1	-$11.7	-$27.9	**-$171.7**
Employment (FTEs)	-1,403	-165	-649	**-2,217**
Government revenues (millions)	-$33.7	-$4.7	-$13.6	**-$52.0**
Pickering				
GDP (millions)	-$9.0	-$0.7	-$0.8	**-$10.5**
Wages and salaries (millions)	-$8.9	-$0.4	-$0.3	**-$9.6**
Employment (FTEs)	-91	-6	-9	**-105**
Government revenues (millions) †	$0.1	$0.0	$0.0	**$0.1**

† Government revenue economic impacts for Ontario refer to revenues generated from all forms of taxation, for the City of Pickering they refer to Payments in Lieu of Property Taxes only.

PNGS officially ends commercial operations in 2020. Economic activity – employment and expenditures – occurring at PNGS decreases significantly at this time. Across the Province, the retirement of PNGS is expected to decrease GDP by roughly $221.8 million and result in a reduction in 2,217 jobs relative to the baseline. Government revenues from all forms of taxation are also expected to decrease by $52.0 million. The impact to Pickering residents and businesses and the Corporation of the City of Pickering is expected to be much more muted, which is due to the fact that only a small percentage of PNGS employees actually live in Pickering and a majority of PNGS expenditures occur outside the City of Pickering. Relative to the baseline, we estimate that 105 Pickering residents will lose their jobs and GDP generated by residents and local businesses will decrease by $10.5 million when indirect and induced effects

are considered. However, based on OPG projections municipal government revenues from Payments in Lieu of Property Taxes are expected to increase slightly.

Table 9 – Economic and financial impact of the retirement of PNGS in 2025 (compared to 2015)

	Direct impact	Indirect impact	Induced impact	Total impact
Ontario				
GDP (millions)	-$630.0	-$35.8	-$123.9	**-$789.7**
Wages and salaries (millions)	-$287.1	-$20.5	-$59.5	**-$367.1**
Employment (FTEs)	-3,020	-291	-1,388	**-4,698**
Government revenues (millions)	-$153.8	-$8.4	-$29.0	**-$191.2**
Pickering				
GDP (millions)	-$46.0	-$1.2	-$1.6	**-$48.8**
Wages and salaries (millions)	-$20.0	-$0.7	-$0.8	**-$21.4**
Employment (FTEs)	-203	-10	-18	**-231**
Government revenues (millions) †	-$0.5	$0.0	$0.0	**-$0.5**

† Government revenue economic impacts for Ontario refer to revenues generated from all forms of taxation, for the City of Pickering they refer to Payments in Lieu of Property Taxes only.

By 2025, the gross economic impact of the retirement of PNGS is expected to result in $789.7 million less in GDP to Ontario. Of this, approximately $48.8 million in GDP results from economic activity that is no longer carried out by Pickering residents and local business. In terms of employment, the retirement of PNGS is expected to result in 4,698 less jobs in Ontario and 231 less jobs in Pickering. Contributions to government revenues are also expected to decrease by $191.2 million across Ontario.

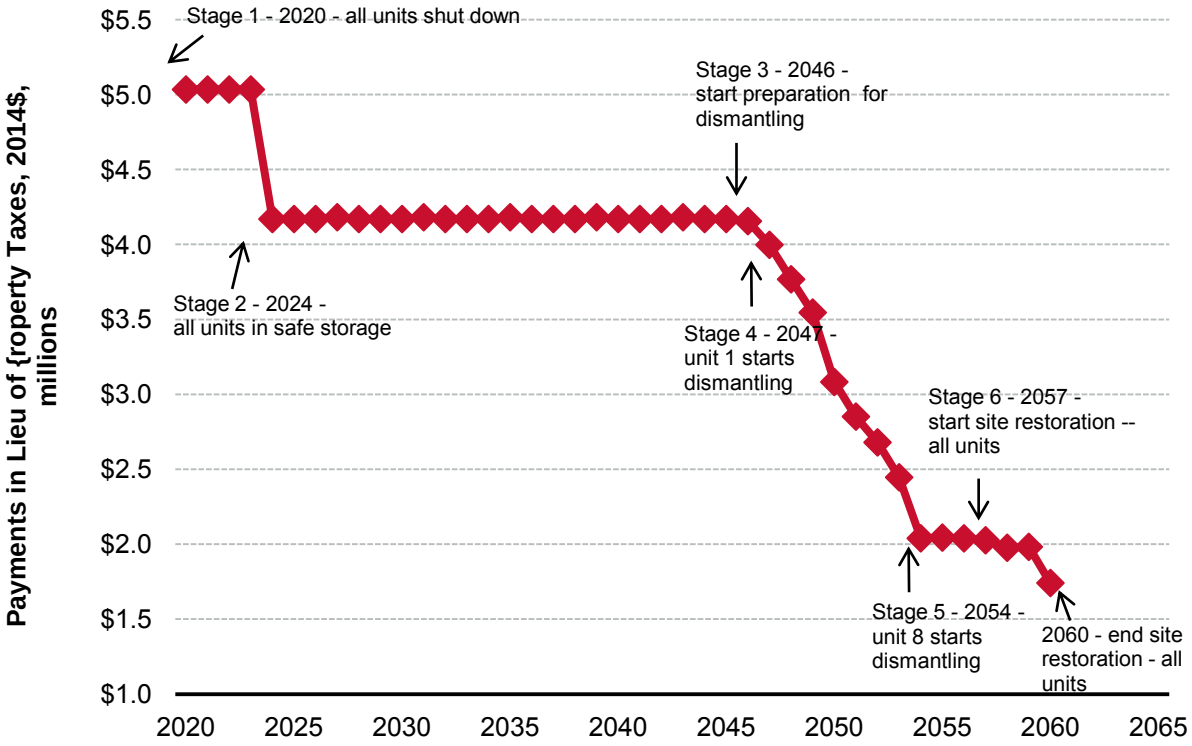
What does this mean for Pickering residents? As we have seen from some of the data presented in Section 2 of this report, the majority of Pickering residents work outside of Pickering - mainly in Toronto and Markham. Further data obtained from OPG also indicated that

only 8% of the employees at PNGS actually live in Pickering. Accordingly, we estimate that 231 residents of Pickering will lose their jobs as a result of the retirement of PNGS by 2025. While this is still a large a number it is far less than the estimates presented in the table above and suggests that the retirement of PNGS are distributed across the GTA and Durham Region and other parts of Ontario where employees of PNGS and employees of contractors and suppliers of PNGS live.

Financial impact of the retirement of PNGS

The previous section showed that the retirement of PNGS, on a gross basis, is expected to have a significant negative impact across Ontario. The impact to Pickering's residents is less severe, which is a result of employment opportunities being dispersed across the GTA. However, PNGS currently makes approximately $5.0 million in annual Payments in Lieu of Property Taxes of which the City of Pickering retains roughly 60%. Based on the City's most recently available audited financial statements, this represents about 3% of the City's total revenues. We met with the City of Pickering and OPG to discuss how these payments will change once PNGS no longer operates commercially and OPG provided a forecast of future Payments in Lieu of Property Taxes over the analysis period of this study and over the broader decommissioning horizon shown in Figure 17 below.

Figure 17 – Projected estimated Payments in Lieu of Property Taxes for PNGS site to Durham Region and Pickering based on OPG estimates



According to these estimates, the first drop in taxes will occur in 2023 when all units are in safe storage. The second major decline will last from 2046 to 2054 during the unit dismantling. Eventually, annual property taxes are expected to decrease from the current $5.0 million to $1.7

million in 2060 based on property tax assumptions developed by OPG. However, there was disagreement between the City and OPG with respect to certain tax assumptions and the City deemed that further investigation into the future tax structure is required. Accordingly, we have identified these payments as being “at risk” given that it is still too early to determine definitively how these payments will change. More work needs to be done, which may require the need to engage specialized consulting resources in the property tax and assessment field to investigate and defend the City’s financial interests.

Key findings

Our analysis indicates that the retirement of PNGS is not expected to significantly impact Pickering’s residents and local businesses. This is largely because the economy and labour market of the City of Pickering is relatively diversified and does not rely exclusively on PNGS as a source of employment. Furthermore, the number of individuals that work and live in Pickering is relatively small and this is especially the case for PNGS employees. The negative economic impact of the retirement of PNGS is therefore distributed much more broadly across Durham Region and the rest of Ontario. We estimate that, by 2025, 231 residents of the City of Pickering will lose their jobs as a result of the retirement of PNGS. This includes employees at PNGS, PNGS suppliers located in Pickering and employees in other industries.

While this is still a large number it is far less than the Ontario-wide impacts. The development of Seaton will more than offset these job losses and will also help further diversify Pickering’s economy. In this regard, the Province of Ontario – as an owner of substantial employment lands in Seaton – has an opportunity to play a key role in offsetting job losses from the retirement of PNGS by directing and delivering highly-skilled, well-paying jobs to the Seaton community. The City of Pickering should continue to work with the Province and other stakeholders in this regard.

The retirement of PNGS, however, is expected to negatively impact the Corporation of the City of Pickering from a financial perspective. Based on OPG’s projections, annual Payments in Lieu of Property Taxes that are retained by the Corporation of the City of Pickering are expected to decline by roughly $0.5 million in or by 2025 and significantly more by the end of the decommissioning period. The City of Pickering has not accepted OPG’s Payments in Lieu of Property Taxes projections, arguing that it is too early to tell how Payments in Lieu of Property Taxes will change once commercial operations cease at PNGS. The City should consider engaging a specialized property tax consultant to better understand how these may change going forward. There may be an opportunity for OPG to reduce a potentially significant loss of annual Payments in Lieu of Property Taxes and other revenues to the City through the careful selection and early delivery of repurposing options at the PNGS site.

UNDERTAKING JT2.3

Undertaking

TO CONFIRM WHETHER ALL THE ITEMS IN ATTACHMENT 1 ARE INCLUDED IN CHART 1

Response

Yes, all items listed in Environmental Defence's Attachment 1 to Ex. L-6.5-7 ED-18 are included in OPG's Chart 1 in Ex. L-6.5-7 ED-18. Pickering Extended Operations OM&A costs in Attachment 1 appear to have been "double counted" as noted in Ex. L-6.5-7 ED-18. These costs are included in Chart 1 in line item "Total Operating Costs- Initial".

UNDERTAKING JT2.4

Undertaking

TO RECONCILE ED 18, BOARD STAFF 116, AND GEC 38, AND ADVISE THE DIFFERENCES WHAT COSTS WERE INCLUDED OR EXCLUDED AS BETWEEN THE THREE.

Response

The numbers used in the three referenced documents are different because they were produced to respond to specific questions from the requesting parties. However, they are consistent and are reconciled below.

Exhibit L-6.5-1 Staff-116 (Staff-116) provides the values for the variables in Chart 1 at Ex. F2-2-3. Chart 1 at Ex. F2-2-3 shows the estimated operating costs to enable Extended Operations and operate Pickering in each year of the IR Term as proposed to be recovered in the revenue requirement. These costs include OM&A expenses and capital costs, but exclude fuel costs. As shown in Staff-116, the total planned fully allocated operating costs for Pickering are $1,395M in 2021.

Exhibit L-6.5-8 GEC-38 (GEC-38) asks for Pickering's "total allocated operating costs." As this term is not precisely defined, OPG responded based on a standard industry definition. OPG benchmarks its financial performance against other utilities based on industry accepted (EUCG) metrics including Total Generating Cost (TGC) per MWh. GEC 38 (and by reference Ex. L-6.2-15 SEC-063) provides a derivation of TGC per MWh, and shows the 2021 TGC as $1,526.9M. As established by EUCG, TGC includes Base OM&A, Outage OM&A, Project OM&A, Corporate Support & Administrative costs, component of centrally held costs (excluding OPEB and Pension amounts and IESO Non-energy Charges as noted in Ex. L-6.2-1 Staff-104), fuel costs, and capital costs.

As shown in the reconciliation provided in Chart 1 in GEC-38, OPG started with the total planned operating costs in Staff 116 and made necessary adjustments to arrive at the TGC. Specifically, OPG made the following adjustments:

Additions:

- Fuel costs: TGC includes fuel costs. As noted above, Chart 1 at Ex. F2-2-3 and therefore L-6.5-1 Staff 116 excluded fuel costs (although fuel costs are included in the Business Case Summary supporting Extended Operations at Attachment 2 to that exhibit, as indicated in Ex. L-6.5-1 Staff-118 (b)).
- Pickering portion of Tritium Removal Facility: TGC includes these costs but for purposes of Chart 1 at Ex. F2-2-3 and therefore L-6.5-1 Staff 116, these costs were excluded for the reasons discussed at JT2.05.
- Inventory Obsolescence: TGC includes inventory obsolescence costs but for purposes of Chart 1 at Ex. F2-2-3 and therefore L-6.5-1 Staff 116, these costs were excluded for the reasons discussed at JT2.05

Subtraction:

- Asset User (Service) Fee: These costs are excluded from the TGC per industry standards but are included for purposes of Chart 1 at Ex. F2-2-3.

Exhibit L-6.5-7 ED-18 (ED-18) asked OPG to confirm Environmental Defense's calculations of Pickering Nuclear Station's operating and fuel costs for 2017, 2018, 2019 and 2020 broken out by sixteen components. OPG noted in its response to ED-18, that Environmental Defence's methodology for allocating costs is inconsistent with OPG's approved allocation methodology (see Ex. F3-1-1) and that certain of the sixteen components such as depreciation, property tax and income tax are not classified as "OM&A," which is why OPG excludes those cost elements from its calculation of total operating costs.

As per GEC-38, TGC in 2021 is $1,526.9M. Chart 1 in ED-18 establishes in the first subtotal an amount of $1,537.6M in 2021. The TGC in 2021 can be reconciled to the $1,537.6M by subtracting the asset service fee of $10.7M (rounded to $11M in Chart 1 of GEC-38), which is excluded from TGC, but included within Environmental Defense's sixteen cost components.

In preparing this undertaking, OPG noted that there is an inadvertent spreadsheet error in Chart 1 in ED-18 for the year 2021. The amount of -$22.7M in the line item designated "Other" was not deducted in the spreadsheet totals. As a result, the $1,654.0M grand total for 2021 should be revised to $1,631.4M. A revised Chart 1 is included below.

The remaining difference between the $1,526.9M in GEC-38 and the $1,631.4M grand total in Chart 1 below is explained by the removal of capital costs of $23.1M, as well as the exclusion of various non-operating cost components listed in the chart below the second subtotal for the reasons set out in JT2.5.

1

	Pickering Costs							
($M, unless otherwise stated)	2014 Actual	2015 Actual	2016 Budget	2017 Plan	2018 Plan	2019 Plan	2020 Plan	2021 Plan
Total Operating Costs - Initial	**1,319.4**	**1,347.2**	**1,364.0**	**1,351.4**	**1,351.4**	**1,391.7**	**1,337.9**	**1394.5**
Add								
Inventory Obsolescence[1]	0.0	0.0	12.4	12.4	12.4	12.4	12.4	12.4
Pickering portion of Tritium Removal Facility[1]	0.0	0.0	10.4	11.2	11.6	10.9	12.2	12.8
Fuel Costs	113.5	120.4	120.2	114.4	115.5	116.5	120.5	117.9
Subtotal	**1,432.9**	**1,467.6**	**1,507.0**	**1,489.4**	**1,490.9**	**1,531.5**	**1,483.0**	**1537.6**
Less								
Capital	119.5	90.9	124.3	85.2	29.8	28.0	23.2	23.1
Subtotal	**1,313.4**	**1,376.7**	**1,382.7**	**1,404.2**	**1,461.1**	**1,503.5**	**1,459.8**	**1514.5**
Add								
OPEB and Pension excluded from Centrally Held Costs	10.7	45.8	48.5	62.7	39.2	25.5	15.7	10.0
IESO Non energy Charges[2]	32.2	51.5	27.6	30.6	28.2	25.7	28.7	22.3
Other[1]	0.0	0.0	-3.7	-68.6	-37.3	-25.8	-30.6	-22.7
Subtotal	**1,356.3**	**1,474.0**	**1,455.1**	**1,428.8**	**1,491.2**	**1,529.0**	**1,473.5**	**1,524.2**
Add								
Depreciation and Amortization _Pickering[2]	140.9	147.3	165.7	199.9	223.2	226.7	233.3	53.1
Depreciation and Amortization- Pickering Generic[2]	44.2	53.5	34.2	38.6	37.1	34.9	36.7	20.4
Income Tax - Pickering[2]	-25.7	-15.2	-8.3	-9.2	-9.2	-9.1	26.9	27.5
Property Tax- Pickering	4.9	4.9	5.0	5.4	5.5	5.7	5.8	6.3
Total								
Planned Operating Costs	**1,520.5**	**1,664.5**	**1,651.7**	**1,663.6**	**1,747.9**	**1,787.2**	**1,776.2**	**1631.4**
Pickering Generation - TWh	**20.1**	**21.2**	**20.8**	**19.1**	**19.2**	**19.4**	**19.6**	**18.8**
Planned Operating Costs- $/MWh	**75.7**	**78.4**	**79.5**	**87.3**	**91.1**	**92.3**	**90.5**	**86.7**

[1] Included in Total Operating Costs- Initial in 2014 actual and 2015 actual

[2] Allocation based on Pickering % of generation

2

UNDERTAKING JT2.5

Undertaking

OF THE COSTS INCLUDED IN ED 18, BOARD STAFF 116, AND GEC 38, TO ADVISE WHICH WERE INCLUDED OR EXCLUDED FROM THE ECONOMIC ASSESSMENT OF PICKERING, INCLUDING THE CALCULATION OF THE 6.5 CENTS PER KILOWATT-HOUR

Response

OPG notes that levelized unit energy cost (LUEC) is an economic measure and as such is based on incremental costs and generation. The approach used to calculate LUEC differs from a rate calculation. For example, LUEC calculations exclude "non-cash" items such as depreciation and amortization expense, and instead include the incremental capital expenditures in the year incurred. As well, LUEC calculations exclude non-incremental costs that are considered to be independent of the decision being made. Please see also OPG's response to Ex. L-04.3-6 EP-014. OPG's response to JT 1.17E Attachment 1 provides an explanation of the LUEC methodology.

The LUEC calculation referenced in the Pickering Extended Operations Economic Assessment (Ex. F2-2-3 Attachment 2) includes the following cost categories:

1. Base OM&A (Station and Nuclear Support)
2. Outage OM&A (Station Direct and Nuclear Support)
3. Project OM&A
4. Capital
5. Corporate Support
6. Fuel Costs

Using 2021 as an example, the sum of the above cost categories excluding Fuel Costs is $1,395M, on a fully allocated basis (as provided in Ex. L-06.5-1 Staff-116 and Ex. L-06.5-1 GEC-38, and the first line of Chart 1 in Ex. L-06.5-7 ED-018). With the exception of Fuel Costs, these categories are itemized in Ex. L-06.5-1 Staff-118 (a) & (b). Incremental Fuel Costs are $118M in 2021, as provided in Ex. L-06.5-7-ED-018 and Ex. L-06.5-1 GEC-38. All of these values are expressed in escalated dollars.

As described in the Pickering Extended Operations Economic Assessment, the financial evaluation and the related LUEC are calculated using incremental operating costs relative to a 2020 Pickering shutdown. The incremental OM&A and Capital costs are shown in constant 2015 M$ in Interrogatories Ex. L-6.5-7 ED-028 part (i) and Ex. L-6.5-1 Staff-126, Chart 2. For the year 2021, the non-fuel incremental Operating Costs assumed in the Pickering Extension Business Case are $987M (2015$). The difference in 2021 operating costs between the $987M and the $1,395M described above is related to escalation from constant to nominal dollars and the exclusion of non-incremental costs (i.e., the assumed non-incremental portion of nuclear and corporate support costs).

Cost categories shown in Ex. L-06.5-7 ED-018 that are not included in the economic assessment or LUEC calculation are provided below. Amounts provided below refer to 2021 values from Chart 1 in Ex. L-06.5-7 ED-018, for reference purposes:

1. Inventory Obsolescence ($12.4M) – These costs are excluded as a non-cash item.
2. Pickering Portion of Tritium Removal Facility ($12.8M) -- These costs are considered non-incremental as they would be borne by OPG in the absence of operating Pickering units.
3. OPEB and Pension excluded from Centrally Held Costs and Other Costs ($-12.7M) – These costs primarily represent non-current service components of pension and OPEB amounts that largely would be incurred whether or not the operation of the Pickering station were extended, as well as the pension and OPEB adjustment for cash to accrual differences shown at Ex. F4-4-1 Table 3 line 2.
4. IESO Non-Energy Charges ($22.3M) – If not paid by OPG, these costs (e.g., transmission charges or IESO administration fees) are assumed to be recovered from other transmission system customers and therefore are not incremental.
5. Depreciation and Amortization Pickering ($53.1M) – These costs are non-cash accounting transactions related to matching capital costs to the period when benefits are considered to be realized. Instead, incremental capital costs associated with the extending Pickering operations are reflected in the LUEC.
6. Depreciation and Amortization Pickering Generic ($20.4M) – These costs are non-cash accounting transactions related to matching capital costs to the period when benefits are considered to be realized.
7. Income Tax Pickering ($27.5M) – Income taxes are not directly related to costs of operating an asset; rather, they result from earning income from the asset.
8. Property Tax Pickering ($6.3M) – Property taxes for the Pickering site were assumed to be payable in the post-2020 period regardless of whether or not the operation of the station were extended, and are therefore not incremental.

UNDERTAKING JT2.6

Undertaking

TO CONSIDER MR. ELSON'S QUESTION FOR RELEVANCE, AND ADVISE WHETHER IT CAN BE ANSWERED AND REASONS WHY OR WHY NOT.

Response

OPG believes that to the extent it is possible to answer this question, the IESO has done so in Undertaking JT1.17g, part 2.

UNDERTAKING JT2.7

Undertaking

TO ADVISE THE BUDGETARY NUMBER FOR TURBINE CONTROLS

Response

The turbine controls on U2 were removed from DRP scope as a result of the Darlington Nuclear Refurbishment Scope Review that took place between August and October 2013. At this time the cost was estimated at approximately $29M.

UNDERTAKING JT2.8

Undertaking

TO PROVIDE IN ELECTRONIC FORMAT THE TABLE IR 4.2 AMPCO 17, IF POSSIBLE

Response

Ex. L4.2-2 AMPCO-17 Attachment 1 is attached in Excel spreadsheet format. Confidential information has been removed from the attached file.

UNDERTAKING JT2.9

Undertaking

TO PROVIDE THE INFORMATION FOR ITEMS AND 2 AND 3.

Response

This undertaking provides information regarding the adjustments made to the denominator in the derivation of Total Generating Cost per MWh to normalize for the planned refurbishment of various Darlington units over the test period. Chart 1 provides a calculation of all normalization adjustments referenced in Ex. L-6.2-1 Staff-101, part (b). Please note that the 1% FLR adjustment referenced in the third bullet in Ex. L-6.2-1 Staff-101 part (b) also adds back generation for an anticipated higher Unit 2 post refurbishment force loss rate, i.e., Unit 2's expected forced loss rate of 12% in 2020 and 6% in 2021 as described at Ex. E2-1-1 page 4. This adjustment is included in Chart 1.

Chart 1

Per Ex. L-6.2-15 SEC-63 ($ millions)		2017	2018	2019	2020	2021
Stations		398.9	405.5	391.1	409.2	336.2
Nuclear Support		324.6	280.5	290.2	316.2	252.4
Corporate Support		218.7	219.8	218.4	219.8	215.9
Total OM&A		**942.3**	**905.8**	**899.8**	**945.2**	**804.4**
Total Capital		**193.8**	**228.2**	**254.4**	**255.3**	**176.3**
Total Fuel		**105.5**	**106.5**	**116.6**	**107.7**	**94.8**
Total Generation (Twh)		**19.0**	**19.3**	**19.7**	**17.7**	**16.6**
Total $TGC/MWh (non-normalized)		**65.23**	**64.36**	**64.61**	**73.82**	**64.90**
Normalization Adjustments (TWh)						
(a) Add: Lost Generation due to Refurb Outage per Ex.L-6.2-1 Staff-101 (b) item 1						
	Unit 2	7.69	7.69	7.69	0.95	
	Unit 3				6.76	7.69
	Unit 1					4.21
(b) Less: Regular Scheduled Outage on Unit 2 per Ex. L-6.2 Staff-101 (b) Item 2						
	Unit 2			-2.07		
(c) Less: Forced Loss Rate adjustments at 1% per Ex. L-6.2 Staff-101 (b) Item 3						
	Unit 2	-0.08	-0.08	-0.08	-0.01	
	Unit 3				-0.07	-0.08
	Unit 1					-0.04
Add: Force Lost Rate adjustment Unit 2 Planned Post Refurbishment						
	Unit 2				0.75	0.38
Total Normalized Generation (Twh)		**26.6**	**26.9**	**25.2**	**26.1**	**28.7**
(e) Revised Fuel Costs (S millions)		**147.2**	**148.0**	**149.1**	**158.0**	**163.3**
Total Normalized TGC$/MWh		**48.16**	**47.68**	**51.68**	**52.04**	**39.80**

(per Ex. F2-2-1 chart 4 page 15 and Chart 5 page 17)

UNDERTAKING JT2.10

Undertaking

TO PROVIDE THE FORECAST FOR SPOT PRICES FOR URANIUM.

Response

Please see the attached confidential forecast from UxC Consulting.

JT2.10 ATTACHMENT 1

IS CONFIDENTIAL IN ITS ENTIRETY

UNDERTAKING JT2.11

Undertaking

TO PROVIDE THE DATA POINTS AND POTENTIALLY UPDATE CHART 2 OF EXHIBIT F2, TAB 5, SCHEDULE 1, PAGE 3

Response

Table 1 below provides data points for Chart 2 found at Ex. F2-5-1, page 3, and updates this information to October 2016 for actual UxcPrice –Spot and UXc Price –Term prices. Table 2 provides data points for actual and forecast OPG Average Purchase Price for the period 2015 to 2021. The OPG Forecast price range is derived from the UxC Annual Spot and Long-Term Base Price Projection (High High 90% Band and Low Low 70% Band) which is attached to JT2.10 (Confidential Attachment).

Table 1

	UxC U3O8 (US$/lb)	
Mth/Yr	**Spot**	**Term**
15-Jan	38.00	49.00
15-Feb	38.75	49.00
15-Mar	39.50	49.00
15-Apr	38.25	49.00
15-May	35.00	49.00
15-Jun	36.50	46.00
15-Jul	36.00	44.00
15-Aug	36.75	44.00
15-Sep	36.50	44.00
15-Oct	36.50	44.00
15-Nov	36.00	44.00
15-Dec	34.25	44.00
16-Jan	34.75	44.00
16-Feb	32.15	44.00
16-Mar	29.15	44.00
16-Apr	27.50	44.00
16-May	27.25	41.00
16-Jun	27.00	41.00
16-Jul	25.00	38.00
16-Aug	25.25	38.00
16-Sep	23.75	38.00
16-Oct	18.75	36.00

Table 2

	OPG Average Uranium Costs		
	(US$/lb)	US$/kg	C$/kg
2015 Actual	US$48.56	US$126.26	C$145.20
2016 Forecast	US$49.39	US$128.41	C$145.10
2016 YTD	US$46.13	US$119.94	C$159.82
2017 Forecast	US$48.67	US$126.54	C $142.98
2018 Forecast	US$45.48	US$118.23	C$133.6
2019 Forecast	US$47.80	US$124.27	C$136.71
2020 Forecast	US$50.18	US$130.46	C$143.52
2021 Forecast	US$49.98	US$129.95	C$141.71

UNDERTAKING JT2.12

Undertaking

TO PROVIDE THE DETAILS OF THE VARIOUS METRICS; ALSO, TO PROVIDE THE DRIVERS BEHIND THE INDEX AND EXPLAIN HOW THEY HAVE BEEN IMPROVING.

Response

The Equipment Reliability Indicator (ERI) comprises 17 sub indicators within eight focus areas (Electrical Generation; Challenge to Operations; System Health, Maintenance; Work Management; Long Term Planning; Monitoring & Trending and Configuration Management) per Table 1. The indicator is an aggregate measure of equipment reliability performance.

The definitions and calculations are performed per CANDU Owners Group (COG) ERI Guideline, COG-GL-2-10-02. ERI is reported on and reviewed by management on a quarterly basis.

Performance improvements are focused on those ERI sub-indicators that are considerably below their maximum ERI points. Currently, for both sites, the focus areas are Unmitigated Single Point Vulnerability (System Health) and Deferral of Critical PM Deferrals/Critical PMs Open in 2nd Half of Grace (Maintenance). The performance improvements are being implemented using best practices at both Darlington and Pickering by such actions as forming dedicated teams to address performance. As an example of addressing Single Point Vulnerability (SPV), OPG has reviewed all equipment at the Darlington and Pickering stations, has reconfirmed equipment that are SPVs and has confirmed the maintenance program has mitigation strategies (preventive, condition, predictive maintenance or enhanced surveillance activities) in place to prevent equipment failures.

1
2

Table 1

Equipment Reliability Indicator			
Area	**Sub Indicator Number**	**ERI Sub-Indicators**	**Max points**
Electrical Generation	1.1	Rolling Forced Loss Rate	8
	1.2	Unplanned Power Reductions Per 7000 Hrs Critical	8
	1.3	Quarterly Forced Loss Events	6
Challenge to Operations	2.1	Unplanned S/D Clock Activation	4
	2.2	Operator Work Arounds	2
	2.3	AP-913 Consequential Failure Event	10
System Health	3.1	Safety System Unavailability	5
	3.2	Unmitigated Single Point Vulnerability (SPV)	8
Maintenance	4.1	Equipment Rework Index	5
	4.2	Defficient Critical Work Backlog	5
	4.3	Deferral of Critical PMs (rolling 12 months)	6
	4.4	Critical PM's Open in 2nd Half of Grace (end of month)	6
Work Management	5.1	Work Week Schedule Scope Survival (Average of last 3 months, per unit)	8
Long Term Planning	6.1	Plant Health Committee Effectiveness (PHCE)	7
	6.2	Age of Red and Yellow Systems	8
Monitoring & Trending	7.1	Chemistry Effectiveness	2
Configuration Management	8.1	Preventative Maintenance Change Request Backlog	2
ERI - Total Points			**100**

3

UNDERTAKING JT2.13

Undertaking

TO ADVISE WHETHER THE FIGURE 1 DATA IS REPRESENTATIVE OF HOW THE FIRMS ARE ACTUALLY DOING VERSUS PARTICULAR SAFETY TARGETS.

Response

OPG measures the ESMSA contractors All Injury Rate safety performance for nuclear projects separately and in addition to the DRP.

Year to date AIR performance for nuclear projects for each of the three ESMSA contractors is 0.0. OPG is moving to revise the ESMSA score card to include AIR in the safety performance metric.

UNDERTAKING JT2.14

Undertaking

TO UPDATE REFERRED TABLE TO REFLECT P-50 CONFIDENCE LEVEL SCHEDULE FOR DARLINGTON REFURBISHMENT PROJECT

Response

The updated table reflecting a P-50 confidence level schedule for Darlington Refurbishment is attached. The cells in the table in Attachment 1 that have been changed are highlighted in yellow.

The P-50 confidence level schedule moves the end date for Unit 2 refurbishment from February 14, 2020 to November 15, 2019 (see Ex. L-4.5-5 CCC-022 Attachment 1 page 6 and 7, Tables 3 and 4) and has cascading impacts on other refurbishment and post refurbishment mini-outages. The Unit 3 refurbishment starts one month after the Unit 2 returns to service.

The net impacts to the forecast of generation in the test period by using a P-50 schedule for Darlington Refurbishment versus a P-90 schedule are as follows:

Gain of approximately 0.6TWh in 2019.

Loss of approximately 1.3TWh in 2021.

Total impact would be a loss of production of approximately 0.7TWh during the test period.

Please note that the formulas used to calculate total production and total revenue impacts for Darlington in 2020 were incorrect in Ex. L-5.1-5 CCC-024 and have been corrected in the updated table. The corrected formulas result in total 2020 production increasing from 14.8TWh to 18.1TWh. To be clear, however, there is no change in total production impact and revenue impact in 2020 as a result of updating the table to reflect a P-50 confidence level schedule for Darlington Refurbishment.

Year		Outage	Unit Affected	Description	Outage Duration (days)	Forecast Production (TWh) Impact Due to Outage	Revenue Impact of Outage ($M)
2017	Pickering	P1711	Unit 1	Planned Outage	204.9	2.6	168.0
		P1742	Unit 4	Mid-Cycle Outage	43.0	0.5	35.2
		P1751	Unit 5	Planned Outage	160.7	2.0	132.0
		P1761	Unit 6	Planned Outage	133.0	1.7	109.2
		Total			**541.6**	**6.8**	**444.4**
	Darlington	D1711	Unit 1	Planned Outage	108.4	2.3	152.9
		DNRU2	Unit 2	Refurbishment Outage	365.0	7.8	514.8
		D1731-PD	Unit 3	Planned Derate	2.5	0.1	3.5
		D1732	Unit 3	PHT Pump Motor Outage	20.0	0.4	28.2
		D1741-PD	Unit 4	Planned Derate	2.5	0.1	3.5
		D1742	Unit 4	PHT Pump Motor Outage	20.0	0.4	28.2
		Total			**518.4**	**11.1**	**731.2**
Total 2017					**1,060.0**	**17.9**	**1,175.6**
2018	Pickering	P1812	Unit 1	Mid-Cycle Outage	43.0	0.5	39.1
		P1841	Unit 4	Planned Outage	144.1	1.8	131.2
		P1871	Unit 7	Planned Outage	193.5	2.4	176.4
		P1881	Unit 8	Planned Outage	150.2	1.9	136.9
		Total			**530.8**	**6.6**	**483.6**
	Darington	D1811	Unit 1	PHT Pump Motor Outage	20.0	0.4	31.3
		DNRU2	Unit 2	Refurbishment Outage	365.0	7.8	571.4
		D1831	Unit 3	Planned Outage	103.3	2.2	161.7
		D1841	Unit 4	PHT Pump Motor Outage	20.0	0.4	31.3
		Total			**508.3**	**10.9**	**795.8**
Total 2018					**1,039.1**	**17.5**	**1,279.4**
2019	Pickering	P1911	Unit 1	Planned Outage	128.5	1.6	129.8
		P1942	Unit 4	Mid-Cycle Outage	43.0	0.5	43.4
		P1951	Unit 5	Planned Outage	165.6	2.1	167.6
		P1961	Unit 6	Planned Outage	180.1	2.2	182.3
		Total			**517.2**	**6.5**	**523.1**
	Darlington	D1911	Unit 1	PHT Pump Motor Outage	20.0	0.4	34.8
		D1912-PD	Unit 1	Planned Derate	2.5	0.1	4.3
		DNRU2	Unit 2	Refurbishment Outage	318.5	6.8	553.5
		DNRU3	Unit 3	Refurbishment Outage	17.0	0.4	29.5
		P1931-PD	Unit 3	Planned Derate	2.5	0.1	4.3
		D1941	Unit 4	Planned Outage	99.1	2.1	172.2
		Total			**459.6**	**9.9**	**798.7**
Total 2019					**976.8**	**16.3**	**1,321.8**
2020	Pickering	P2012	Unit 1	Mid-Cycle Outage	43.0	0.5	48.2
		P2041	Unit 4	Planned Outage	164.5	2.0	184.4
		P2071	Unit 7	Planned Outage	102.5	1.3	115.1
		P2081	Unit 8	Planned Outage	188.9	2.4	212.2
		Total			**498.9**	**6.2**	**560.0**
	Darlington	D2011	Unit 1	Planned Outage	108.2	2.3	208.7
		DNRU2	Unit 2	Refurbishment Outage	0.0	0.0	0.0
		D2022-PD	Unit 2	Planned Derate	2.5	0.1	4.8
		D2021	Unit 2	Post Refurb Mini Outage	55.0	1.2	106.1
		DNRU3	Unit 3	Refurbishment Outage	366.0	7.8	706.0
		D2042-PD	Unit 4	Planned Derate	2.5	0.1	4.8
		D2041	Unit 4	PHT Pump Motor Outage	20.0	0.4	38.6
		Total			**554.2**	**11.9**	**1069.1**
Total 2020					**1,053.1**	**18.1**	**1,629.1**
2021	Pickering	P2111	Unit 1	Planned Outage	150.5	1.9	187.3
		P2141	Unit 4	Vacuum Building Outage	30.0	0.4	37.3
		P2151	Unit 5	Planned Outage	179.7	2.2	224.1
		P2161	Unit 6	Planned Outage	112.6	1.4	140.4
		P2162	Unit 6	Vacuum Building Outage	30.0	0.4	37.4
		P2171	Unit 7	Vacuum Building Outage	30.0	0.4	37.4
		P2181	Unit 8	Vacuum Building Outage	30.0	0.4	37.4
		Total			**562.8**	**7.0**	**701.3**
	Darlington	DNRU1	Unit 1	Refurbishment Outage	261.0	5.6	558.9
		D2121	Unit 2	Post Refurb Mini Outage	31.2	0.7	66.8
		D2122-PD	Unit 2	Planned Derate	2.5	0.1	5.4
		DNRU3	Unit 3	Refurbishment Outage	365.0	7.8	781.6
		D2142-PD	Unit 4	Planned Derate	2.5	0.1	5.4
		D2141	Unit 4	PHT Pump Motor Outage	20.0	0.4	42.8
		Total			**682.2**	**14.6**	**1,460.8**
Total 2021					**1,245.0**	**21.6**	**2,162.1**

UNDERTAKING JT2.15

Undertaking

TO PROVIDE A FORECAST OF ZIRCONIUM COSTS IF IT EXISTS

Response

Zirconium costs represent approximately 5% of the total nuclear fuel bundle cost (i.e., the weighted average cost of manufactured uranium fuel bundles loaded into a reactor as described in Ex. F2-5-1).

The forecast of zirconium costs over the test period is based upon actual prices paid escalated forward by 2% per year.

UNDERTAKING JT2.16

Undertaking

BESIDE COLUMN D, ON 4.4 SEC 46, PROVIDE THE VALUE OF THE FIRST EXECUTION BUSINESS CASE AND PUT AN EXTRA COLUMN IN WITH THE VALUE OF THE FIRST EXECUTION BUSINESS CASE FOR THE PROJECT AND THE CORRESPONDING VARIANCE ATTACHED TO THAT.

Response

Values may not add due to rounding.

Projects	OEB Tier	Actual or Forecast In-Service Date	Actual or Forecast In-Service (M$)	Total Cost - First Execution BCS(M$)	Variance to First Execution BCS (M$)	Approved Cost (M$)	Variance (M$)
(a)	(b)	(c)	(d)			(e)	(f)
25619 - DN OSB Refurbishment	1	Oct-15	60.6	47.8	12.8	62.7	(2.1)
33955 - Shutdown System Computer Aging Management	1	Nov-16	20.4	17.2	3.2	20.4	0.0
34000 - DN Auxiliary Heating System	1	Oct-17	98.7	45.6	53.1	107.1	(8.4)
41023 - Unit 1 & 4 Fuel Channel East Pressure Tube Shift Tooling (Capital)	1	Mar-16	27.8	22.0	5.8	29.7	(1.9)
73706 - DN Holt Road Interchange Upgrade	1	Aug-16	24.6	31.0	(6.4)	31.0	(6.4)
31306 - DN Passive Auto-Catalytic Recombiners	2	Jun-16	5.1	6.5	(1.4)	5.8	(0.7)
33623 - DN Installation of partial discharge monitors	2	Feb-14	5.6	3.3	2.3	7.1	(1.5)
36002 - DN MOT Capital Spares	2	Sep-16	8.1	8.3	(0.2)	8.3	(0.2)
40680 - PB Main Generator AVR and Protective Relay Upgrade	2	Jul-15	18.7	16.1	2.6	18.8	(0.1)
46605 - PA Passive Auto-Catalytic Recombiners	2	May-14	12.1	5.0	7.1	14.4	(2.3)
49116 - PB SG/EPG Fire Detection Upgrade and CO2 Suppression Removal	2	Jul-16	6.9	5.7	1.2	10.7	(3.8)
49126 - PB Powerhouse Office Facilities (Capital)	2	Dec-14	4.2	9.0	(4.8)	6.7	(2.5)

Projects	OEB Tier	Actual or Forecast In-Service Date	Actual or Forecast In-Service (M$)	Total Cost - First Execution BCS(M$)	Variance to First Execution BCS (M$)	Approved Cost (M$)	Variance (M$)
(a)	(b)	(c)	(d)			(e)	(f)
49132 - PB RBSW Dechlorination & MISA Cleanup	2	Dec-16	14.1	11.8	2.3	14.1	(0.0)
49134 - PB Replacement of Containment Box-up Monitors	2	Jul-15	6.9	7.9	(1.0)	8.8	(1.9)
49140 - PB Screenhouse Trash Bar Screen Replacement	2	Jul-15	6.8	3.1	3.7	7.7	(0.9)
49146 - PN Fire Code Compliance for Relocatable Structures in Un-Zoned Area for Pickering Station	2	Jul-16	17.1	9.6	7.5	18.8	(1.7)
49247 - Unit 1 & 4 Fuel Channel East Pressure Tube Shift Tooling (CMFA)	2	Mar-16	8.7	10.1	(1.4)	8.9	(0.2)
49267 - PN Standby Boiler Capacity Improvement	2	Nov-15	5.1	6.1	(1.0)	6.4	(1.3)
49284 - PN Administration Building Rehab	2	Dec-14	16.4	13.5	2.9	19.4	(3.0)
49296 - PA Class II Emergency Lighting	2	Aug-15	4.0	6.1	(2.1)	6.1	(2.1)
66255 - OPGN Pressure Tube to Calandria Tube Gap	2	Aug-15	16.8	26.3	(9.5)	17.5	(0.7)
66533 - Multiple Simultaneous Inspections for Feeders	2	Sep-14	0.4	8.3	(7.9)	0.5	(0.0)
73397 - DN ESW Pipe and Component Replacement	2	Jan-16	5.2	6.7	(1.5)	6.7	(1.5)
80027 - SES Station Personnel Emergency Accounting	2	Dec-16	0.2	3.3	(3.2)	3.3	(3.2)
25918 - Security Project A	2	Dec-16	9.9	4.7	5.2	9.9	0.0
31406 - DN SG Battery Rectifier upgrade (Capital)	3	Mar-14	3.8	4.6	(0.8)	4.0	(0.2)
31410 - DN TRF CRS Hydrogen Compressors Condition Monitoring System	3	May-16	6.6	6.6	0.0	6.6	(0.0)
31437 - DN F/H Service Area Bridge Mtce Platform	3	Dec-14	0.6	0.6	(0.0)	0.6	(0.0)
31530 - DN MOT/LIST/SST/10MVA Spare Transformer Storage Facility	3	Sep-16	5.1	5.6	(0.5)	5.6	(0.5)
31538 - DN RIH Instrumentation	3	Dec-16	1.4	2.3	(0.9)	1.7	(0.3)

Projects	OEB Tier	Actual or Forecast In-Service Date	Actual or Forecast In-Service (M$)	Total Cost - First Execution BCS(M$)	Variance to First Execution BCS (M$)	Approved Cost (M$)	Variance (M$)
(a)	(b)	(c)	(d)			(e)	(f)
Upgrade							
33214 - DN Building Heating Condensate Return Header Pipe Movement	3	Jan-16	2.8	2.5	0.3	2.8	0.0
33218 - DN Bleed Condenser Isolating Valve - Unit 1	3	Jul-14	1.2	1.5	(0.3)	1.5	(0.3)
33220 - DN End Shield Cooling Button-up Valve Access Platform	3	Dec-14	0.8	0.8	(0.0)	0.8	(0.0)
33222 - DN FH IFB ESW Top-up Valve Access Platform	3	Apr-15	0.7	0.6	0.1	0.7	(0.0)
33904 - Plant Information System Addt'n in the MCR	3	Apr-14	4.6	4.4	0.2	4.8	(0.2)
36005 - DN Class IV 4kV 10MVA Transformer Capital Spare	3	Oct-16	0.5	0.5	0.0	0.5	0.0
36007 - DN UST Capital Spare	3	Oct-16	2.7	1.8	0.9	3.0	(0.3)
38946 - DN Domestic Waterline Replacement	3	Dec-15	3.4	3.0	0.4	3.9	(0.5)
40658 - PB Boiler Level Control Obsolescence	3	Feb-15	1.9	2.9	(1.1)	2.9	(1.1)
40692 - PB Turbine Supervisory Equipment (TSE) Obsolescence (Capital)	3	Dec-16	3.9	5.5	(1.6)	5.0	(1.1)
40708 - PB Bleed Condenser Bundle Replacement	3	Jan-16	3.9	5.9	(2.0)	4.4	(0.5)
40975 - PN N293-07 Fire Code Compliance Modifications	3	May-15	4.3	3.0	1.3	4.3	0.0
40978 - PN Fueling Machine Vault Camera Replacement	3	Dec-16	4.0	2.5	1.5	4.2	(0.2)
40982 - PA Enhancement of Pickering A Chlorination System (Capital)	3	Sep-15	3.1	3.4	(0.3)	3.4	(0.3)
40987 - PA Replacement of AIFB Supertool	3	Dec-16	3.1	0.7	2.4	3.4	(0.3)
40992 - PN Replacement of Auto Transfer Switch ATS1 & ATS2	3	Aug-14	0.4	0.4	(0.0)	0.4	(0.0)
40993 - PA Bulk CO2 Tank Replacement	3	Aug-14	1.2	0.7	0.5	1.5	(0.3)

Projects	OEB Tier	Actual or Forecast In-Service Date	Actual or Forecast In-Service (M$)	Total Cost - First Execution BCS(M$)	Variance to First Execution BCS (M$)	Approved Cost (M$)	Variance (M$)
(a)	(b)	(c)	(d)			(e)	(f)
40994 - PA Fire Water Chlorination Skid	3	Sep-16	1.6	0.6	1.0	1.7	(0.2)
40998 - PA Generator Field Breaker Replacement	3	May-14	0.8	0.7	0.1	1.0	(0.2)
40999 - PA Generator Turbine Temperature Monitor Replacement	3	Apr-15	0.3	0.4	(0.1)	0.4	(0.1)
41005 - PA Reheat Drain Pumps Reliability Improvement	3	Dec-16	2.3	1.1	2.2	2.3	0.0
41006 - PN Comfo Washer Replacement	3	Nov-16	0.5	0.6	(0.1)	0.6	(0.1)
41008 - PN South Decontamination Shop Facility Upgrade	3	Feb-14	0.2	0.4	(0.2)	0.4	(0.2)
41009 - PA SRV Enclosure Ventilation Improvement	3	May-15	1.3	0.7	0.6	1.5	(0.1)
41011 - PN Upper Chamber Vacuum Pumps Replacement	3	Mar-14	0.3	1.0	(0.7)	1.0	(0.7)
41012 - PA 230 kV Disconnect Switches Replacement (DS138/DS142/DS154)	3	Apr-14	1.0	1.9	(0.9)	1.9	(0.9)
41033 - PN Whole Body Monitor Seismic Qualification	3	Feb-14	0.4	1.2	(0.9)	1.2	(0.9)
41034 - PA Fire Code Compliance (FSA Followup)	3	Jun-15	2.8	3.0	(0.2)	3.0	(0.2)
41040 - PN Permanent Power Supplies For Ontario Electrical Safety Code Compliance	3	Apr-14	0.8	0.9	(0.1)	0.9	(0.1)
41047 - PA Critical Pump and Motor Spares	3	Dec-15	0.5	3.9	(3.4)	2.9	(2.4)
49124 - PB Permanent Data Logger for Screenhouse	3	Sep-15	3.3	4.5	(1.2)	3.5	(0.2)
49142 - Pickering Site Engineering Services Bldg - 1 (ESB1) HVAC System Upgrades	3	Sep-14	4.2	4.4	(0.2)	4.4	(0.2)
49143 - PB Purchase of CEP Motor Capital Spares	3	Mar-16	0.3	0.3	0.0	0.3	(0.0)
49144 - PB Purchase of HPSW Motor Capital Spares	3	Mar-16	0.2	0.2	0.0	0.2	0.0

Projects	OEB Tier	Actual or Forecast In-Service Date	Actual or Forecast In-Service (M$)	Total Cost - First Execution BCS(M$)	Variance to First Execution BCS (M$)	Approved Cost (M$)	Variance (M$)
(a)	(b)	(c)	(d)			(e)	(f)
49163 - PA Fire Code Compliance for Relocatable Structures in Powerhouse	3	Dec-16	2.0	4.6	(2.6)	4.8	(2.8)
49289 - Pickering A - AVR Replacement for Standby Generators	3	Jul-16	4.8	5.2	(0.4)	4.8	0.0
49302 - PB Fire Code Compliance for Relocatable Structures in Powerhouse	3	Jan-16	2.9	4.6	(1.6)	4.6	(1.6)
62552 - Inspection Qualification	3	Dec-16	3.4	4.2	(0.8)	3.4	(0.0)
66599 - IMS Steam Generator Inspection Improvements	3	Dec-14	1.5	2.5	(0.9	2.5	(0.9)
80020 - DN TRF Cold Box Vacuum System Obsolescence	3	May-16	3.7	4.9	(1.3)	4.9	(1.3)
80119 - PA Switchyard Air Blast Circuit Breaker Replacement	3	Apr-14	3.5	3.5	0.0	3.5	0.0
80149 - DN Sewage Lift Station Replacement	3	Feb-16	1.2	4.8	(3.5)	4.8	(3.5)

1

UNDERTAKING JT2.17

Undertaking

TO PROVIDE THE CAUSES AND LENGTHS OF THE POST-REFURBISHMENT MINI-OUTAGES FROM SOME OF THE OTHER CANDU PLANTS MENTIONED IN THE IR TO SEE HOW THEY WOULD COMPARE TO WHAT IS BEING PROPOSED, INCLUDING THE LENGTHS OF THOSE OUTAGES.

Response

Operating experience from other CANDU plants has identified a number of issues that have resulted in additional outages and derates in the immediate post refurbishment period. These include, but are not limited to, the following:

Pt Lepreau
Forced outage and derates due to boiler chemistry – 57 days
Derate due to channel closure plug – 40 days
Derate due to main steam line vibration – 85 days

Bruce 1
Forced outage to restore Annulus Gas Flow – 31 days
Injection valve issues – 20 days

Pickering 4
Forced outage due to Liquid relief valve issues – 12 days
Planned and forced outages due to Liquid Zone Control issues – 36 days
PHT pump motor trip – 12 days

Pickering 1
Planned outage for PHT pump motor coolers – 14 days
Forced outages due to Liquid Zone Control issues – 35 days

UNDERTAKING JT2.18

Undertaking

TO PROVIDE THE PARALLEL NUMBER THAT'S PROVIDED IN J5.3.

Response

The parallel figures to those provided in EB-2010-0008 Undertaking J5.3 (lines 28-32) are:

- Approximately 525 people currently needed to cover the minimum complement at Pickering;
- Approximately 475 people currently needed to cover the minimum complement at Darlington.

UNDERTAKING JT2.18A

Undertaking

TO CLARIFY THE RESPONSE TO PW IR 4, TAB 4.2, SCHEDULE 13 ABOUT THE HOLT ROAD INTERCHANGE

Response

The discussion at Technical Conference Tr. V2, pages 136-137 asks if cost sharing between Ministry of Transportation (MTO) and OPG would have been the same post refurbishment or would OPG have avoided any costs related to Holt Road Interchange modifications at that time.

Holt Road interchange work was originally planned by MTO to occur after the completion of the DRP. OPG's preferred alternative, as set out in Ex. D2-1-3 Tab 1 Attachment 28 was to negotiate an earlier completion date with the MTO and additional upgrades to the Holt Road interchange work. The negotiations included a cost sharing agreement. The preferred alternative allows OPG to accommodate the large volume of traffic entering and leaving the Darlington site during DRP and particularly to accommodate the peak traffic flow when a planned outage occurs during the Refurbishment period.

Other options were examined in Ex. D2-1-3 Tab 1 Attachment 28 including a "do nothing strategy" that would have deferred the Holt Road to the post refurbishment period as originally planned by MTO thus avoiding any cost sharing agreement. However this alternative was assessed as being less optimal relative to the preferred alternative because of its timing and scope.

UNDERTAKING JT2.19

Undertaking

TO PROVIDE THE CAPITAL IN-SERVICE AND WHAT WAS ACTUALLY DONE DURING THE RATE PERIOD PROJECT BY PROJECT FOR TIER 1 AND TIER 2.

Response

The following table details the 2014 Approved, 2014 Actual, 2015 Approved and 2015 Actual capital in-service amounts. While in-service amounts by specific project have been identified as "2014 Approved" and "2015 Approved" in this undertaking and Ex. L-4.4-1 Staff-76, OPG notes that the Board in its Decision in EB-20134-0321 approved a total in-service amount and not project specific amounts.

The numbers may not add due to rounding.

Projects	2014 Approved	2014 Actual	2015 Approved	2015 Actual
Tier 1 Projects				
25609 - Physical Barrier System	0.0	7.0	0.0	0.0
25619 - DN Operations Support Building Refurbishment	0.0	0.0	29.7	55.1
31412 - DN Class II Uninterruptible Power Supply Replacement	0.0	1.3	3.8	0.0
31508 - DN Fukushima Phase 1 Beyond Design Basis Event Emergency Mitigation Equipment	0.0	0.0	0.0	2.6
31518 - DN Restore Emergency Service Water and Firewater Margins	0.0	0.0	0.0	0.0
31524 - DN Station Roofs Replacement	0.0	0.0	0.0	0.0
31542 - DN Transformer Multi-Gas Analyzer Installation	0.0	7.2	0.0	2.1
31552 - DN Condenser Cooling Water and Low Pressure Service Water Travelling Screens Replacement	0.0	0.0	0.0	6.8
31710 - DN Shutdown Cooling Heat Exchanger Replacement	0.0	0.0	0.0	0.0
31717 - DN Improve Maintenance Facilities at Darlington	2.0	0.0	0.0	0.0
33621 - Air Conditioning Unit Replacement for Secondary Control Area	7.3	0.0	0.0	0.0
33819 - DN Major Pump-sets Vibration Monitoring System Upgrades	3.2	0.0	2.7	0.0
33955 - Shutdown System Computer Aging Management	1.9	0.3	0.0	15.1
33973 - DN Standby Generator Controls	3.9	6.2	0.0	4.1

Projects	2014 Approved	2014 Actual	2015 Approved	2015 Actual
Replacement				
33977 - DN Digital Control Computer Replacement / Refurbishment / Upgrades	1.7	0.0	0.0	1.3
34000 - DN Auxiliary Heating System	0.0	0.0	36.3	0.0
36001 - DN Purchase of Primary Heat Transport Pump Motor Capital Spares	0.0	14.5	0.0	6.7
38948 - DN Zebra Mussel Mitigation Improvements	0.0	0.0	0.0	0.0
40976 - PB Fuel Handling Reliability Modifications	0.0	12.5	0.0	0.0
41023 - Unit 1 & 4 Fuel Channel East Pressure Tube Shift Tooling	0.0	0.0	0.0	19.3
41027 - PN Fukushima Phase 2 Beyond Design Basis Event Emergency Mitigation Equipment	0.0	0.0	0.0	0.0
46634 - PA Fuel Handling Single Point Vulnerability Equipment Reliability Improvement Project	2.0	0.0	0.0	0.0
49109 - PB Standby Generator Governor Upgrade	0.0	0.0	0.0	1.1
49158 - PB Fukushima Phase 1 Beyond Design Basis Event Emergency Mitigation Equipment	0.0	4.3	8.1	5.6
49299 - PA Fukushima Phase 1 Beyond Design Basis Event Emergency Mitigation Equipment	0.0	0.0	0.0	1.8
66600 - IMS Machine Delivered Scrape	0.0	0.0	0.0	0.0
73566 - DN RS PHT Pump Motor Replacement	0.0	0.0	0.0	0.0
73706 - DN Holt Road Interchange Upgrade	0.0	0.0	0.0	0.0
80144 - DN Primary Heat Transport Pump Motor Overhaul	0.0	0.0	0.0	0.0
Tier 1 Total	**22.0**	**53.3**	**80.5**	**121.6**
Tier 2 Projects				
25918 – Security Project A	0.0	0.0	0.0	0.0
31306 - DN Passive Auto-Catalytic Recombiners	1.2	0.0	0.3	0.0
31403 - DN Active Liquid Waste System Upgrade	6.7	0.0	0.0	0.0
31422 - DN Pressurizer Heaters & Controllers Replacement Project	4.3	0.8	0.0	0.0
31426 - DN F/H Inverter Replacement	4.3		0.0	0.0
31436 - DN Computer Upgrade for Heavy	0.0	2.1	0.0	0.0

Projects	2014 Approved	2014 Actual	2015 Approved	2015 Actual
Water Management System (TRF/SUP)				
31520 - DN Replacement of Obsolete Online Chemistry Analysers	0.0	0.0	0.0	0.0
31536 - DN T/G Lube Oil Purifier Replacement	0.0	0.0	0.0	2.0
32202 - DN Fukushima Phase 2 Beyond Design Basis Event Emergency Mitigation Equipment	0.0	0.0	0.0	0.0
33258 - DN Replacement of EPS Uninterruptible Power Supply	4.8	6.6	0.0	1.4
33509 - Replacement of Obsolete Computer Components	0.0	0.0	0.0	0.0
33623 - DN Installation of partial discharge monitors	1.7	1.1	0.0	0.0
33815 - FH Computer Replacement	0.0	1.9	0.0	1.3
34006 - DN Suit and Maintenance Communication Replacement	1.8	0.0	0.9	0.0
40680 - PB Main Generator Automatic Voltage Regulator and Protective Relay Upgrade	6.6	5.8	2.4	6.2
40691 - PB Emergency Power Generator Protective Relays	1.7	0.0	1.1	0.8
40972 - PA Standby Generator Reliability	0.0	0.0	0.0	0.0
40983 - PB Machine Guarding Improvement on Low Risk Equipment	0.0	0.5	0.0	1.3
40985 - PN Replacement of Obsolete Online Chemistry Analysers	0.0	1.2	0.0	0.4
41043 - PN Emergency Power Generator Engine Replacement	0.0	0.0	0.0	0.0
41044 - PA SG Protective Relay Upgrade	0.0	0.0	0.0	0.0
46605 - PA Passive Auto-Catalytic Recombiners	4.3	(3.0)	0.0	0.0
49116 - PB SG/EPG Fire Detection Upgrade and CO2 Suppression Removal	1.1	2.0	0.0	0.4
49126 - PB Powerhouse Office Facilities (Capital)	0.0	0.0	0.0	0.0
49132 - PB Reactor Building Service Water Dechlorination & MISA Cleanup	1.8	0.0	0.0	0.0
49134 - PB Replacement of Containment Box-up Monitors	3.2	2.1	0.0	0.6
49140 - PB Screenhouse Trash Bar Screen Replacement	0.0	0.0	0.0	5.2
49146 - PN Fire Code Compliance for Relocatable Structures in Un-Zoned Area for Pickering Station	0.0	0.0	0.0	0.7

Projects	2014 Approved	2014 Actual	2015 Approved	2015 Actual
49154 - PB Replacement of Obsolete Instrumentation and Control Equipment	0.0	0.0	0.0	4.3
49247 - Unit 1 & 4 Fuel Channel East Pressure Tube Shift Tooling	15.4	0.0	0.0	2.7
49267 - PN Standby Boiler Capacity Improvement	1.4	0.2	0.0	2.5
49284 - PN Administration Building Rehab	0.0	4.1	0.0	0.0
49296 - PA Class II Emergency Lighting	0.8	1.6	0.2	2.3
49298 - PA Replacement of U1, U4 and IFB-A Stack Monitors	0.0	0.0	0.0	0.0
66255 - OPGN Pressure Tube to Calandria Tube Gap	2.1	1.7	0.0	0.3
66594 - IMS CIGAR Gap System and Drive Reliability	2.4	0.0	0.7	0.8
73397 - DN Emergency Service Water Pipe and Component Replacement	0.0	0.0	0.0	4.9
80027 - SES Station Personnel Emergency Accounting	0.0	0.0	0.0	0.5
80069 - PA Firewater Buried Ring Header Replacement	0.0	0.0	0.0	0.0
82949 - DN X-750 Spacer Retrieval	0.0	0.0	0.0	0.0
Total – Tier 2 Projects	**65.6**	**28.7**	**5.5**	**38.5**
Total – Tier 3 Projects	**11.5**	**43.7**	**0.9**	**21.7**
Supplemental In-Service Forecast	**37.9**	**0.0**	**99.1**	**0.0**
Total [1]	**137.0**	**125.7**	**186.0**	**181.8**

[1] The 2015 Total includes $66M for the Operations Support Building and Auxiliary Heating System which were moved from DRP

UNDERTAKING JT2.20

Undertaking

TO DO A REVIEW LOOKING FOR A FORMALIZED BENCHMARKING STUDY IN RESPECT OF THE ELEMENTS THAT FORM PART OF THE COSTS PARAMETERS RELEVANT TO THE CONSIDERATION OF ESTABLISHING PAYMENT AMOUNTS

Response

A study entitled “Nuclear Inventory Benchmarking Report” is attached, based on OPG’s internal review using the criteria set out in the undertaking.

ONTARIO POWER GENERATION

scottmadden
MANAGEMENT CONSULTANTS

Smart. Focused. Done Right.®

OPG Nuclear Inventory Benchmarking Report

Findings and Recommendations

November 2015

ONTARIO POWER GENERATION

Table of Contents

scottmadden
MANAGEMENT CONSULTANTS

Executive Summary

Filed: 2016-11-21
EB-2016-0152
JT2.20, Attachment 1
Page 4 of 74

ONTARIO POWER GENERATION

Approach

This document contains the results of a survey that collected metrics and practices related to inventory management in nuclear power generation. The study was sponsored by Ontario Power Generation (OPG).

- OPG engaged ScottMadden to partner on survey design
- ScottMadden independently administered the survey, acting as a blinding agent for all participants (including OPG), and interpreted the results, which were focused on:
  - Inventory Management Metrics
  - Inventory Management Practices, including
    - Categorization
    - Decision Rights
    - Policies and Procedures
- Participants were selected based on reactor technology and location. Each participant:
  - Filled out a comprehensive survey with both quantitative and qualitative questions
  - Answered follow-up interview questions regarding responses provided, when necessary
- Operators who participated in this survey are detailed on the following page

scottmadden
MANAGEMENT CONSULTANTS

ONTARIO POWER GENERATION

Approach (Cont'd)

Operators who participated in the survey include:

- Arizona Public Service
- Bruce Power
- China National Nuclear Operations Corporation
- Duke Energy
- Exelon
- FirstEnergy Corporation
- New Brunswick Power
- NextEra Energy
- Ontario Power Generation
- Pacific Gas & Electric
- Public Service Enterprise Group
- Societatea Nationala NuclearElectrica S.A.
- Wolf Creek Nuclear Operating Corporation

Note: All dollar values stated in this report are in Canadian dollars and indicated by $

scottmadden MANAGEMENT CONSULTANTS

Filed: 2016-11-21
EB-2016-0152
JT2.20, Attachment 1
Page 6 of 74

ONTARIO POWER GENERATION

Key Observations for OPG

OPG commissioned this independent benchmarking analysis on inventory for OPG Nuclear in order to identify opportunities for cost control of materials and supplies. This study is in response to OPG's Nuclear Executive Committee decision to drive changes in inventory management for improved reliability and value for money. OPG also has initiatives underway to improve the management of the inventory asset (e.g., "Improve Inventory Management," which is part of a program called "NFI-07"). This increased emphasis on inventory management is a positive step for the organization.

Managing nuclear inventory is challenging for any operator as many nuclear parts are slow-moving and expensive, driving need for significant investment to mitigate low-likelihood events. At OPG, managing nuclear inventory is also complicated in two additional, noteworthy ways. First, the Pickering plant has older, more parts-intensive and lower capacity units and is also approaching end of commercial operations. Thus, there is a large amount of inventory and a need to tightly control growth. Second, the Darlington plant has been preparing for a multi-year, multi-billion-dollar refurbishment project. While this inventory is not included in the benchmark data, it will have an impact on the existing inventory asset for the operating plant.

This study showed that OPG is currently in-line with peer performance in many, but not all, of the selected metrics. Noteworthy exceptions are in a greater inventory size per MW for Pickering, a higher inventory growth rate for Darlington, and a comparatively large number of unique parts in the company catalog and on-site at both plants. OPG's inventory management practices, which ultimately drive the metrics, are positive in some cases (e.g., segmentation of inventory, management of critical spares, and allocation of budget for surplus/obsolete reductions) but have significant improvement opportunities in others (e.g., aligning decision rights with leading practices, intelligently setting and managing stocking levels, and tightening approval authorities). Adopting management practices to address these gaps will help the organization to meet its objective of improving reliability and value for money. As such, it is important that OPG now focus strongly on taking actions that align with the recommendations in this report.

scottmadden
MANAGEMENT CONSULTANTS

Filed: 2016-11-21
EB-2016-0152
JT2.20, Attachment 1
Page 7 of 74

ONTARIO POWER GENERATION

Key Observations for OPG (Cont'd)

Inventory Size

- PNGS has 58% more inventory per MW and 7% more inventory per unit than the median of the CANDU panel
- DNGS inventory per MW is 4% lower than the median for CANDUs and 2% less than median for the Canada peer group
- As is the case with most respondents, OPG does not currently calculate an inventory carrying cost

Inventory Growth

- PNGS has the second lowest growth rate among CANDU respondents; however, at this growth rate, PNGS will have C$162,303 in inventory per MW by 2021, a 42% increase from 2014
- Although DNGS inventory size per MW is lower than the median for CANDUs, its growth rate is higher than all peer group medians
  - Assuming the growth rate for DNGS is sustained, inventory per MW for DNGS will surpass the current medians of all peer groups in 3 years, and will increase to C$117,838 by 2021, which is higher than the 2014 value at PNGS
- OPG is among the majority of respondents using manual calculations to assign inventory stocking level criteria and does not use system-generated or automatic calculations
- OPG does not regularly reassess inventory stocking criteria though most respondents reassess with each purchase

Excess Inventory

- PNGS has a higher level of inventory in excess of set stocking levels than the median of all peer groups
- DNGS has less excess inventory than the median of the CANDU and Canada peer panels, but considerably greater inventory in excess of set stocking levels than the median of PWRs and BWRs
- OPG did not report any inventory reduction strategies in place

scottmadden
MANAGEMENT CONSULTANTS

Filed: 2016-11-21
EB-2016-0152
JT2.20, Attachment 1
Page 8 of 74

ONTARIO POWER GENERATION

Key Observations for OPG (Cont'd)

Disposal of Surplus or Obsolete Stock

- OPG allocates the highest annual budget for disposal of surplus or obsolete stock each year, and allocates two times as much as the second highest allocation percentage
- Unfortunately, this budget is not being utilized as fully as it could be
- OPG is one of the four respondents who do not have a formal procedure to identify and dispose of excess or obsolete material

Parts On-Site and in the Catalogue

- Total unique parts on site for PNGS is 83% higher than that of the Canada peer group
- While DNGS has a lower number of unique parts on site than PNGS, it is higher than the Canada peer group by 34%
- OPG has 62% more Cat IDs in its company catalogue than does the CANDU operator with the second highest number

Setting Inventory Thresholds

- A significant majority of respondents do not set inventory thresholds for each site, though some responses indicated related targets are established:
  - "Inventory levels are budgeted based on expected growth and requests to increase inventory must be approved"
  - "No thresholds, but goals are established for new and surplus inventory growth"

Approval Levels

- OPG has much higher thresholds for review and approval at the manager level than other respondents with approval authority going up to $2,000,000 for bands G and H

scottmadden MANAGEMENT CONSULTANTS

Recommendations for OPG's Nuclear Executives

Ensure decision rights related to inventory management are consistent with leading practices by:

- Understanding who should do what and avoiding overlap (see high-level example below)
- Helping all groups to understand their roles and become both willing and able to execute them

Engineering, Ops & Mtce	Purchasing	Inventory Management	Materials Management
What materials do we need?	Which suppliers will we use?	How much should we keep on hand?	How do we receive and issue efficiently?
How much do we need?	How much should we pay?	In which warehouse should it be stored?	Where will it be stored in the warehouse?
When do we need it?	How do we ensure supply?	From where should each request be drawn?	Is the shelf count accurate?
Where will we use it?	What are the expected lead times?		Is it maintained adequately?
What is our risk tolerance?	Who will deliver it and when?		

Recommendations for OPG's Nuclear Executives (Cont'd)

Focus on slowing down inventory growth by:

- Establishing growth targets and incentives for each site
- Ensuring that stocking levels are intelligently set and managed
  - The goal of the Improve Inventory Management Initiative in NFI-07 is to ensure ROP/TMAX values are set and maintained using a standardized approach that is documented in governance including clear roles and responsibilities for all stakeholders
  - Solution should include a) better leveraging optimization tools rather than relying on judgment and manual calculations and b) reassessing more frequently (i.e. every time a purchase is made, like some survey respondents)
- Reducing approval authorities for some inventory driving actions to improve review and challenge of requests prior to procurement

OPG Nuclear Executives must communicate the financial implications of excessive inventory to the organization and direct all work groups to manage the inventory asset, particularly additions to it, in a way that ensures value for money.

Reduce surplus inventory by:

- Making the process for actually disposing of surplus or obsolete stock more effective (OPG budgets but does not execute)
- Ensuring the process involves multiple departments working collaboratively to distribute the accountability and ensure monitoring

OPG Nuclear Executives must focus on reducing surplus at PNGS in a shorter time frame given PECO.

OPG Nuclear Executives must ensure that the introduction of new parts due to Refurbishment at DNGS and replacement of major station systems and components also results in removal of old, obsolete parts.

Filed: 2016-11-21
EB-2016-0152
JT2.20, Attachment 1
Page 11 of 74

ONTARIO POWER GENERATION

Recommendations for OPG's Nuclear Executives (Cont'd)

Emphasize inventory carrying cost by:

- Regularly calculating it (at least annually)
- Ensuring those who play a role in inventory management decisions understand inventory carrying cost and that this cost must be balanced against desired material availability

OPG Nuclear Executives must 1) communicate that this is a real cost that is neither understood by or being factored into the decisions of those who are driving growth in inventory today and 2) ensure that future decisions balance material availability with carry cost.

Improve information accuracy to allow for better planning and increased impact by:

- Cleaning up the catalogue
  - NFI-07 is addressing a sub-set of the catalog, but additional clean-up efforts and elimination of redundant, inaccurate, or unused parts information would further improve performance

OPG Nuclear Executives must recognize that robust and accurate underlying data is necessary to enable efficient and effective management of nuclear assets and commit to cleaning up such data.

scottmadden
MANAGEMENT CONSULTANTS


Report

ONTARIO POWER GENERATION

Detailed Approach

OPG developed a taskforce to conduct this benchmarking initiative. This taskforce was led by a VP in the Nuclear organization and included representatives from Nuclear, Nuclear Projects, Supply Chain, and Finance. Survey design was vetted by this team and approved by the Executive Committee, which included OPG's President of Nuclear and Chief Nuclear Officer, Chief Nuclear Engineer, Site Vice Presidents for Darlington and Pickering Nuclear Generating Stations, VP of Projects and Modifications, SVP of Business and Administrative Services, Chief Supply Officer, and VP of Nuclear Finance.

This survey was conducted according to the approach below.

1. Design Survey

- Define metrics (quantitative questions)
- Design management practices survey (qualitative questions)
- Select desired participants (invitees)

2. Administer Survey

- Contact invitees
- Determine actual participants
- Receive results and "scrub the data"

3. Analyze Results

- Normalize data and determine final peer panels for comparison
- Calculate metrics and statistics
- Identify relationships and develop insights

4. Build Report

- Document approach
- Compile and produce key findings
- Review with OPG stakeholders, finalize, and distribute to survey participants

ScottMadden conducted the survey on OPG's behalf and the findings presented within this report are the direct result of this effort.

scottmadden
MANAGEMENT CONSULTANTS

ONTARIO POWER GENERATION

Detailed Approach (Cont'd)

Thirteen of the 23 operators invited to participate (57%) submitted a response, as detailed in the following peer panels.

CANDU Panel

CANDU Operators	Sites / Reactor Units Included in Data
Bruce Power	1 site / 8 units
China National Nuclear Operations Corporation	1 site / 2 units
New Brunswick Power	1 site / 1 units
Ontario Power Generation	2 sites / 10 units
Societatea Nationala NuclearElectrica S. A.	1 site / 2 units

- The CANDU operator panel includes 5 operators, 6 unique sites, and 23 unique reactors

PWR Panel

PWR Operators	Sites / Units Included in Data
Arizona Public Service	1 site / 3 units
Duke Energy	5 sites / 9 units
Exelon	5 sites / 9 units
FirstEnergy Corporation	2 sites / 3 units
NextEra Energy	4 sites / 7 units
Pacific Gas & Electric	1 site / 2 units
Public Service Enterprise Group	1 site / 2 unit
Wolf Creek Nuclear Operating Corporation	1 site / 1 unit

- The PWR operator panel includes 8 operators, 20 unique sites, and 36 unique reactor units

BWR Panel

BWR Operators	Sites / Units Included in Data
Duke Energy	1 site / 2 units
Exelon	8 sites / 14 units
FirstEnergy Corporation	1 site / 1 unit
NextEra Energy	1 site / 1 unit
Public Service Enterprise Group	1 site / 1 unit

- The BWR operator panel includes 5 operators, 12 unique sites, and 19 unique reactor units

scottmadden MANAGEMENT CONSULTANTS

ONTARIO POWER GENERATION

Detailed Approach (Cont'd)

Regional panels include Canadian and US operators

Canada Panel

Canada Operators	Sites / Units Included in Data
Bruce Power	1 site / 8 units
New Brunswick Power	1 site / 1 units
Ontario Power Generation	2 sites / 10 units

- The Canada operator panel includes 3 operators, 4 unique sites, and 19 unique reactor units

US Panel

US Operators	Sites / Units Included in Data
Arizona Public Service	1 site / 3 units
Duke Energy	6 sites / 11 units
Exelon	13 sites / 23 units
FirstEnergy Corporation	3 sites / 4 units
NextEra Energy	5 sites / 8 units
Pacific Gas & Electric	1 site / 2 units
Public Service Enterprise Group	2 sites / 3 units
Wolf Creek Nuclear Operating Corporation	1 site / 1 unit

- The US operator panel includes 8 operators, 32 unique sites, and 55 unique reactor units

scottmadden
MANAGEMENT CONSULTANTS

ONTARIO POWER GENERATION

Detailed Approach (Cont'd)

Market Structure panels include regulated and merchant (non-regulated) operators

Regulated Panel

Regulated Operators	Sites / Units Included in Data
Arizona Public Service	1 site / 3 units
Bruce Power	1 site / 8 units
China National Nuclear Operations Corporation	1 site / 2 units
Duke Energy	6 sites / 11 units
Exelon	1 site / 2 units
FirstEnergy Corporation	2 sites / 3 units
New Brunswick Power	1 site / 1 units
NextEra Energy	2 sites / 4 units
Ontario Power Generation	2 sites / 10 units
Pacific Gas & Electric	1 site / 2 units
Societatea Nationala NuclearElectrica S. A.	1 site / 2 units
Wolf Creek Nuclear Operating Corporation	1 site / 1 unit

- The Regulated operator panel includes 12 operators, 20 unique sites, and 49 unique reactor units

Merchant Panel

Merchant Operators	Sites / Units Included in Data
Exelon	12 sites / 21 units
FirstEnergy Corporation	1 site / 1 unit
NextEra Energy	3 sites / 4 units
Public Service Enterprise Group	2 sites / 3 units

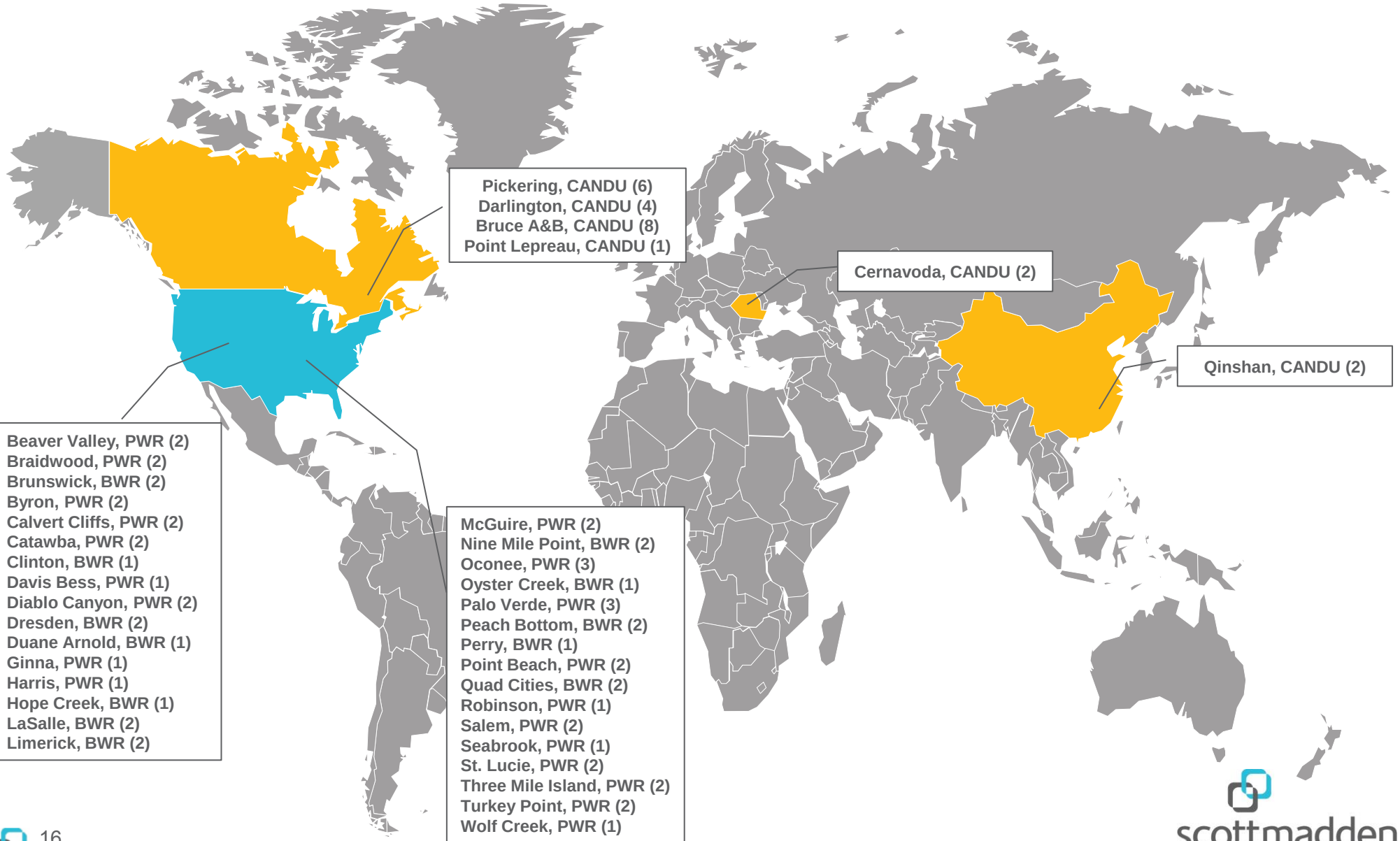
- The Merchant operator panel includes 4 operators, 18 unique sites, and 29 unique reactor units

scottmadden MANAGEMENT CONSULTANTS

ONTARIO POWER GENERATION

Detailed Approach (Cont'd)

Participants include CANDU operators in Canada, Romania, and China and many US-based PWR and BWR operators



scottmadden
MANAGEMENT CONSULTANTS

Inventory Benchmarking Results

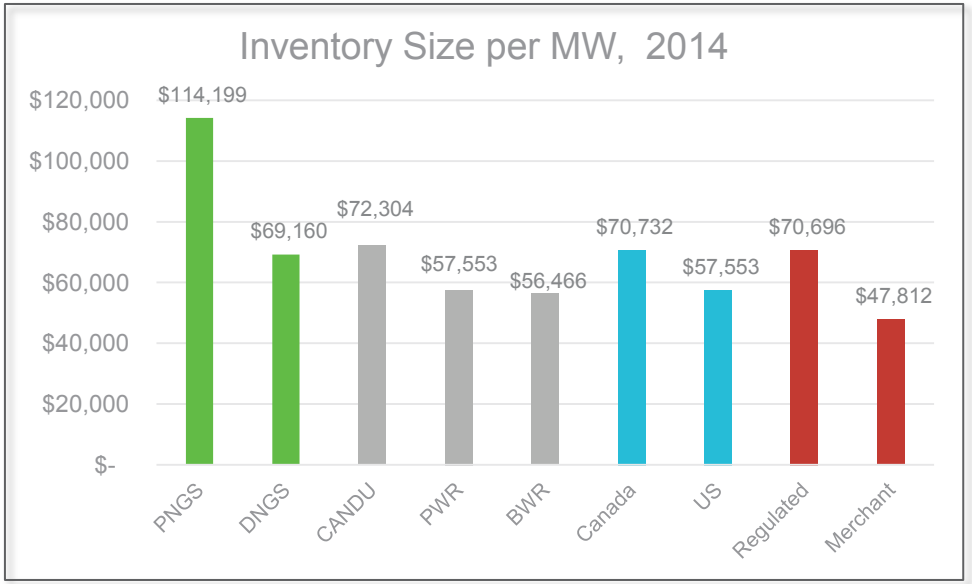
Inventory Size:

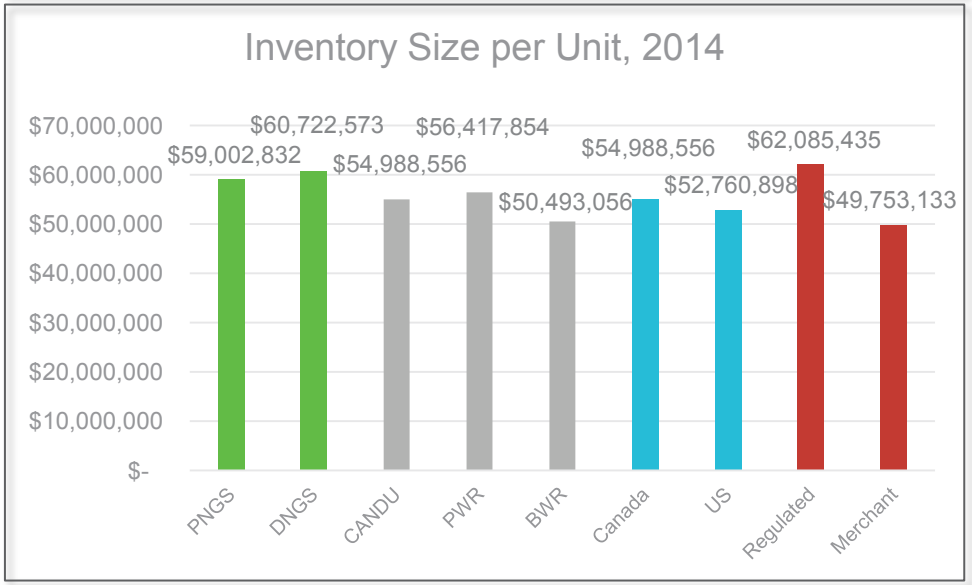
Dollar value of total on-site inventory per MW (see top right) and per unit (see bottom right) at the end of 2014

- Median inventory per MW is 26-28% higher for CANDU sites than PWR and BWR sites, but is 3% lower than PWRs and 9% higher than BWRs on a per unit basis
- CANDU technology is more parts-intensive than PWRs and BWRs and 75% of the PWRs and BWRs in our sample are larger than the largest CANDU units in MWs
- In our sample, the largest PWR or BWR site has 3 units, which is only the median number of units for a CANDU site
- Median inventory per MW for PWRs and BWRs is within 2%, but PWRs are 12% greater on a per unit basis
- Median inventory size of sites in Canada is 23% greater than sites in the US when normalized per MW, but only 4% greater than that of sites in the US when normalized per unit; which, as expected, is similar to the comparison across technologies
- Median inventory per MW is 48% greater for Regulated sites than Merchant, likely due to the difference in financial implications and management actions

Observations for OPG:

- PNGS has 58% more inventory per MW and 7% more inventory per unit than the median of the CANDU panel
- DNGS inventory per MW is 4% lower than the median for CANDUs and 2% less than median for the Canada peer group
- DNGS inventory size per unit is 10% greater than that of the median for CANDU and Canada (which are equal), and 8-20% greater than the median of PWRs and BWRs, respectively





Technology Panel
Regional Panel
Market Structure Panel
OPG Only Data

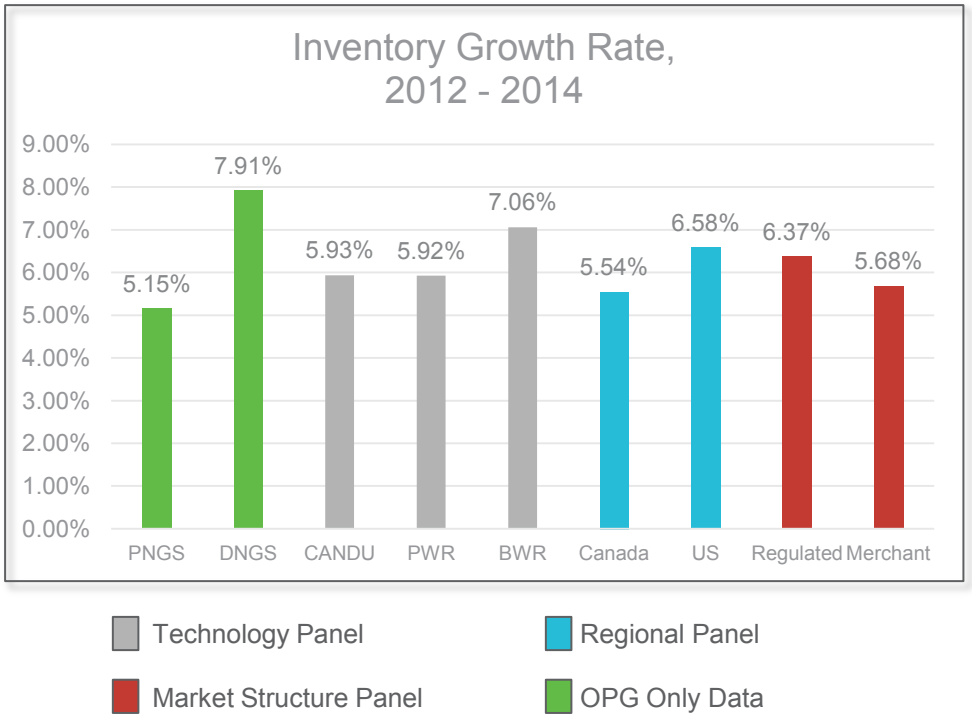
scottmadden MANAGEMENT CONSULTANTS

Inventory Benchmarking Results (Cont'd)

Inventory Growth Rate:

Compound annual growth rate of inventory size for the past 3 years (% change in inventory)

- Three sites among all responses to this question reported negative inventory growth rates while three sites reported growth rates above 15%
- BWRs have the highest median growth rate among technologies, although they have the lowest inventory size per MW. However, assuming these growth rates continue, BWRs will surpass PWRs in inventory size per MW in 2 years
- Median inventory growth rate for sites in Canada is lower than that of sites in the US by 1.04%. While small, the difference between these growth rates on C$100M over 10 years is C$18M
- Median inventory growth rate for Regulated sites is only 0.69% higher than the inventory growth rate for Merchant sites. Regulated sites, however, already carry 48% more inventory per MW than Merchant sites. If this difference in growth rates continues at present inventory sizes, Regulated sites would carry 53% more inventory per MW in only 5 years



Observations for OPG:

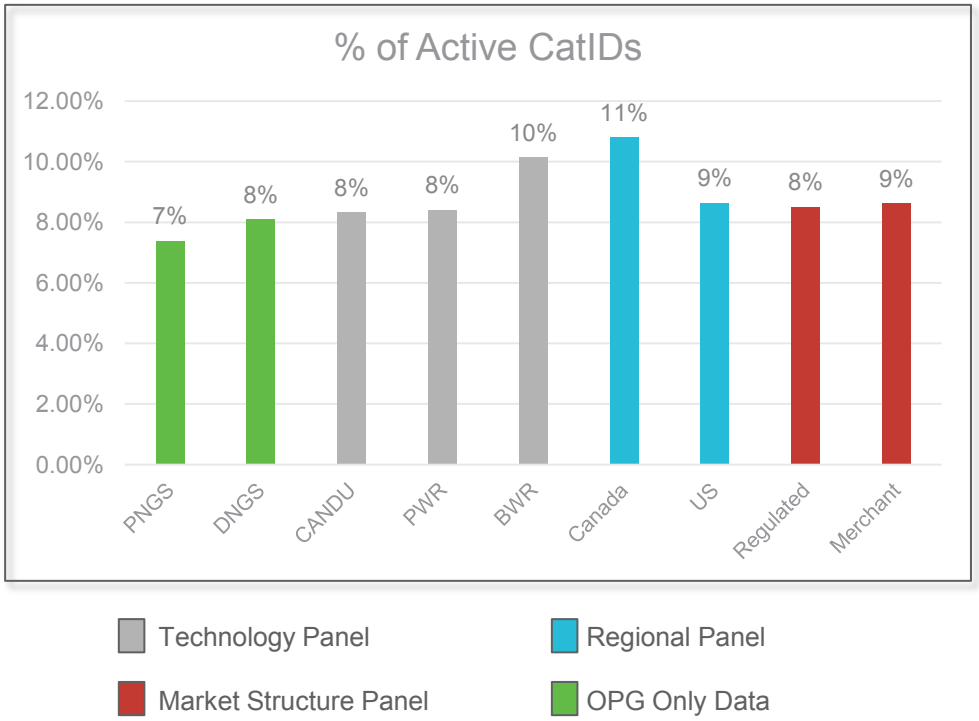
- PNGS has the second lowest growth rate among CANDU respondents
- However, at this growth rate, PNGS will have C$162,303 in inventory per MW by 2021, a 42% increase from 2014
- Although DNGS inventory size per MW is lower than the median for CANDUs, its growth rate is higher than all peer group medians
- Assuming the growth rate for DNGS is sustained, inventory per MW for DNGS will surpass the current medians of all peer groups in 3 years, and will increase to C$117,838 by 2021, which is higher than the 2014 value at PNGS

Inventory Benchmarking Results (Cont'd)

Percent of Active Unique Parts:

Number of SKUs or Cat IDs (unique parts) with issues during prior 12 months / total number of SKUs or Cat IDs (unique parts) at this location

- Nuclear inventory is slow moving across technologies, regions, and market structures
- The highest "active unique parts" among all responses to this question was about 40% while the lowest was about 3%
- BWR sites have a higher median percent of active Cat IDs on site by 2% when compared to both CANDUs and PWRs
- Sites in Canada have a 2% higher median percentage of active Cat IDs than those in the US. The Canada panel is 3% higher than the CANDU panel, due to low percentages from international respondents
- Merchant sites have a higher median percentage of active Cat IDs by 1% when compared to Regulated sites



Observations for OPG:

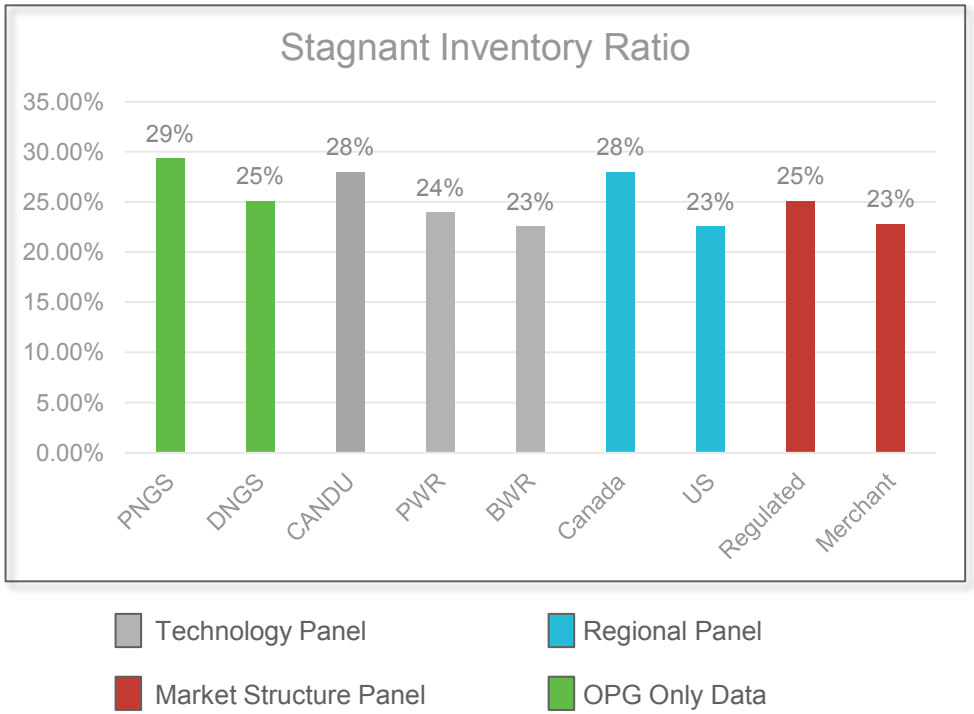
- PNGS has a lower percentage of active Cat IDs on site and a higher number of unique parts on site than the median of all peer groups
- DNGS has a 3% lower percentage of active Cat IDs on site than the median for sites in Canada

Inventory Benchmarking Results (Cont'd)

Stagnant Inventory Ratio:

Total dollar value of inventory (non-critical spares) with no demand for 5 + years / dollar value of total inventory at the end of 2014

- All peer panels report a significant portion of inventory that has no demand for 5 or more years. This is likely due to a combination of inventory management practices and the need for significant investment to mitigate low likelihood events
- Four sites among all responses to this question reported stagnant inventory ratios below 10% while three sites reported ratios above 40%
- The median stagnant inventory ratio at CANDU sites is 5% higher than BWR sites and 4% higher than PWR sites. Only 4 of 20 PWR sites and 2 of 12 BWR sites have stagnant inventory ratios at or above the CANDU median
- The median stagnant inventory ratio at sites in Canada is 5% higher than sites in the US, which is similar to the technology panel based on peer group makeup
- The median stagnant inventory ratio at Regulated sites is 2% higher than that of Merchant sites, as expected given the Regulated peer group's higher inventory size per MW and higher spares inventory value



Observations for OPG:

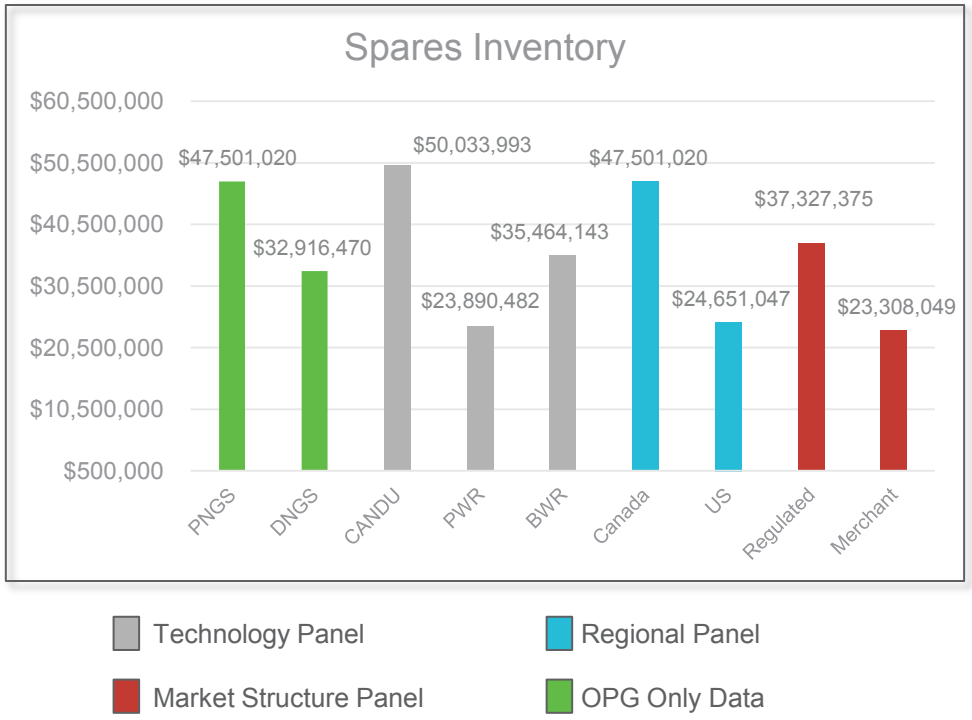
- PNGS's stagnant inventory ratio is higher than the median of all peer groups, which is not surprising given other inventory-related comparisons, but it is not the highest among CANDU respondents in our sample
- DNGS's stagnant inventory ratio is lower than the median for CANDUs and is the lowest among CANDU respondents in our sample

Inventory Benchmarking Results (Cont'd)

Spares Inventory Dollar Value:

Dollar value of minimum stock on hand to support spares (e.g., lifetime, critical, single point vulnerability, crit 1-2, ROP TMAX) in 2014

- Spares Inventory Dollar Value varies widely across responses to this question, likely due primarily to significant differences in industry practices for designating spares. For example, the number of categories within "Spares" varies from a low of one category up to a high of seven categories
- Median spares inventory for CANDU sites is 1.4 – 2.1 times larger than that of BWRs and PWRs
- CANDU technologies have a higher percentage of components that are indicated as "Critical" than other technologies, but CANDUs in the survey reported lower percentage of median total inventory dollars allocated to critical spares than PWRs and BWRs (CANDU median = 10%)
- Median spares inventory for sites in Canada is 1.9 times larger than sites in the US, which is expected due to the Canada peer group consisting entirely of CANDU technology
- Median spares inventory for Regulated sites is 1.6 times larger than that of Merchant sites, which could suggest a lower risk tolerance across Regulated sites



Observations for OPG:

- PNGS has the second lowest spares inventory dollar value of all CANDU operators in our sample
- DNGS has the lowest spares inventory dollar value of all CANDU operators in our sample

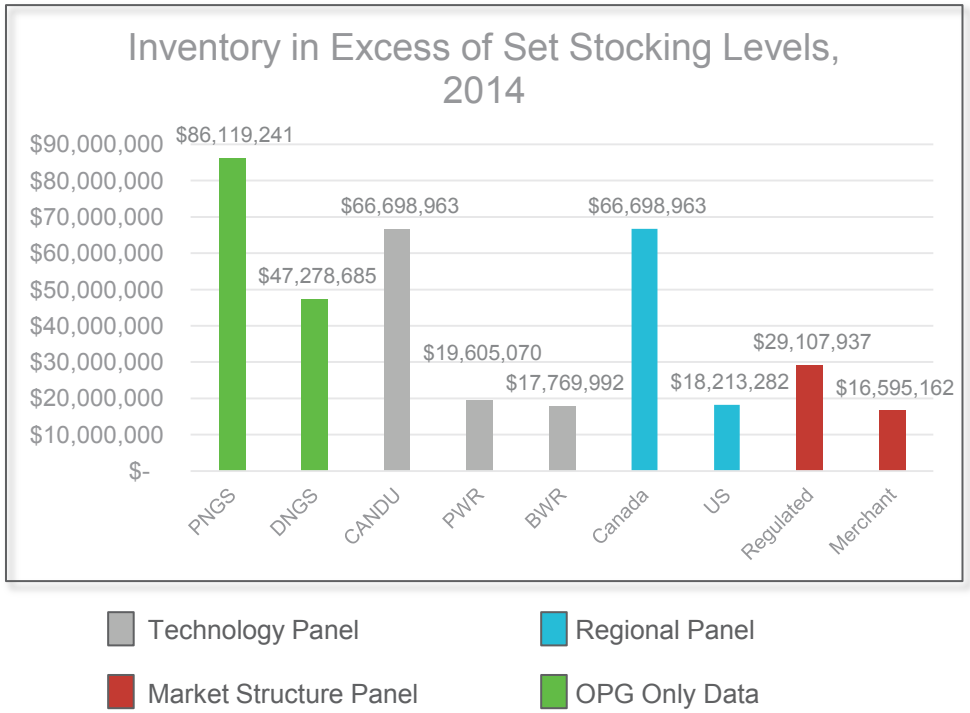
scottmadden MANAGEMENT CONSULTANTS

Inventory Benchmarking Results (Cont'd)

Excess Inventory:

Dollar value of all items on hand in excess of set stocking levels for their SKU or CatID (unique part)

- All responding sites have inventory in excess of set stocking levels, but there is significant variability across respondents with two sites below $3M and three sites above $90M
- Median excess inventory with set stocking levels on CANDU sites is 240-275% larger than that of PWRs and BWRs, which is beyond what can be accounted for by differences in overall inventory size
- Median excess inventory with set stocking levels on sites in Canada is 266% larger that that on sites in the US, which is expected due to the peer group make-up
- Median excess inventory with set stocking levels for Regulated sites is 75% higher than that of Merchant sites, which is a greater difference than that shown for normalized total inventory values



Observations for OPG:

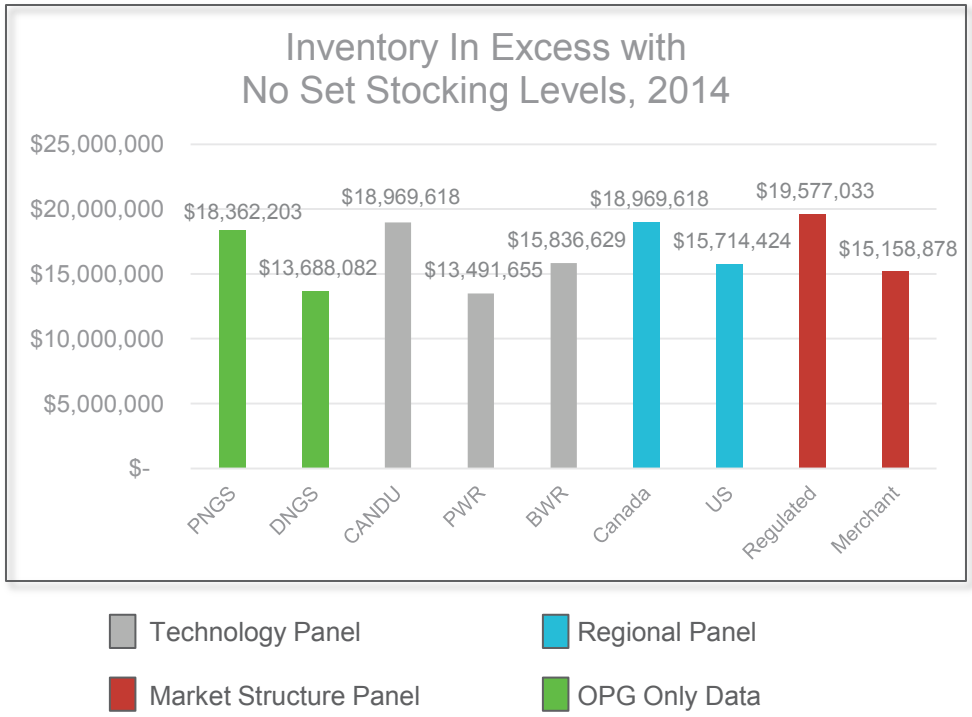
- PNGS has a higher level of inventory in excess of set stocking levels than the median of all peer groups and only three respondents indicated greater value of inventory in excess of set stocking levels
- DNGS has less excess inventory than the median of the CANDU and Canada peer panels, but considerably greater inventory in excess of set stocking levels than the median of PWRs and BWRs

Inventory Benchmarking Results (Cont'd)

Excess Inventory (Cont'd):

Dollar value of all items on hand that have no set stocking level, but have inventory on hand that is greater than the projected and approved demand for that part

- Of the sites with inventory in excess with no set stocking level, four sites reported over $30M while two sites reported under $7M
- Median excess inventory without set stocking levels is highest for CANDU plants and is 15% higher for BWRs when compared to PWRs, even though BWRs have the lowest median stagnant inventory ratio of the technology panel
- Median excess inventory without set stocking levels for sites in Canada is 21% higher than that of sites in the US, which is expected due to peer group make-up
- Regulated sites have 29% higher median excess inventory without set stocking levels than that of Merchant sites, and the highest median excess inventory without set stocking levels among all peer groups



Observations for OPG:

- PNGS has a lower level of excess inventory with no set stocking levels than the median of the CANDU, Canada, and Regulated peer panels
- DNGS has less excess inventory with no set stocking levels than the all peer group medians except one; DNGS has 1% more than the median of the PWR peer panel

Inventory Benchmarking Results (Cont'd)

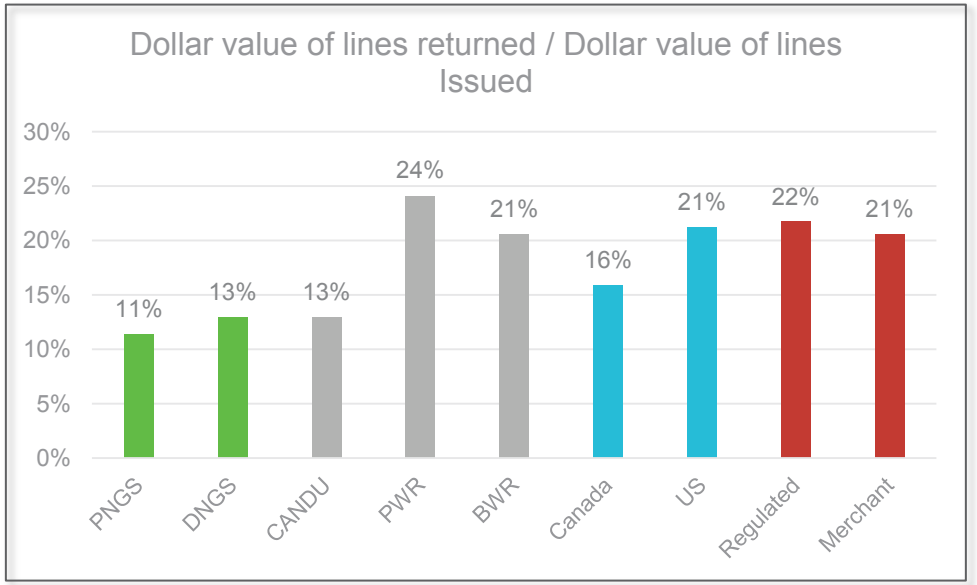
Returns Ratios:

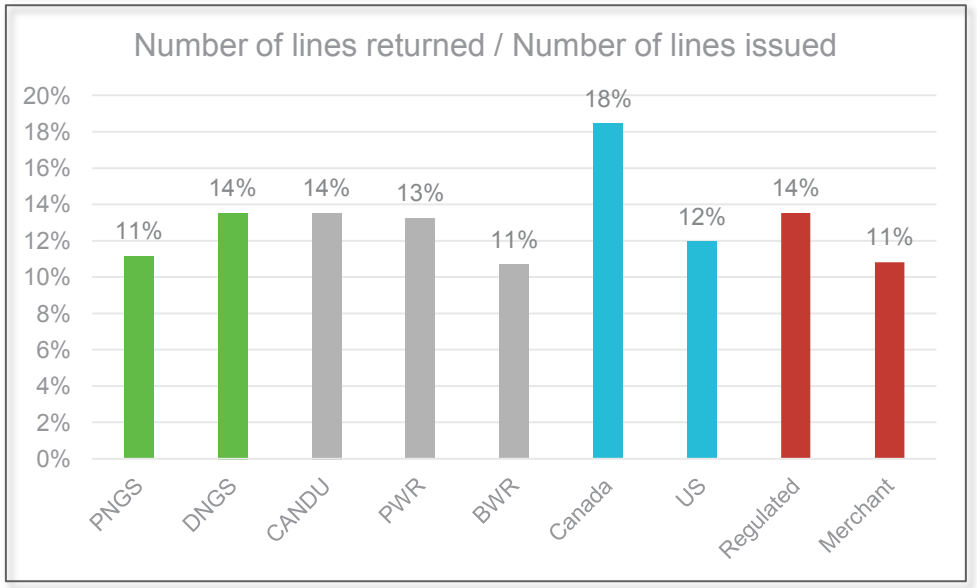
Dollar value of lines returned / dollar value of lines issued; Number of lines returned / number of lines issued in 2014

- While dollar value of lines returned / dollar value of lines issued for CANDU sites is lower than that of PWR and BWR sites by 11% and 8%, respectively, the number of lines returned as a percentage of lines issued is actually higher, indicating that the average line returned at CANDU sites is less expensive relative to issued lines than at PWR or BWR sites
- Dollar value of lines returned / dollar value of lines issued for sites in Canada is 5% lower than that for sites in the US and the number of lines returned as a percentage of lines issued is higher, also indicative of the average line returned at sites in Canada being less expensive relative to issued lines than at PWR or BWR sites
- While dollar value of lines returned / dollar value of lines issued for Regulated sites is greater than Merchant sites by 1%, the number of lines returned as a percentage of lines issued is 3% higher, indicating that the average line returned at Regulated sites is less expensive relative to issued lines than at Merchant sites

Observations for OPG:

- PNGS's dollar value returns ratio is lower than the median of all peer groups and third lowest across all responding sites in our sample
- Dollar value returns ratio for DNGS is lower than the median of PWRs and BWRs and the number returns ratio for DNGS is higher than the median of PWRs and BWRs





Technology Panel
Regional Panel
Market Structure Panel
OPG Only Data

scottmadden MANAGEMENT CONSULTANTS

Inventory Benchmarking Results (Cont'd)

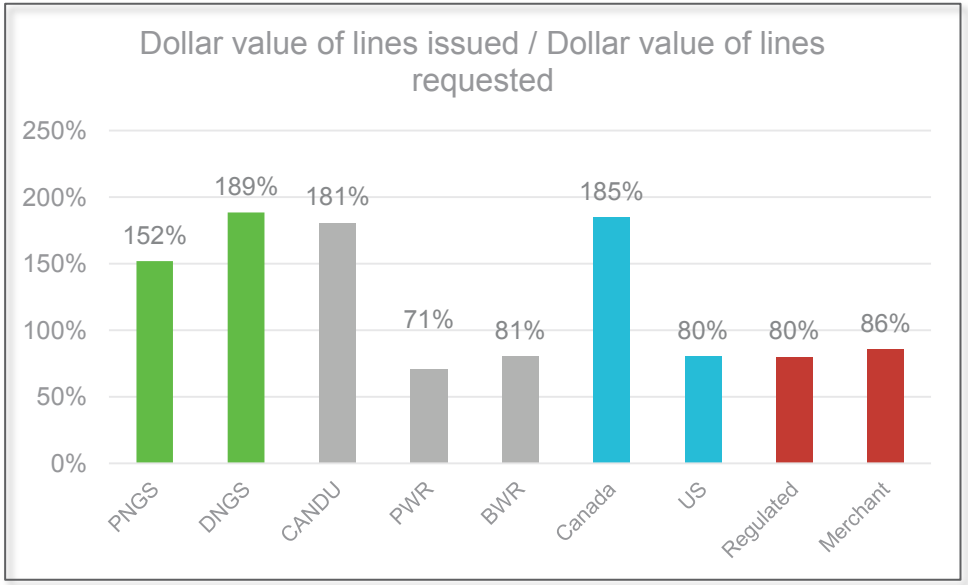
Percent of Requests Issued:

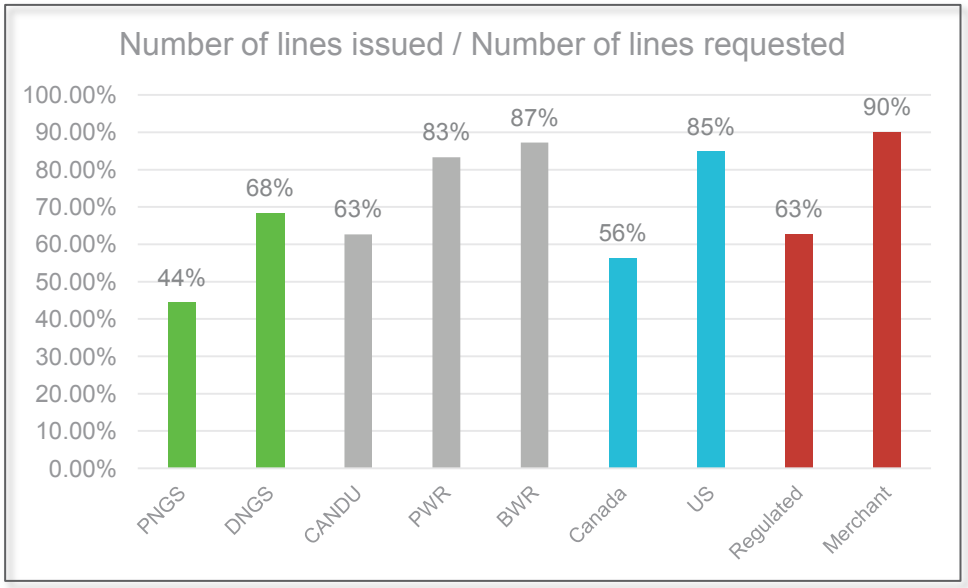
Dollar value of lines issued / dollar value of lines requested; Number of lines issued / number of lines requested in 2014

- Median dollar value of lines issued / dollar value of lines requested for CANDU sites is more than double than that of PWRs and BWRs, and the median number of lines issued / number of lines requested for CANDU sites is 20% lower than that of PWRs and 24% lower than that of BWRs
- It is interesting that, while CANDU sites issued considerably fewer lines than requested, the average dollar value of those lines was much higher than the average of lines requested
- Median dollar value of lines issued / dollar value of lines requested for sites in Canada is more than double that of sites in the US while the median number of lines issued / number of lines requested is 29% lower than that of sites in the US
- Some difference is to be expected due to timing differences between request dates and issue dates, but the significant difference in dollar values between requested and issued lines is confined to respondents in Canada
- Median dollar value of lines requested / dollar value of lines issued is 6% lower for Regulated sites than for Merchants, and the median number of lines issued / number of lines requested is 27% lower for Regulated sites

Observations for OPG:

- The number of lines issued / number of lines requested for PNGS is lower than the median than all peer groups
- DNGS issued 68% of lines requested, which is higher than the CANDU and Canadian median, but still represents many more requests than issues





Technology Panel
Regional Panel
Market Structure Panel
OPG Only Data

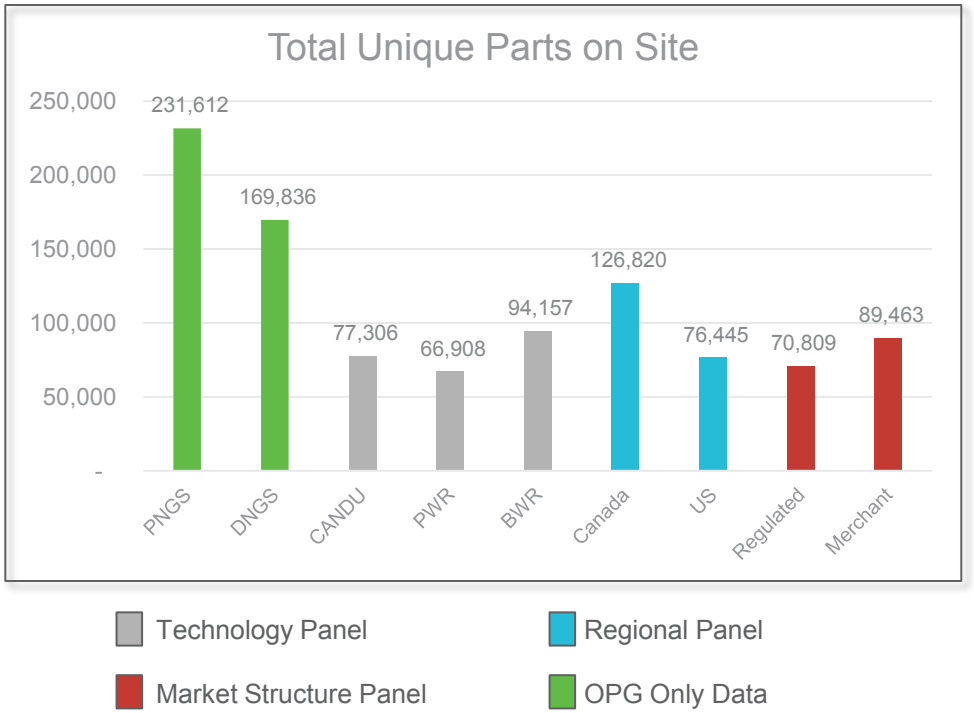
scottmadden MANAGEMENT CONSULTANTS

Inventory Benchmarking Results (Cont'd)

Total Unique Parts (CatIDs) on site:

Number of different SKUs or CatIDs (unique parts) at this location

- Median total number of unique parts in inventory for PWRs is 13% less than that of CANDUs and 29% less than that of BWRs
- Median total number of unique parts for sites in Canada is 66% higher than that for sites in the US. The greater median number of unique parts in Canada relative to CANDU is driven by lower numbers from international respondents
- Median total number of unique parts for Regulated sites is 21% less than that of Merchant sites, even though Regulated sites have a 48% higher inventory size per MW and a higher growth rate



Total Unique Parts (CatIDs) within the company catalogue:

Number of different SKUs or CatIDs (unique parts) maintained within the company inventory system

- Total unique CatIDs within the company catalogue range from a low of 73,547 to a high of 938,610 across the thirteen responding operators
- There was no consistent relationship in the underlying data between the number of units and the number of unique CatIDs; likely due not only to differences in equipment, but also the health of the various catalogues

Observations for OPG:

- Total Unique parts on site for PNGS is 83% higher than that of the Canada peer group
- While DNGS has a lower number of unique parts on site than PNGS, it still is higher than the Canada peer group by 34%
- OPG has 62% more Cat IDs in its company catalogue than does the CANDU operator with the second highest number. This likely indicates a significant opportunity to reduce the size OPG's catalogue

scottmadden MANAGEMENT CONSULTANTS

Inventory Benchmarking Results (Cont'd)

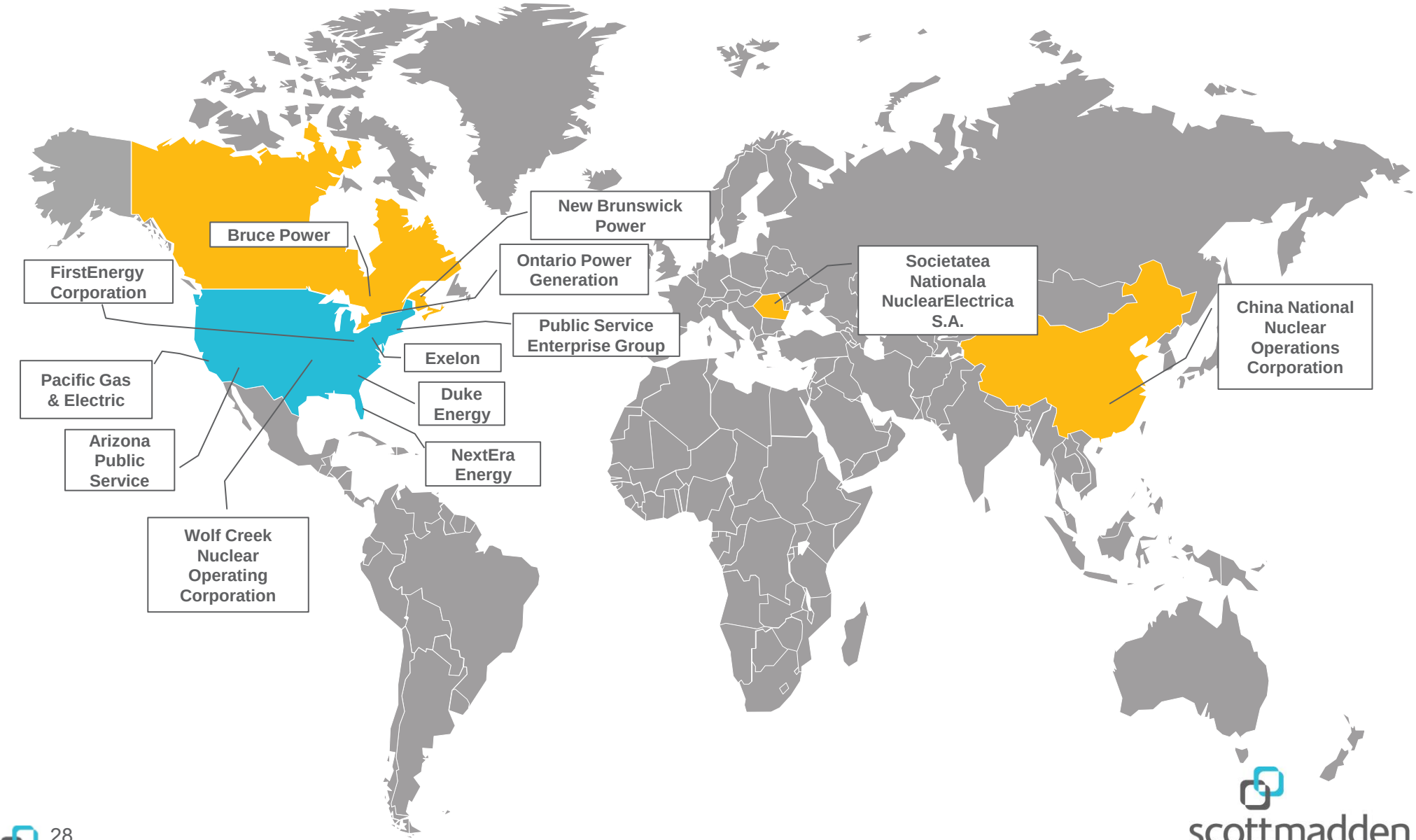
Provisional Charges for End Of Life:

Allowances to account for inventory which will become stranded when the asset reaches the end of its operating life

- While respondents did present information on Provisional Charges, not enough quantitative data was provided to drive insightful analysis as a metric
- This being said, information on how each respondent calculates Provisional Charges is presented in the Inventory Management Results section, which starts on the following page

Inventory Management Results

Inventory management results provided in the following slides are the responses received from 13 operators



scottmadden MANAGEMENT CONSULTANTS

Inventory Management Results (Cont'd)

Inventory Categorization

1. When segmenting your inventory, does your organization use a calculated or assigned coding system (such as ABC usage value analysis, XYZ holding value analysis, movement frequency, criticality ranking, or availability)?
   - ❑ Yes
   - ❑ No
     a. If yes, is each inventory segment calculated and managed separately / differently?
     b. If yes, is each inventory segment managed by a separate owner?

- Majority of respondents do not use calculated or assigned coding systems to segment inventory
- One respondent who does not currently use calculated or assigned coding systems to segment inventory has plans in place to incorporate a segmentation method
- Segmenting inventory into categories such as "Critical Spares," "Maintenance Inventory," and "Consumables" is a leading practice, with each category managed differently in terms of demand forecasting and inventory replenishment

Calculated or assigned coding system used?	
Yes = 5	No = 8
If yes, is each inventory segment calculated and managed separately?	
Yes = 4	No = 1
If yes, is each inventory segment managed by a separate owner?	
Yes = 1	No = 3

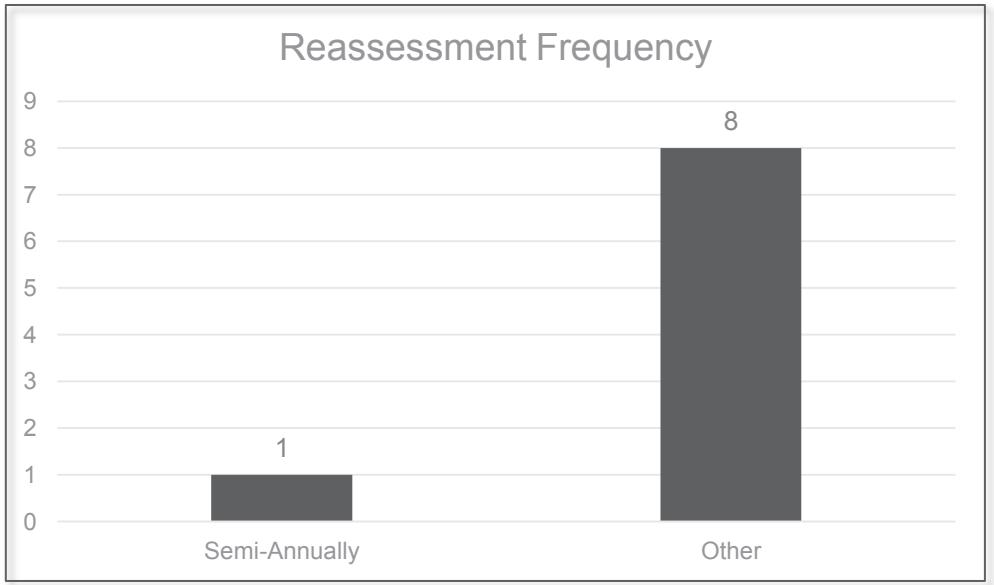
Observations for OPG:

- OPG is the only respondent who has each inventory segment managed by a separate owner
- Key to success is the manner of segmentation and the quality of the associated management practices

Inventory Management Results (Cont'd)

2. When inventory is segmented, how often is inventory reassessed and new ABC, etc. values applied?
   - ❑ Annually
   - ❑ Semi-Annually
   - ❑ Quarterly
   - ❑ Monthly
   - ❑ Other (please explain)

- Reassessment frequency varies across respondents
- Once criteria are set by those respondents who segment inventory, reassessment and changes to those criteria are infrequent



*Options with no responses were eliminated from chart; "Other" responses include "no segmentation," "no reassessment," or an ad-hoc / by exception method

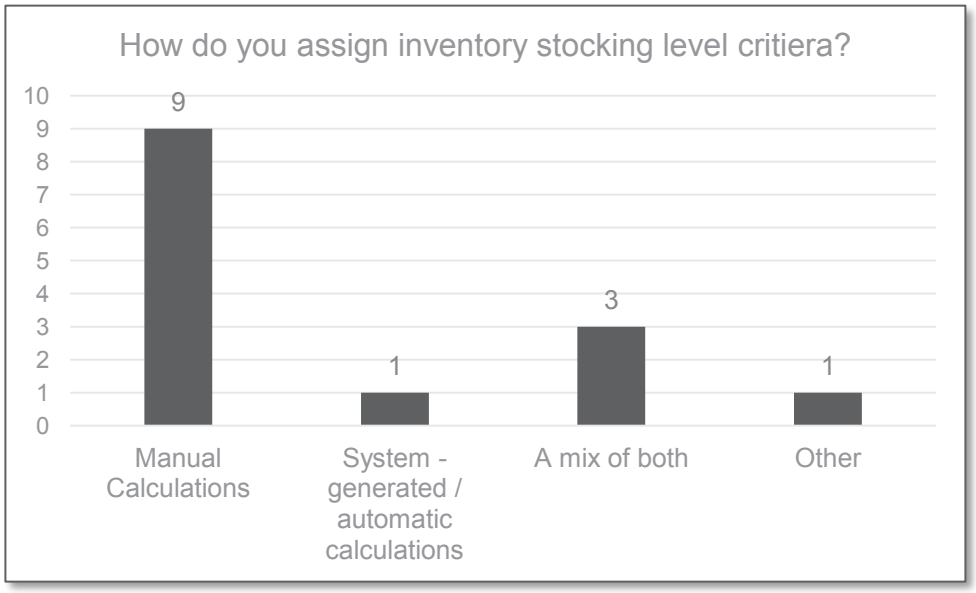
Observations for OPG:

- OPG is the only respondent whose reassessment is triggered by "exception, when a new item is created, as a result of a design change or engineering review initiative, or per an inventory management initiative."

scottmadden MANAGEMENT CONSULTANTS

Inventory Management Results (Cont'd)

3. How do you assign inventory stocking level criteria (e.g., safety stock, reorder point, estimated lead time demand, economic order quantitates, etc.) for your sites?
   - ❑ Manual calculations
   - ❑ System – generated / automatic calculations
   - ❑ A mix of both manual calculations and automatic calculations
   - ❑ We do not utilize inventory stocking level criteria
   - ❑ Other (please specify)



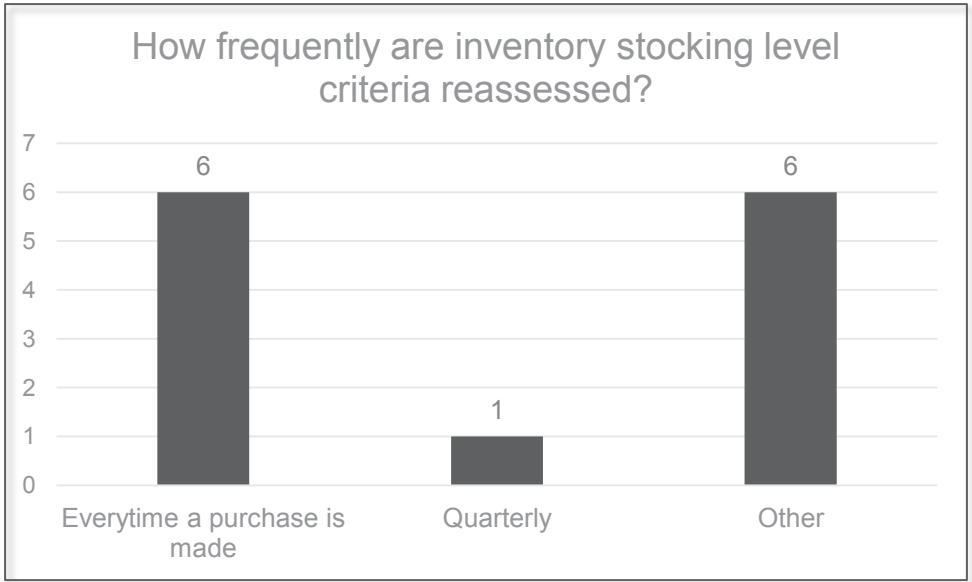
- Survey respondents report using manual calculations most often for assigning inventory stocking level criteria, followed by "a mix of both."
- Respondents who use either "system-generated / automatic calculations" or "a mix of both" have lower excess inventory with set stocking levels than over half of all respondents in our sample

Observations for OPG:
- OPG is among the majority of respondents using manual calculations

Inventory Management Results (Cont'd)

3a. How frequently are inventory stocking level criteria reassessed?

- ❑ Every time a purchase is made
- ❑ Once a month
- ❑ Once a quarter
- ❑ Once a year
- ❑ Other (please specify)



*Options with no responses were eliminated from chart

- The reported preferred frequency of reassessment is every time a purchase is made
- Respondents who reassess criteria more frequently also reported lower values of inventory above set stocking levels. This finding supports the leading practice that a higher frequency of evaluation drives greater inventory effectiveness

- Other reassessment frequency responses include:
  - "Frequency is not on a set schedule"
  - "Usually an inventory stocking level will be used for years"
  - "Stocking parameters are assessed on an ongoing basis as level of effort and demand permits"

Observations for OPG:

- OPG reassesses stocking level criteria based on exception or when demand triggers procurement. The best practice, and the most common among respondents, is to reassess every time a purchase is made

scottmadden MANAGEMENT CONSULTANTS

Inventory Management Results (Cont'd)

4. How are safety stock levels determined? (Safety stock is defined as the level of extra stock that is kept on hand to mitigate risk of stock-outs)
   - ❑ Statistical calculation based on demand forecast, forecasted error rates and desired service level
   - ❑ Optimization algorithms which minimize total inventory costs for each SKU
   - ❑ System owners or maintenance / operations personnel assign based on judgement and experience
   - ❑ Other (please specify)

- The most common method of determining safety stock levels among respondents is for system owners or maintenance / operations personnel to assign based on judgment and experience
- Using statistical calculations to set safety stock levels based on a desired service level is an industry leading practice

How are safety stock levels determined?	
Statistical calculations	1
Optimization algorithms	1
System owners	7
Other	4

- "Other" responses include
  - "We do not maintain safety stock"
  - "System owners determine spares part safety stock… but use a statistical calculation for demand forecasts"

Observations for OPG:
- OPG does not use safety stock calculations to set stocking parameters

Inventory Management Results (Cont'd)

5. What categories are included within "Spares"? Please include all that apply (e.g., lifetime spares, critical spares, single point vulnerabilities, crit 1 & 2)

The number of categories within "Spares" varies across all respondents from one category up to seven separate categories within "Spares"

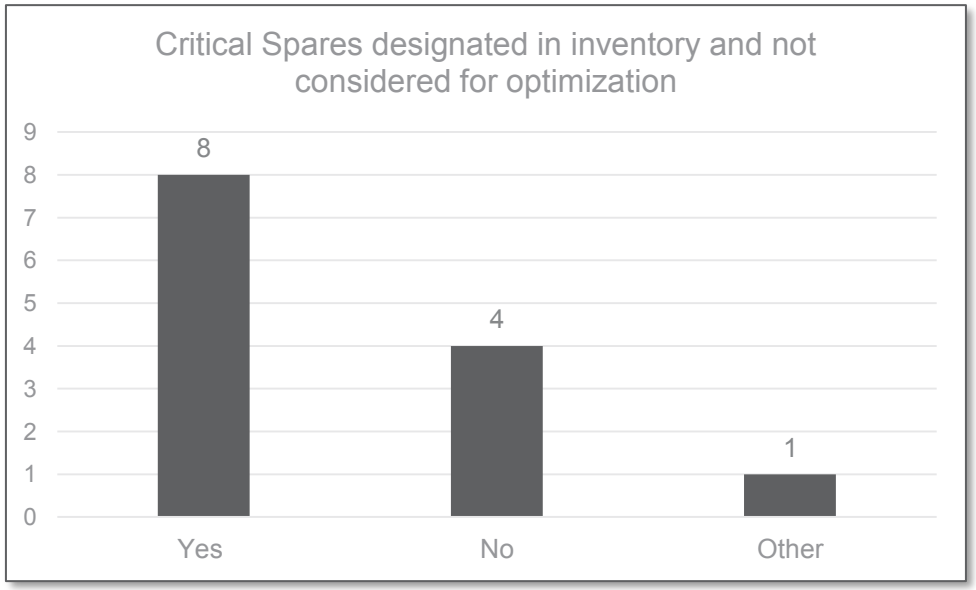
- Though the category names of "Spares" are not consistent across respondents, "Critical Spares" is the most commonly used designation
  - All but one respondent identifies "Critical Spares" as a "Spares" category
- "Strategic Spares" as a designation was found in the majority of CANDU respondents, and only CANDUs

Observations for OPG:

- OPG is in the middle of number of categories based on our sample by identifying four types of spares: Critical Spares, Lifetime Spares, Pandemic Stock, and Capital Spares
- For OPG. "attributes such as SPV and Criticality Coding relates to importance of plant equipment operability to safety and production and does not directly define a requirement to stock inventory for all Bill of Material related inventory items"

Inventory Management Results (Cont'd)

6. Are "Critical Spares" (i.e., items that are essential to operations and must be kept on hand at a certain level regardless of optimization tool recommendations) designated in your inventory management system and not considered for optimization?
   - ❑ Yes
   - ❑ No
   - ❑ Other (please specify)



- The practice of designating materials as "Critical Spares" is common across all our respondents and is in line with industry practice
- Majority of respondents exclude "Critical Spares" when optimizing inventory levels

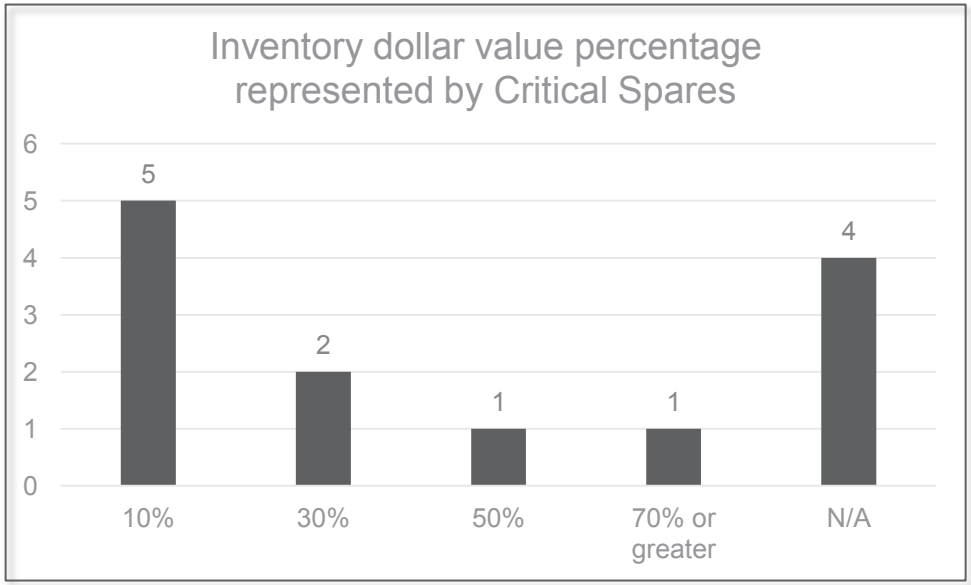
- "The "Other" response states:
  - "The min stocking level is considered the 'critical' quantity, which is owned by the business. Supply Chain may optimize the max stocking level"

Observations for OPG:
- OPG excludes "Critical Spares" from optimization, along with the majority of our respondents

scottmadden MANAGEMENT CONSULTANTS

Inventory Management Results (Cont'd)

7. If your company uses "Critical Spares" (or a similar term) as a designation, what percentage of inventory dollar value do these Critical Spares represent?
   - ❑ 0%
   - ❑ 10%
   - ❑ 20%
   - ❑ 30%
   - ❑ 40%
   - ❑ 50%
   - ❑ 60%
   - ❑ 70% or greater



*Options with no responses were eliminated from chart

- The dollar value of "Critical Spares" within inventory varied among respondents with 10% of inventory dollar value the most frequently designated percentage

Observations for OPG:
- OPG is in the majority with 10% of inventory dollar value represented by "Critical Spares"

scottmadden MANAGEMENT CONSULTANTS

Inventory Management Results (Cont'd)

8. If your organization identifies "Critical Spares" (or a similar term) within inventory, briefly describe the criteria used to define "Critical Spares":
    a. What is the number of material items defined as "Critical Spares" (or similar term) in 2014?
    b. What was the total value of the items defined as "Critical Spares" (or similar term) in 2014?

- While there is no industry standard definition for "Critical Spares", the top characteristics of "Critical Spares" are consistent across all respondents and technologies:
    - Required to uphold the safety or reliability of components
    - Considered critical to the ongoing operation of the plant
    - Some respondents also consider components with long lead times to be "Critical"
- Based upon the most commonly accepted characteristics from past ScottMadden research, a common industry definition might read as follows:
    - "A Critical Spare is an item that is unique to the asset it supports, whose absence would cause a significant loss of asset service availability or a significant negative impact on safety, the environment, or meeting regulatory requirements; is rarely used, and has a long lead time for replenishment."
- The number of "Critical Spares" across respondents ranges from 375 to 17,000 per site

Observations for OPG:

- OPG reported 951 and 2,374 critical spares at DNGS and PNGS, respectively, which is comparable to operators with the lowest numbers of critical spares per site

Inventory Management Results (Cont'd)

9. If your organization identifies "Lifetime Spares" (items required to be stocked at any given time due to a foreseeable lack of availability in the marketplace) within inventory, briefly describe the criteria used to define Lifetime Spares:
    a. What is the number of material items defined as Lifetime Spares in 2014?
    b. What was the total value of items defined as Lifetime Spares in 2014?

- Only one respondent identifies "Lifetime Spares" within inventory
- One respondent identifies a similar spare group called "Strategic Spares," which is a subset of "Critical Spares" where the cost to replace is very high and must be approved by the Chief Nuclear Engineer

Observations for OPG:

- OPG is the only respondent who identifies "Lifetime Spares"

Inventory Management Results (Cont'd)

10. Within your organization, how do you define "Surplus Materials"? (e.g., inventory no longer required or in excess of the quantity required)
    a. Within your organization, who has the authority to sign off on changes to / movement of "Surplus Material"?

- Seven respondents define "Surplus Materials" within their organization
  - Three respondents define "Surplus" as material no longer useful in the plant
    - These respondents have higher excess inventory above stocking levels than two-thirds of our sample
  - Three respondents define "Surplus" as excess material or material over stocking and projected demand levels
  - One respondent defines "Surplus" as obsolete material
- Approval authority for changes to / movement of "Surplus Material" varies across respondents with Supply Chain being the most common owner, but Engineering, Maintenance, and Operations were also often involved

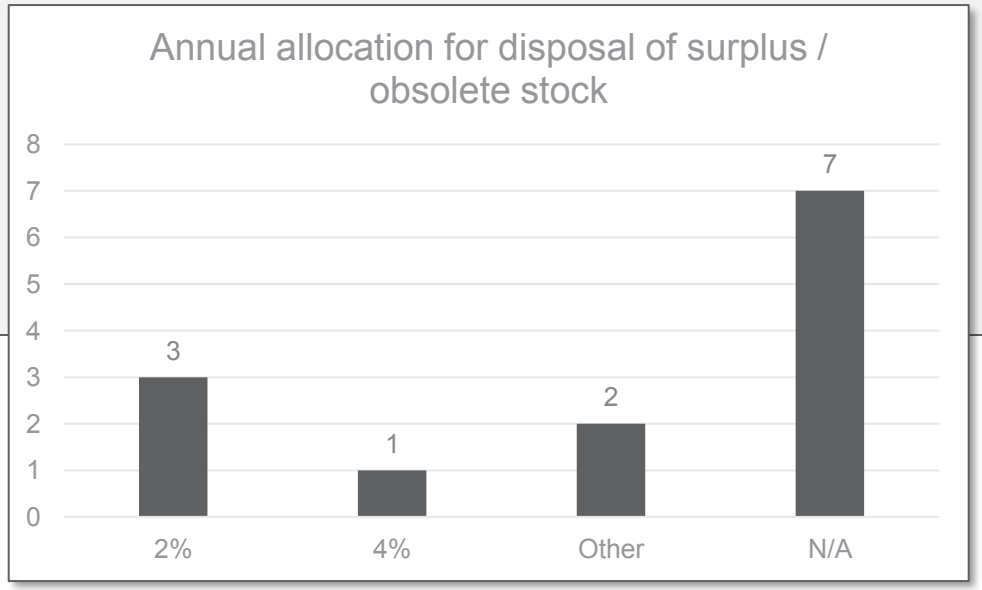
Observations for OPG:

- OPG is one of three respondents who define "Surplus" as material no longer useful in the plant

Inventory Management Results (Cont'd)

11. If your organization allocates an annual budget for disposal of surplus or obsolete stock each year, what is the budget value as a percentage of inventory value that you use?

- ❑ 0%
- ❑ 2%
- ❑ 4%
- ❑ 6%
- ❑ 8%
- ❑ 10% or higher



*Options with no responses were eliminated from chart

- Majority of respondents do not allocate any set percentage of annual budget to the disposal of surplus or obsolete material

- "Other" responses include:
  - 0.5%
  - 0.01%

Observations for OPG:

- OPG allocates the highest annual budget for disposal of surplus or obsolete stock each year, and allocates two times as much as the second highest allocation percentage
- Unfortunately, this budget is not being utilized as fully as it could be and the process for disposing of surplus or obsolete stock needs to be made more effective

Inventory Management Results (Cont'd)

Inventory Decision Rights

12. Please select which of the following your customers (e.g., system owners, maintenance / operations personnel, etc.) have a role in determining:

- ❑ Service levels by SKU (e.g., CatID, Catalogue Item, etc.)
- ❑ Criticality codes
- ❑ Projected future usage by SKU
- ❑ Supplier lead times
- ❑ No involvement
- ❑ Other (please specify)

Respondent:	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
Criticality codes	X	X	X		X	X	X	X	X	X		X		10
Service levels		X	X	X		X					X		X	6
Projected future usage by SKU		X	X					X					X	4
Other				X								X		2
Supplier lead times						X								1

- The area where customers (of Supply Chain) have the most involvement is in determining criticality codes, followed by service levels
- Respondents who indicated that organizations have a role in multiple areas that include service levels have lower median excess inventory with stocking levels than respondents who do not have customers play a role in service levels. These respondents also have a median total number of requests issued higher than the majority of our sample
  - This supports the leading practice of actively engaging customers and managing their service levels. Leading companies have programs in place to ensure continued improvement in customer service
- "Other" responses include stocking levels (min / max)

Observations for OPG:

- Criticality codes was an area in which customers of Supply Chain play a role for OPG; additionally, Engineering specifies stocking level parameters for critical spares

Inventory Management Results (Cont'd)

13. If your organization has a formal process for establishing new inventory items and for calculating initial stocking levels, please explain what organization manages this process / determines maximum or minimum level of inventory:

Owner:	Supply Chain	Maintenance	Engineering
Limited Input From:	Engineering	Supply Chain (Optional)	Maintenance
# of Respondents:	5	1	2

- The most common practice is for Supply Chain to own the process of establishing new inventory items and calculating initial stocking levels with limited input and recommendations from Engineering

Observations for OPG:

- OPG is one of the two respondents who has Engineering own this process. Supply Chain simply "processes procurement."
- This area represents an opportunity to refine and clarify decision rights (and the actual decisions) to be more consistent with leading practices

Inventory Management Results (Cont'd)

14. If your organization has a formal process for setting system stocking levels (inventory parameters) for commonly stocked commodities, what organization carries out this process?
    - ❑ Central Supply Chain organization
    - ❑ Central Plant / Maintenance organization
    - ❑ Individual Plant / Maintenance organization
    - ❑ Other (please specify)

Respondent:	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
Central Supply Chain	X	X					X	X				X	X	6
Other				X	X	X			X		X			5
Individual Plant / Maintenance			X							X				2
Central Plant / Maintenance														0

- Central Plant / Maintenance organizations do not set system stock levels for commonly stocked commodities for any of our respondents
- "Other" responses include:
  - Individual Plant Supply Chain
  - "We don't have a formal process for this"

Observations for OPG:

- OPG is among the majority of respondents by having its central supply chain organization manage system stocking levels for commonly stocked commodities

Inventory Management Results (Cont'd)

15. If your organization sets inventory level thresholds for each site, please explain what the inventory level thresholds are (e.g., maximum dollar value, etc.)

- A significant majority of respondents do not set inventory thresholds for each site, though some responses indicated related targets are established:
  - Inventory levels are budgeted based on expected growth and requests to increase inventory must be approved
  - No thresholds, but goals are established for new and surplus inventory growth

Observations for OPG:

- OPG does not presently set any inventory level thresholds for its sites

Inventory Management Results (Cont'd)

16. What approval and controls are in place to ensure orders for parts are appropriate? (i.e., requisitions exceeding a certain dollar value require a manual review before the order is placed)

- All respondents have some form of review and approval process and most frequently with inventory dollar value thresholds tiered for approval:
  - The lowest reported inventory dollar threshold requiring escalation is $2,000
  - The highest reported inventory dollar threshold for a manager is $2,000,000
- Respondents with the lowest reported inventory dollar threshold at the manager or director level also have inventory growth rates lower than the median of their respective peer panels

Observations for OPG:

- OPG has much higher thresholds for review and approval at the manager level than other respondents with approval authority going up to $2,000,000 for bands G and H
- OPG should consider reducing certain approval levels to help achieve greater control over inventory growth

Inventory Management Results (Cont'd)

17. If your organization has inventory reduction strategies in place, how are they being applied?
    a. What are the focus areas of these inventory strategies?
    b. Who is accountable to these strategies?

- Majority of respondents have an inventory reduction strategy in place and common themes of these strategies are:
  - Changing min / max levels
  - Better review and challenge of requests prior to procurement
  - Reduction and disposition of surplus or obsolete material
  - Catalogue clean up and data validation
- Majority of these strategies are overseen by Supply Chain personnel
- A few respondents develop cross-departmental teams that share accountability for the success of these strategies
  - Respondents who incorporate multiple departments have growth rates lower than the median growth rates for their respective peer panels
- One respondent has its strategies owned by the sites collectively, with one site general manager leading the task force and supported by representatives from each site

Observations for OPG:

- OPG did not report any inventory reduction strategies in place
- Establishing a collaborative, cross-functional approach is an effective way to improve inventory control and reduction

Inventory Management Results (Cont'd)

18. For your sites, what area owns the decision rights for parts order / reorder?
    - ❑ Plant Operations
    - ❑ Plant Engineering
    - ❑ Plant Maintenance
    - ❑ Other (please specify)

- Survey responses report that the originating requesting organization is responsible for the parts order / reorders, while a few respondents report Supply Chain as responsible for parts order / reorder
- Few survey respondents assign parts order / reorder decision rights to the following organizations, despite original requestor:
  - Plant Engineering – one respondent
  - Plant Operations – one respondent
  - Site Manager / VP – one respondent

Observations for OPG:
- OPG is the only respondent that has Plant Operations solely own the decision rights for parts order / reorder

Inventory Management Results (Cont'd)

19. For your sites, what roles (if any) do the following organizations play in the approval of parts purchase?
    - ❑ Finance
    - ❑ Engineering
    - ❑ Plant Maintenance
    - ❑ Other (please specify)

- Roles within the approval of parts purchase vary across all respondents
- Majority of respondents have either Plant Maintenance or Supply Chain central to the approval of parts purchase
  - When Plant Maintenance is central, Engineering and Finance roles are limited
  - When Supply Chain is central, Engineering, Finance, and Maintenance roles are limited
    - One respondent has Supply Chain and Maintenance as central owners, with Engineering and Finance roles limited
- Some of roles noted for each organization among the responses are:

Finance	Engineering	Plant Maintenance	Other	
			Supply Chain	Various Organizations
Makes decisions on Cap vs. O&M expense codes	Determines parts specifications	Identifies material needs	Approves and executes requisitions	Provides input on parts specifications
Sets purchase levels and limits	Establishes criticality codes	Sets stocking levels	Sets maximum stocking levels	
Oversees budget process	Sets minimum stocking levels	Confirms stocking levels	Sets stocking criteria with customer input	

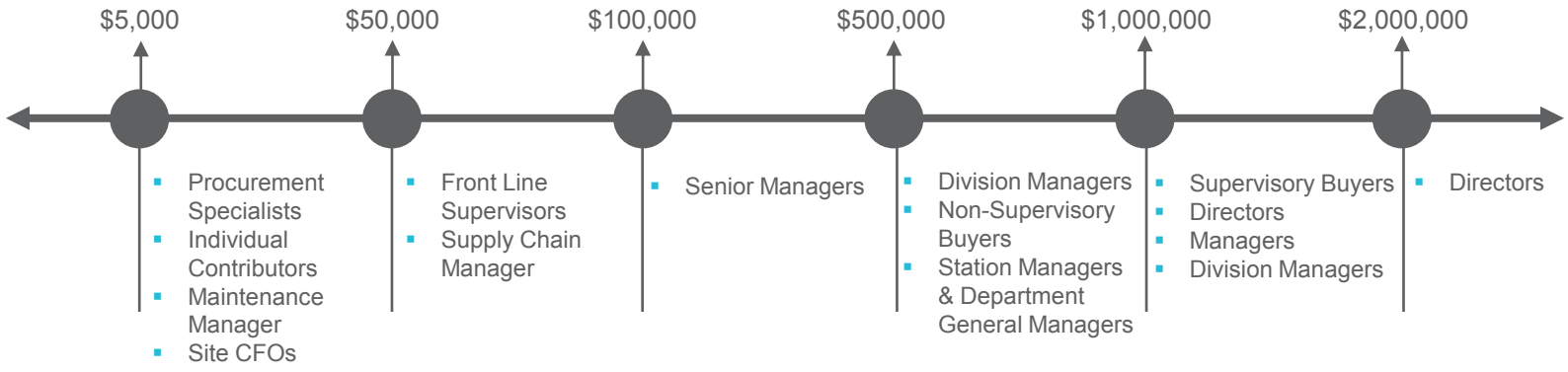
Observations for OPG:

- OPG has an allocation of roles that is comparable to other operators. Key to success is ensuring that these roles are being completed with quality

Inventory Management Results (Cont'd)

20. For your sites, what cost thresholds (dollar value) exist for parts purchase which require additional approval?

- Costs thresholds vary across all respondents, with the lowest additional approval required starting at $2,000
- To illustrate the varying approval structure, a sampling of approval cost thresholds and required approvers are listed below:



Observations for OPG:

- OPG has the highest beginning cost threshold of $500,000 for "Non-Supervisory Buyers" to approve a purchase order. Management bands G and H can approve POs up to $3M

Inventory Management Results (Cont'd)

21. If your organization has a formal procedure to identify obsolete (inventory for which the company no longer has use for) or excess material in inventory, how often is this procedure carried out?
    - ❑ On an ongoing basis
    - ❑ Monthly
    - ❑ Quarterly
    - ❑ Yearly
    - ❑ Other (please specify)
        a. Who leads this obsolescence and excess material identification process?
            - ❑ Warehouse personnel
            - ❑ Plant Maintenance personnel
            - ❑ Plant Engineering personnel
            - ❑ Plant Planners
        - ❑ Other (please specify)

Ongoing	Monthly	Quarterly	Yearly	Other
7	0	0	2	4

- "Other" responses include:
  - Obsolete ongoing, Excess quarterly
  - "We do not have a formal process in place"

Warehouse Personnel	Plant Maintenance	Plant Engineering	Plant Planners	Other
2	1	3	0	5

- "Other" responses include:
  - Material Analysts
  - Supply Chain
- Survey respondents indicate that identifying obsolete or excess material is an ongoing process with Supply Chain accountable

- Many survey responses align with the leading practice of incorporating a formal line item into each business units' budget for inventory obsolescence, forecasted each year and based on historical data and projected inventory counts
- It is unclear whether the survey respondents push accountability for identifying obsolete or excess material to the lowest possible level within each business unit, which is also a leading practice

Observations for OPG:
- OPG is one of the four respondents who do not have a formal procedure to identify obsolete or excess material

scottmadden MANAGEMENT CONSULTANTS

Inventory Management Results (Cont'd)

Management Policies and Procedures

22. If your organization calculates inventory carrying costs, which of the following do you consider in your calculations (please check all that apply):

- ❑ Financing Costs / Opportunity Costs
- ❑ Transportation Costs
- ❑ Warehouse Space
- ❑ Warehouse Labor
- ❑ State and Local Property Taxes
- ❑ Property Insurance
- ❑ Commodity Devaluation
- ❑ Inventory Damage / Repair Costs
- ❑ Obsolescence / Write – offs
- ❑ Third Party Inventory Management Fees

a. How do you calculate inventory carrying costs and what was your inventory carrying cost in 2014?

- Carrying costs are calculated for four of our respondents and are typically calculated at the corporate level but not the site level
  - The most commonly considered costs among respondents are State and Local Property Tax and Property Insurance, followed by Financing and Opportunity Costs
  - None of the respondents consider Third Party Inventory Management Fees within its carrying cost calculation, likely because they are not leveraging third parties to manage their inventory
- Calculating and incorporating inventory carrying costs is a leading practice. Understanding the cost to carry inventory can help encourage better informed management decisions. Inventory carrying costs are calculated with consideration of each item in the list above

Observations for OPG:

- As is the case with most respondents, OPG does not currently calculate an inventory carrying cost

Inventory Management Results (Cont'd)

23. When calculating Provisional Charges for End of Life, what percentage of inventory is allocated to be used up by End of Life? (Provisional Charges for End of Life are allowances to account for inventory which will become stranded when the asset reaches the end of its operating life)

    a. How do you calculate Provisional Charges for End of Life?

- Four respondents shared information on their provisional charges for end of life. These responses range from a highly automated algorithm to manual calculations
- Majority of these respondents recalculate provisional charges annually while one reevaluates these charges on a quarterly basis
- Some differences exist in the calculations provided by respondents, but the calculation below provides a summary:

Current Inventory Value	+	Future Purchases	-	Future Consumption	-	Other Dispositions	=	New Provision for EOL
		Based on expected operating life of plant						
		■ ROP/TMAX ■ Safety stock ■ Historical usage		■ Demand forecast		■ Current provision ■ Scrap & write-offs ■ Returns to supplier		

Observations for OPG:

- OPG is one of the four respondents that calculate provisional charges for end of life and OPG does so in a manner that is similar to the other confirming respondents

Inventory Management Results (Cont'd)

24. What processes are used to determine the level of spares procured for major projects or modifications / refurbishment?
    a. What segments of that process do the following groups own:
        i. Engineering
        ii. Plant Maintenance
        iii. Nuclear Supply Chain
        iv. Nuclear Finance
        v. Other (please specify)

- Majority of respondents do not have a formal process to determine the level of spares procured for major projects or modifications / refurbishment
- Of the four respondents who do:
  - Two have Nuclear Supply Chain own the process, with support from Engineering or Plant Maintenance
  - Two have Engineering own the process, with support from Supply Chain
- Where a plant is in its life-cycle might play a role in whether or not certain respondents have formalized processes for major projects or modifications / refurbishment

Observations for OPG:

- OPG is in the minority of respondents that has a separate process for determining spares procured for major projects or modifications / refurbishment
- The OPG response indicates that "the Nuclear Engineering Change Control (ECC) process has a requirement for a minimum addition to plant inventory of a quantity of two for every new Cat ID," which is arbitrary and should be re-examined

Inventory Management Results (Cont'd)

25. If your organization has incentives for meeting inventory management targets, please explain what these incentives are:

- Majority of respondents do not have incentives for meeting inventory management targets, which is contrary to the leading practice of rewarding employees for achieving cost savings (cost avoidance or cost reductions)
- Of the respondents who do:
  - One respondent incorporates a corporate driven incentive for Nuclear Supply Chain to stay at or below a specified annual growth rate target
  - One respondent incorporates inventory targets into its overall key performance indicators

Observations for OPG:

- OPG does not currently have any incentives in place for meeting inventory management targets

Key Observations for OPG

Inventory Size

- PNGS has 58% more inventory per MW and 7% more inventory per unit than the median of the CANDU panel
- DNGS inventory per MW is 4% lower than the median for CANDUs and 2% less than median for the Canada peer group
- As is the case with most respondents, OPG does not currently calculate an inventory carrying cost

Inventory Growth

- PNGS has the second lowest growth rate among CANDU respondents; however, at this growth rate, PNGS will have C$162,303 in inventory per MW by 2021, a 42% increase from 2014
- Although DNGS inventory size per MW is lower than the median for CANDUs, its growth rate is higher than all peer group medians
  - Assuming the growth rate for DNGS is sustained, inventory per MW for DNGS will surpass the current medians of all peer groups in 3 years, and will increase to C$117,838 by 2021, which is higher than the 2014 value at PNGS
- OPG is among the majority of respondents using manual calculations to assign inventory stocking level criteria and does not use system-generated or automatic calculations
- OPG does not regularly reassess inventory stocking criteria though most respondents reassess with each purchase

Excess Inventory

- PNGS has a higher level of inventory in excess of set stocking levels than the median of all peer groups
- DNGS has less excess inventory than the median of the CANDU and Canada peer panels, but considerably greater inventory in excess of set stocking levels than the median of PWRs and BWRs
- OPG did not report any inventory reduction strategies in place

Key Observations for OPG (Cont'd)

Disposal of Surplus or Obsolete Stock

- OPG allocates the highest annual budget for disposal of surplus or obsolete stock each year, and allocates two times as much as the second highest allocation percentage
- Unfortunately, this budget is not being utilized as fully as it could be
- OPG is one of the four respondents who do not have a formal procedure to identify and dispose of excess or obsolete material

Parts On-Site and in the Catalogue

- Total unique parts on site for PNGS is 83% higher than that of the Canada peer group
- While DNGS has a lower number of unique parts on site than PNGS, it is higher than the Canada peer group by 34%
- OPG has 62% more Cat IDs in its company catalogue than does the CANDU operator with the second highest number

Setting Inventory Thresholds

- A significant majority of respondents do not set inventory thresholds for each site, though some responses indicated related targets are established:
  - "Inventory levels are budgeted based on expected growth and requests to increase inventory must be approved"
  - "No thresholds, but goals are established for new and surplus inventory growth"

Approval Levels

- OPG has much higher thresholds for review and approval at the manager level than other respondents with approval authority going up to $2,000,000 for bands G and H

Recommendations for OPG's Nuclear Executives

Ensure decision rights related to inventory management are consistent with leading practices by:

- Understanding who should do what and avoiding overlap (see high-level example below)
- Helping all groups to understand their roles and become both willing and able to execute them

Engineering, Ops & Mtce	Purchasing	Inventory Management	Materials Management
What materials do we need?	Which suppliers will we use?	How much should we keep on hand?	How do we receive and issue efficiently?
How much do we need?	How much should we pay?	In which warehouse should it be stored?	Where will it be stored in the warehouse?
When do we need it?	How do we ensure supply?	From where should each request be drawn?	Is the shelf count accurate?
Where will we use it?	What are the expected lead times?		Is it maintained adequately?
What is our risk tolerance?	Who will deliver it and when?		

Recommendations for OPG's Nuclear Executives (Cont'd)

Focus on slowing down inventory growth by:

- Establishing growth targets and incentives for each site
- Ensuring that stocking levels are intelligently set and managed
  - The goal of the Improve Inventory Management Initiative in NFI-07 is to ensure ROP/TMAX values are set and maintained using a standardized approach that is documented in governance including clear roles and responsibilities for all stakeholders
  - Solution should include a) better leveraging optimization tools rather than relying on judgment and manual calculations and b) reassessing more frequently (i.e. every time a purchase is made, like some survey respondents)
- Reducing approval authorities for some inventory driving actions to improve review and challenge of requests prior to procurement

OPG Nuclear Executives must communicate the financial implications of excessive inventory to the organization and direct all work groups to manage the inventory asset, particularly additions to it, in a way that ensures value for money.

Reduce surplus inventory by:

- Making the process for actually disposing of surplus or obsolete stock more effective (OPG budgets but does not execute)
- Ensuring the process involves multiple departments working collaboratively to distribute the accountability and ensure monitoring

OPG Nuclear Executives must focus on reducing surplus at PNGS in a shorter time frame given PECO.

OPG Nuclear Executives must ensure that the introduction of new parts due to Refurbishment and replacement of major station systems and components also results in removal of old, obsolete parts.

Recommendations for OPG's Nuclear Executives (Cont'd)

Emphasize inventory carrying cost by:

- Regularly calculating it (at least annually)
- Ensuring those who play a role in inventory management decisions understand inventory carrying cost and that this cost must be balanced against desired material availability

OPG Nuclear Executives must 1) communicate that this is a real cost that is neither understood by or being factored into the decisions of those who are driving growth in inventory today and 2) ensure that future decisions balance material availability with carry cost.

Improve information accuracy to allow for better planning and increased impact by:

- Cleaning up the catalogue
  - NFI-07 is addressing a sub-set of the catalog, but additional clean-up efforts and elimination of redundant, inaccurate, or unused parts information would further improve performance

OPG Nuclear Executives must recognize that robust and accurate underlying data is necessary to enable efficient and effective management of nuclear assets and commit to cleaning up such data.

Appendix

Appendix

ONTARIO POWER GENERATION

Quantitative Survey Questions

Each respondent received a quantitative survey portion with the below questions

1.0	**Contact Information**
1.1	Name of individual (respondent) completing this survey
1.2	Respondent's title
1.3	Respondent's phone number
1.4	Respondent's email address
2.0	**Warehouse Identification**
2.1	Name of warehouse supporting site
2.2	Street Address
2.3	City, State / Province, Zip
2.4	Is warehouse support central or distributed?
2.5	Please provide the following:
2.5.1	Total Plant / Site capacity (MW)
2.5.2	Number of units and year of commercial operation date
3.0	**Warehouse Facilities**
3.1	Total covered storage space (in square feet)
3.2	Total uncovered (yard) space (in square feet)

scottmadden
MANAGEMENT CONSULTANTS

ONTARIO POWER GENERATION

Quantitative Survey Questions (Cont'd)

4.0	Inventory Information
4.1	Total dollar value of all inventory on site at the end of the following years:
4.1.1	2014
4.1.1.1	Inventory
4.1.1.2	Non-costed, capitalized materials
4.1.2	2013
4.1.2.1	Inventory
4.1.2.2	Non-costed, capitalized materials
4.1.3	2012
4.1.3.1	Inventory
4.1.3.2	Non-costed, capitalized materials
4.2	Dollar value of minimum stock on hand to support spares (e.g., lifetime, critical, single point vulnerability, crit 1-2, ROP TMAX) in 2014
4.3	Dollar value of inventory (non-crit spares) with no current demand or demand for the past 5+ years
4.4	Dollar value of all lines requested in 2014 (including requested but not issued) in 2014
4.5	Total number of all lines requested in 2014 (including requested but not issued) in 2014
4.6	Dollar value of all lines issued in 2014
4.7	Total number of lines issued in 2014
4.8	Dollar value of all lines issued and returned to the warehouse (excluding returns for repairs) in 2014
4.9	Total number of all lines issued and returned to the warehouse (excluding returns for repairs) in 2014
4.10	Total value of Provisional Charges for End of Life in 2014

scottmadden
MANAGEMENT CONSULTANTS

Quantitative Survey Questions (Cont'd)

5.0	Inventory Parts (SKUs, CatIDs) Information
5.1	Total number of CatIDs (unique parts) at this location
5.2	Total number of CatIDs (unique parts) maintained within the company's inventory system
5.3	Total number of CatIDs (unique parts) issued during the prior 12 months (at least 1 issue during the prior year) at this location
5.4	Total number of CatIDs (unique parts) on hand that are in excess of set stocking levels
5.5	Dollar value of CatIDs (unique parts) that are in excess of set stocking levels
5.6	Total number of CatIDs (unique parts) that have no set stocking level, but have inventory on hand that is greater than the projected and approved demand for that part
5.7	Dollar value of CatIDs (unique parts) that have no set stocking level, but have inventory on hand that is greater than the projected and approved demand for that part

Appendix

ONTARIO POWER GENERATION

Quantitative Survey Questions (Cont'd)

Each participant received the following terminology definitions within each quantitative survey

	Terminology / Survey Question	Definition
4.1.1.1	Inventory	Material and goods held by an organization (1) to support production (raw materials, sub-assemblies, and work in progress), (2) for support activities (repair, maintenance, and consumables) or (3) for sale or customer service (merchandise, finished goods, and spare parts). Inventory excludes non-costed, capitalized material
4.1.1.2	Non-costed, Capitalized	Materials located in the warehouse that have "zero" cost in the Plant Materials and Operating Supplies (FERC 154 for US Operators) inventory account since they have been capitalized at the time of receipt
4.2	Spares Inventory Support	Minimum stock on hand to support spares (pandemic material – materials required to be on hand) (e.g., lifetime, critical, single point vulnerability, crit 1-2, ROP TMAX)
4.4	Line	Material request line item, or a specific requested quantity of a CatID
5.0	SKUs or CatIDs	Catalogue inventory item or unique part
5.2	Total number of CatIDs (unique parts) maintained within the company's inventory system	Includes all inventory, excluding those out for repairs, etc.
5.4	Total number of CatIDs (unique parts) on hand that are in excess of set stocking levels	Number of unique parts on hand in a quantity greater than the set stocking levels for that CatID
5.5	Dollar value of CatIDs (unique parts) that are in excess of set stocking levels	Dollar value of all unique parts on hand in a quantity greater than set stocking levels
5.6	Total number of CatIDs (unique parts) that have no set stocking level, but have inventory on hand that is greater than the projected demand for that part	Number of unique parts that do not have established set stocking levels but do have a quantity on hand that is greater than the projected demand for that unique part
5.7	Dollar value of CatIDs (unique parts) that have no set stocking level, but have inventory on hand that is greater than projected demand for that part	Dollar value of unique parts that do not have established set stocking levels but do have a quantity on hand that is greater than the projected demand for that unique part

scottmadden MANAGEMENT CONSULTANTS

Qualitative Survey Questions

Each respondent received a qualitative survey portion with the below questions

Inventory Categorization

1. When segmenting your inventory, does your organization use a calculated or assigned coding system? (such as ABC usage value analysis, XYZ holding value analysis, movement frequency, criticality ranking, or availability):
   - ❑ Yes
   - ❑ No
     a. If yes, is each inventory segment calculated and managed separately / differently?
     b. If yes, is each inventory segment managed by a separate owner?
2. When inventory is segmented, how often is inventory reassessed and new ABC, etc. values applied?
   - ❑ Annually
   - ❑ Semi-Annually
   - ❑ Quarterly
   - ❑ Monthly
   - ❑ Other (please explain)

ONTARIO POWER GENERATION

Qualitative Survey Questions (Cont'd)

3. How do you assign inventory stocking level criteria (e.g., safety stock, reporter point, estimated lead time demand, economic order quantitates, etc.) for your sites?
   - ❑ Manual calculations
   - ❑ System – generated / automatic calculations
   - ❑ A mix of both manual calculations and automatic calculations
   - ❑ We do not utilize inventory stocking level criteria
   - ❑ Other (please specify)
     a. How frequently are inventory stocking level criteria reassessed?
     - ❑ Every time a purchase is made
     - ❑ Once a month
     - ❑ Once a quarter
     - ❑ Once a year
     - ❑ Other (please specify)
4. How are safety stock levels determined? (Safety stock is defined as the level of extra stock that is kept on hand to mitigate risk of stock-outs):
   - ❑ Statistical calculation based on demand forecast, forecast error rates and desired service level
   - ❑ Optimization algorithms which minimize total inventory costs for each SKU
   - ❑ System owners or maintenance / operations personnel assign based on judgement and experience
   - ❑ Other (please specify)

scottmadden
MANAGEMENT CONSULTANTS

ONTARIO POWER GENERATION

Qualitative Survey Questions (Cont'd)

5. What categories are included within "Spares"? Please include all that apply (e.g., lifetime spares, critical spares, single point vulnerabilities, crit 1 & 2)

6. Are "Critical Spares" (i.e., items that are essential to operations and must be kept on hand at a certain level regardless of optimization tool recommendations) designated in your inventory management system and not considered for optimization?

   - ❑ Yes
   - ❑ No
   - ❑ Other (please specify)

7. If your company uses "Critical Spares" (or a similar term) as a designation, what percentage of inventory dollar value do these "Critical Spares" represent?

   - ❑ 0%
   - ❑ 10%
   - ❑ 20%
   - ❑ 30%
   - ❑ 40%
   - ❑ 50%
   - ❑ 60%
   - ❑ 70% or greater

scottmadden
MANAGEMENT CONSULTANTS

Qualitative Survey Questions (Cont'd)

8. If your organization identifies "Critical Spares" (or a similar term) within inventory, briefly describe the criteria used to define "Critical Spares":
    a. What is the number of material items defined as "Critical Spares" (or similar term) in 2014?
    b. What was the total value of the items defined as "Critical Spares" (or similar term) in 2014?
9. If your organization identifies "Lifetime Spares" (e.g. items required to be stocked at any given time due to a foreseeable lack of availability in the marketplace) within inventory, briefly describe the criteria used to define "Lifetime Spares":
    a. What is the number of material items defined as "Lifetime Spares" in 2014?
    b. What was the total value of items defined as "Lifetime Spares" in 2014?
10. Within your organization, how do you define "Surplus Materials"? (e.g., inventory no longer required or in excess of the quantity required):
    a. Within your organization, who has the authority to sign off on changes to / movement of "Surplus Material"?
11. If your organization allocates an annual budget for disposal of surplus or obsolete stock each year, what is the budget value as a percentage of inventory value that you use?
    - ❑ 0%
    - ❑ 2%
    - ❑ 4%
    - ❑ 6%
    - ❑ 8%
    - ❑ 10% or higher

ONTARIO POWER GENERATION

Qualitative Survey Questions (Cont'd)

Inventory Decision Rights

12. Please select which of the following your customers (e.g., system owners, maintenance / operations personnel, etc.) have a role in determining:
    - ❑ Service levels by SKU (e.g., CatID, Catalogue Item, etc.)
    - ❑ Criticality codes
    - ❑ Projected future usage by SKU
    - ❑ Supplier lead times
    - ❑ No involvement
    - ❑ Other (please specify)
13. If your organization has a formal process for establishing new inventory items and for calculating initial stocking levels, please explain what organization manages this process / determines maximum or minimum level of inventory:
14. If your organization has a formal process for setting system stocking levels (inventory parameters) for commonly stocked commodities, what organization carries out this process?
    - ❑ Central Supply Chain organization
    - ❑ Central Plant / Maintenance organization
    - ❑ Individual Plant / Maintenance organization
    - ❑ Other (please specify)
15. If your organization sets inventory level thresholds for each site, please explain what the inventory level thresholds are (e.g., maximum dollar value, etc.)

scottmadden
MANAGEMENT CONSULTANTS

Appendix

ONTARIO POWER GENERATION

Qualitative Survey Questions (Cont'd)

16. What approval & controls are in place to ensure orders for parts are appropriate? (i.e., requisitions exceeding a certain dollar value require a manual review before the order is placed)

17. If your organization has inventory reduction strategies in place, how are they being applied?
    a. What are the focus areas of these inventory strategies?
    b. Who is accountable to these strategies?

18. For your sites, what area owns the decision right for parts order / reorder?
    - ❑ Plant Operations
    - ❑ Plant Engineering
    - ❑ Plant Maintenance
    - ❑ Other (please specify)

19. For your sites, what roles (if any) do the following organizations play in the approval of parts purchase?
    - ❑ Finance
    - ❑ Engineering
    - ❑ Plant Maintenance
    - ❑ Other (please specify)

20. For your sites, what cost thresholds (dollar value) exist for parts purchase which require additional approval?

scottmadden
MANAGEMENT CONSULTANTS

ONTARIO POWER GENERATION

Qualitative Survey Questions (Cont'd)

21. If your organization has a formal procedure to identify obsolete (inventory for which the company no longer has use for) or excess material in inventory, how often is this procedure carried out?
    - ❑ On an ongoing basis
    - ❑ Monthly
    - ❑ Quarterly
    - ❑ Yearly
    - ❑ Other (please specify)
        a. Who leads this obsolescence and excess material identification process?
        - ❑ Warehouse personnel
        - ❑ Plant Maintenance personnel
        - ❑ Plant Engineering personnel
        - ❑ Plant Planners
        - ❑ Other (please specify)

scottmadden
MANAGEMENT CONSULTANTS

Qualitative Survey Questions (Cont'd)

Management Policies and Procedures

22. If your organization calculates inventory carrying costs, which of the following do you consider in your calculations (please check all that apply):
    - ❑ Financing Costs / Opportunity Costs
    - ❑ Transportation Costs
    - ❑ Warehouse Space
    - ❑ Warehouse Labor
    - ❑ State and Local Property Taxes
    - ❑ Property Insurance
    - ❑ Commodity Devaluation
    - ❑ Inventory Damage / Repair Costs
    - ❑ Obsolescence / Write – offs
    - ❑ Third Party Inventory Management Fees

    a. How do you calculate inventory carrying costs and what was your inventory carrying cost in 2014?

23. When calculating Provisional Charges for End of Life, what percentage of inventory is allocated to be used up by End of Life? (Provisional Charges for End of Life are allowances to account for inventory which will become stranded when the asset reaches the end of its operating life)

    a. How do you calculate Provisional Charges for End of Life?

Qualitative Survey Questions (Cont'd)

24. What processes are used to determine the level of spares procured for major projects or modifications / refurbishment?
    a. What segments of that process do the following groups own:
        i. Engineering
        ii. Plant Maintenance
        iii. Nuclear Supply Chain
        iv. Nuclear Finance
        v. Other (please specify)
25. If your organization has incentives for meeting inventory management targets, please explain what these incentives are:

UNDERTAKING JT2.21

Undertaking

TO GO THROUGH THE DIFFERENCES IN PHT OUTAGES AND CONFIRM THAT THAT'S THE REDUCTION NUMBER THAT'S GOING INTO THE FORECAST PRODUCTION.

Response

Exhibit E2-1-1 page 4 advises that eight mini-outages of approximately 20 days duration at Darlington over the period 2016-2021 are required to replace the high risk PHT pump motors.

There are seven PHT Pump Motor outages scheduled in the test period (2017-2021). The eighth PHT Pump Motor outage recently occurred in 2016.

In response to Interrogatory L-5.1-12 OAPPA-6, the answer should have read that the 7 outages reflect 2.95 TWh over the test period. The correct amount of 2.95 TWh is reflected in OPG's 2017-2021 production forecast.

UNDERTAKING JT2.22

Undertaking

TO CONFIRM WHETHER NAVIGANT, IN NORMALIZING THE DIFFERENCES IN THE PEER GROUP, NORMALIZED EACH PEER GROUP MEMBER IN A SIMILAR WAY AS THEY DID TO OPG BY REMOVING COSTS SIMILAR TO PUBLIC AFFAIRS AND REGULATORY OR GRC.

Response

Navigant removed Public Affairs and Regulatory ("PA&R") costs from all peers. The Partial Function cost benchmark consistently normalizes (i.e., removes) PA&R costs for all utilities in the study.

UNDERTAKING JT2.23

Undertaking

TO ADVISE WHEN SIMPLE PIRS ARE DONE OR TRIGGERED, AND THEN WHEN COMPREHENSIVE PIRS ARE DONE OR TRIGGERED

Response

As noted at Ex. A2-2-1 Att. 4, p. 4, lines 6-7, some form of post implementation project assessment is required to be conducted on all projects. The post project assessment plan documented as part of the Business Case Summary typically defines whether a formal Post Implementation Review (PIR) is expected to be performed or whether an assessment of deliverables as part of standard project closure documentation is sufficient. The nature of the post project assessment typically depends on the nature, size and complexity of the project.[1]

The default formal PIR documentation for validating whether project benefits were realized as stated in the BCS and for capturing the lessons learned is the simplified PIR. As discussed at Ex. A2-2-1, Att. 4, p.4, lines 9-15, the comprehensive PIR is a broader evaluation of all phases of the project, typically involving a cross functional team. Since the scope and depth of a comprehensive PIR requires a substantial amount of time and resources, it is performed on a small number of projects. Some of the considerations used to determine whether a comprehensive PIR should be performed include: total project cost, risks associated with achieving success, and the strategic nature and business significance of the project.

[1] An assessment of successful implementation of project deliverables as part of standard project closure documentation typically is considered sufficient for projects with straightforward deliverables. Such projects typically have no operating or reliability parameters to measure post in-service, and do not require a more formal PIR appraisal. An example would be a project to construct a new access road at the station.

UNDERTAKING JT2.24

Undertaking

TO PROVIDE A SCENARIO SHOWING RATE SMOOTHING AND MATERIALITY

Response

OPG has provided an assessment of the impact on Nuclear rate smoothing assuming that the Nuclear all in rate (base payment amounts + riders) is held flat in 2017, with all other aspects of OPG's proposal remaining unchanged. For Nuclear, OPG has calculated the base payment amounts by escalating the amounts by 11% in the years 2018-2026, and determined the rate necessary from 2027-2036 to reach a $0 account balance by the end of 2036.

Chart 1 below provides a comparison of outcomes resulting from OPG's proposal extracted from Ex. A-1-3-3, Page 8, chart 3 and the outcomes resulting from the smoothing scenario summarized in the paragraph above.

Chart 1

OPG Rate Smoothing Proposal Compared to JT2.24 Rate Smoothing Scenario

Line No.		As Filed	JT2.24	Variance (b - a)
		(a)	(b)	(c)
	First Period: 2017-2021			
1	Total Interest Collected ($Bn)	0.3	0.2	(0.1)
2	Total Deferred Revenues[1] ($Bn)	1.7	1.1	(0.6)
3	Peak Balance of Deferral Account ($Bn)	1.9	1.1	(0.7)
4	Average Typical Bill Impact ($/Month)	1.05	1.28	0.2
	Full Period: 2017-2036			
5	Total Interest Collected ($Bn)	1.5	0.6	(1.0)
6	Total Deferred Revenues[1] ($Bn)	2.9	3.5	0.6
7	Peak Balance of Deferral Account ($Bn)	3.5	1.9	(1.6)
8	2027-2035 Rate Increase (%)	(3.4%)	(5.8%)	(2.4%)
9	Transition Impact: 2037 Rate Change ($/MWh / %)	$2/MWh / 2%	$24/MWh / 24%	$22/MWh / 22%

Notes:
1 Recoveries are not included in the calculation of the total deferred revenues

UNDERTAKING JT2.25

Undertaking

TO SHOW THE AMOUNT OF COMPENSATION THAT IS INTENDED TO BE CAPITALIZED IN EACH OF THE TEST YEARS FOR THE NUCLEAR BUSINESS.

Response

The requested information is provided below for the nuclear business, including the directly attributable costs of corporate support functions capitalized:

Capitalized Compensation ($M)	2017	2018	2019	2020	2021
Nuclear Excl. Darlington Refurb.	57.9	57.2	48.3	47.7	48.4
Darlington Refurbishment	147.7	147.7	153.3	152.8	169.0
Total	**205.6**	**204.9**	**201.7**	**200.5**	**217.4**

UNDERTAKING JT2.26

Undertaking

TO PROVIDE HISTORICAL NUMBERS FOR HEAD COUNTS FOR THE YEARS 2012 TO 2014 AND THEN FOR THE TEST PERIOD.

Response

Figure 1 below provides the regular and temporary headcounts as of year end requested. OPG notes that temporary headcount, which is a point in time measure, can fluctuate from year end to year end and within the year depending on work program demands, including the timing of outage and project work

Figure 1

	Actual				*Forecast*					
OPG Year End Headcount	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Regular	10,844	10,266	9,678	9,247	[redacted]					
Temporary	535	617	780	976						
Total	**11,379**	**10,883**	**10,458**	**10,223**						

UNDERTAKING JT2.27

Undertaking

TO PROVIDE THE DESCRIBED CALCULATION REGARDING THE CAPACITY REFURBISHMENT VARIANCE ACCOUTN AND THE RATE SMOOTHING DEFERRAL ACCOUNT

Response

This undertaking has asked for a calculation illustrating the proposed treatment of variances in Nuclear Capacity Refurbishment Variance Account ("CRVA") eligible revenue requirement impacts in the 2017-2021 rate period and any impacts on the Rate Smoothing Deferral Account ("RSDA") account in the case of an under spend on the Darlington Refurbishment Program ("DRP").

The revenue requirement impact of the under spend would be recorded as a credit to the CRVA account. This credit entry would attract interest at the OEB's prescribed interest rate applicable to approved regulatory accounts. The credit entry, along with any accumulated interest, would be returned to rate payers upon disposition of the balance in the account.

The RSDA is a deferral mechanism prescribed by O.Reg. 53/05 to allow the OEB to make more stable the year-over-year changes in the nuclear payment amount. This account will record the difference between: (i) the total annual nuclear revenue requirement approved by the OEB; and, (ii) the portion of that revenue requirement in (i) that is used in connection with setting the nuclear payment amounts in each year (Ex. H1-1-1 Page 29). This account will not record variances between OPG's approved costs and actual costs (capital or otherwise).

There will be a timing difference between when the revenue requirement impacts of in service capital additions are included in OPG's payment amounts, and when the revenue requirement impact of under spend on CRVA-eligible in service capital additions are returned to customers. A part of the revenue requirement impact would be collected in the deferral period of the RSDA, and the remainder in the recovery period of the RSDA (in total over a 20 year time period). The customer would be returned the revenue requirement impact of under spend on CRVA eligible in service capital additions upon disposition of the CRVA account. OPG anticipates that disposition of deferral and variance account balances will occur as part of the mid-term review (in 2019) and as part of the application for 2022 Nuclear payment amounts.

UNDERTAKING JT2.28

Undertaking

TO PROVIDE THOSE OTHER ASPECTS OF REVENUE REQUIREMENT THAT ARE SUBJECT TO THE RULES IN AN UNDERTAKING.

Response

In addition to the aspects of revenue requirement specified in the response to the interrogatory, section 78.1(4) of the Act requires that the Board in setting just and reasonable payment amounts make its order in accordance with the rules prescribed by the regulations. More specifically the section provides:

> *Board orders*
>
> *(4) The Board shall make an order under this section in accordance with the rules prescribed by the regulations and may include in the order conditions, classifications or practices, including rules respecting the calculation of the amount of the payment. 2004, c. 23, Sched. B, s. 15.*

As a result of s.78.1(4) all aspects of revenue requirement are subject to the rules under the regulation.

UNDERTAKING JT2.29

Undertaking

FOR THE 282 SOCIETY REPRESENTED POSITIONS THAT COULD NOT BE BENCHMARKED IN THE GENERAL INDUSTRY CATEGORY, TO GROUP THEM BY JOB FAMILIES

Response

Figure 1 below provides the 282 Society-represented positions in the General Industry segment that were not included in the Willis Towers Watson compensation benchmarking study (Reference: Ex. F4-3-1, Attachment 2). Suitable matches could not be found for these positions as discussed in Ex. L-6.6-1 Staff-152, part (a).

Figure 1

Job Family	Number of Positions
Administration	10
Corporate Services	44
Environment, Health & Safety	36
Finance	42
Human Resources	1
Information Technology	4
Maintenance	23
Operations	90
Supply Chain	32
Total	**282**

UNDERTAKING JT2.30

Undertaking

TO PROVIDE COST FOR ADVERTISING RELATED TO NUCLEAR GENERATION UNDER THE COMMUNICATIONS FUNCTION

Response

There are no advertising costs under the communications function included in nuclear generation during the test period.

UNDERTAKING JT2.31

Undertaking

FOR COLUMN C OF EXHIBIT F3, TAB 1, SCHEDULE 1, PAGE 14 IN THE MIDDLE, TO CLARIFY WHICH IS PEER AND WHICH IS A MEDIUM NUMBER

Response

Answered orally. Please see Technical Conference transcript, November 15, 2016, p. 209:

> MR. FRALICK: … But in response to the previous undertaking with regards to the peers in column C, I have confirmed that they are median.

UNDERTAKING JT2.32

Undertaking

TO EXPLAIN WHETHER THERE IS AN OVERLAP BETWEEN GROUPS THAT HAVE NOT BEEN BENCHMARKED BY TOWERS AND THE GROUPS THAT ARE WITHIN THE ECS CATEGORY.

Response

The Willis Towers Watson study at Ex. F4-3-1, Attachment 2, includes matches from all of the 11 sub-categories included in the Executive and Corporate Services (ECS) category of the Hackett Group benchmarking study as listed in Ex. F3-1-1, p.14, footnote 1.

UNDERTAKING JT2.33

Undertaking

TO EXPLAIN WHY IT IS MORE COMPLEX TO MANAGE FOUR NUCLEAR UNITS THAN TWO NUCLEAR UNITS.

Response

OPG's nuclear fleet consists of stations with 4 (Darlington) and 6 (Pickering) reactors and many interconnected systems. Most US comparator nuclear stations consist of one or two reactors. . The increased number of reactors and interconnected systems increases the scale of the jobs and the complexity of the roles.

OPG has one common control room for 4 nuclear reactors with control room staff accountable for oversight of operations and safety of all 4 reactors. As noted below, the roles at OPG typically have broader scope and accountabilities than the same roles at US reactors and the operations shift crews at OPG stations have many more personnel on them, as compared to the single unit or dual unit U.S. Nuclear Stations.

- Each operating nuclear unit must be operated and maintained to meet all license conditions and to ensure safe operation. This is inherently more complex for a greater number of units as each unit has equipment (e.g., a reactor, reactor cooling systems, turbine generator, steam generators, etc).
- An OPG Shift Manager is responsible for a team of upwards of 50 staff ensuring the safe and efficient operation of multiple reactors. At US facilities the Shift Manager role is responsible for fewer reactors and fewer staff.
- The Manager, Operations Production at OPG is responsible for multiple reactors and an organization of about 400 staff where it is more commonly one or two reactors and 100-200 staff in the US.
- Organization structures at US reactors tend to include at least one more layer of management than at OPG facilities giving the roles at each level increased individual accountabilities.
- The increased complexity at OPG is also evidenced in the training required to become licensed. Initial Qualification Training programs at a single unit or dual unit U.S. Nuclear Station are an average of 14 months in duration. The same training program at OPG is typically 21 months in duration, including a minimum of 18 months formal training. The reason for the difference is the increased number of station systems and the system interrelationships that exist at a 4-Unit OPG Site, as compared to a single unit or dual unit peer nuclear site in the US.

The broader scope and accountabilities associated with OPG's operations, and the larger size of the operations shift crews was also identified in the Goodnight Consulting Inc. staff benchmarking study (Ex. F2-2-1 Attachment 2).

The Goodnight study included a scaling factor to reflect the higher number of staff needed to operate a 4 reactor plant compared to an equivalent 2 reactor plant, as shown in Ex. F2-1-1, Attachment 2, page 24.

UNDERTAKING JT2.34

Undertaking

TO PROVIDE THE ANALYSIS CONDUCTED BY OPG FOR EACH OF THE METRICS FROM THE TOWERS WATSON REPORT FOR 2015-2021.

Response

As noted in L-6.6-1 Staff-147 c), OPG does not update or monitor the four referenced metrics found in the Towers Watson report (EB-2013-0321, Ex. JT2.12, Att. 1). For the purposes of that interrogatory response, OPG estimated the values for each of the metrics based on 2015 actual data and 2016-2021 forecast information underpinning the EB-2016-0152 pre-filed evidence, as updated for 2016-2018 per the January 1, 2016 actuarial valuation of the pension plan (see L-6.6-1 Staff-156). Consistent with the Towers Watson report, the metrics were estimated on a total OPG basis.

The calculations and their results are described below. The calculations are detailed in Attachment 1, which contains confidential information.

Metric 1: Pension/OPEB Cash should not exceed 10% of Gross Revenue

OPG calculated the metric by dividing total pension and OPEB cash amounts by total gross revenue. OPG is within the threshold limit in each of the years 2015-2021.

Metric 2: Pension/OPEB Cash should not exceed 40% of Operating Cash Flow before CapEx[1]

OPG calculated the metric by dividing total pension and OPEB cash amounts by total operating cash flow, which excludes capital expenditures. OPG is within the threshold limit in each of the years 2015-2021.

Metric 3: Pension/OPEB Expense should not exceed 35% of Earnings Before Interest and Taxes (EBIT)[1]

OPG calculated the metric by dividing total pension and OPEB accrual costs by total corporate EBIT. OPG exceeds the metric in each of the years 2015-2017 and is within threshold limits starting in 2018.

[1] Consistent with EB-2013-0321, Ex. JT2.12, Att. 1, p. 4, note 1, "Operating Cash Flow Before CapEx" and "Earnings Before Interest and Taxes" for the purpose of these calculations are determined before the effect of pension/OPEB (that is, they represent the values in the absence of pension/OPEB plans).

Metric 4: Pension/OPEB Expense should not exceed $50K per active employee (constant 2011 dollars)

OPG calculated the metric by dividing total pension and OPEB accrual costs by the total number of regular staff at each year-end and then applying a 2% de-escalation factor to convert the per employee figures to constant 2011 dollars. OPG exceeds the threshold in 2015 and 2016, and is within threshold limits starting in 2017.

Attachment 1

All data in $M and for Total OPG, unless otherwise noted

Line	Description	2015 Actual	2016 Budget	2017 Plan	2018 Plan	2019 Plan	2020 Plan	2021 Plan
	Metric 1: Pension/OPEB Cash should not exceed 10% of Gross Revenue							
A	Pension/OPEB Cash Amounts	477	374	361	369	356	334	344
B	Gross Revenue	5,476						
C	**% of Gross Revenue (A/B)**	**8.7%**						
	Metric 2: Pension/OPEB Cash should not exceed 40% of Operating Cash Flow before CapEx							
D	Pension/OPEB Cash Amounts	477	374	361	369	356	334	344
E	Total Operating Cash Flow	1,465						
F	Add: Pension/OPEB Cash Amounts in Line E	477	474	337	346	356	334	344
G	Operating Cash Flow Before Pension/OPEB	1,942						
H	**% of Operating Cash Flow (D/G)**	**24.6%**						
	Metric 3: Pension/OPEB Expense should not exceed 35% of Earnings Before Interest and Taxes (EBIT)							
I	Pension/OPEB Total Accrual Cost	780	607	517	448	429	414	405
J	EBIT	689						
K	Add: Pension/OPEB Total Accrual Cost	780	607	517	448	429	414	405
L	EBIT Before Pension/OPEB	1,469						
M	**% of EBIT (I/L)**	**53.1%**						
	Metric 4: Pension/OPEB Expense should not exceed $50K per active employee (2011 constant $)							
N	Pension/OPEB Total Accrual Cost	780	607	517	448	429	414	405
O	Year-End Regular Headcount *(#)*	9,247						
P	De-escalation Factor (2% per year)	1.08	1.10	1.13	1.15	1.17	1.20	1.22
Q	**$k/headcount *(constant 2011 $)* ((N/O)/P)*1000**	**77.9**						

References:

Lines A, D and F for 2015 from Ex. F4-3-2 Att. 2, p. 9 (sum of line "2015 Actual Employer Pension Contributions / Benefit Payments").
Lines A and D for 2016-2018 are sum of: (i) Ex. L-6.6-1 Staff-156, Att. 1, p. 4, line "Minimum Required Company Contribution", and (ii) Ex. F4-3-2 Att. 1, pp. 9-11, line "Estimated Employer Pension Contributions / Benefit Payments" for SPP, OPRB and LTD.
Lines A and D for 2019-2021 from Ex. F4-3-2 Att. 1, pp. 12-14 (sum of line "Estimated Employer Pension Contributions / Benefit Payments").
Line B for 2015 from Ex. A2-1-1 Att. 3, p. 114.
Line B for 2016-2018 from Ex. A2-2-1 Att. 1, p. 24 (sum of lines "Electricity Gross Revenues" and "Non-Electricity Generation Gross Margin", plus cost of goods sold reflected in the latter line).
Line E for 2015-2018 from Ex. A2-2-1 Att. 1, p. 29 (line "Net Cash from Operations").
Line F for 2016-2018 from Ex. A2-2-1 Att. 1, p. 24 (sum of "Pension Fund Contribution" and "OPEB Payments" lines)
Lines I, K and N for 2015 from Ex. F4-3-2 Att. 2, p. 9 (sum of line "Total Cost").
Lines I, K and N for 2016-2021 from Ex. F4-3-2 Att. 1, pp. 9-14 (sum of line "Total Cost").
Line J for 2015-2018 from Ex. A2-2-1 Att. 1, p. 24 (sum of "Income before Interest and Other Income" and "Other (Income)/Expense" lines).
Line O from Ex. A2-2-1 Att. 1, p. 27 and Ex. L-6.6-2 AMPCO-145, Table 2.