PRODUCTION FORECAST AND METHODOLOGY – NUCLEAR

1.0 PURPOSE

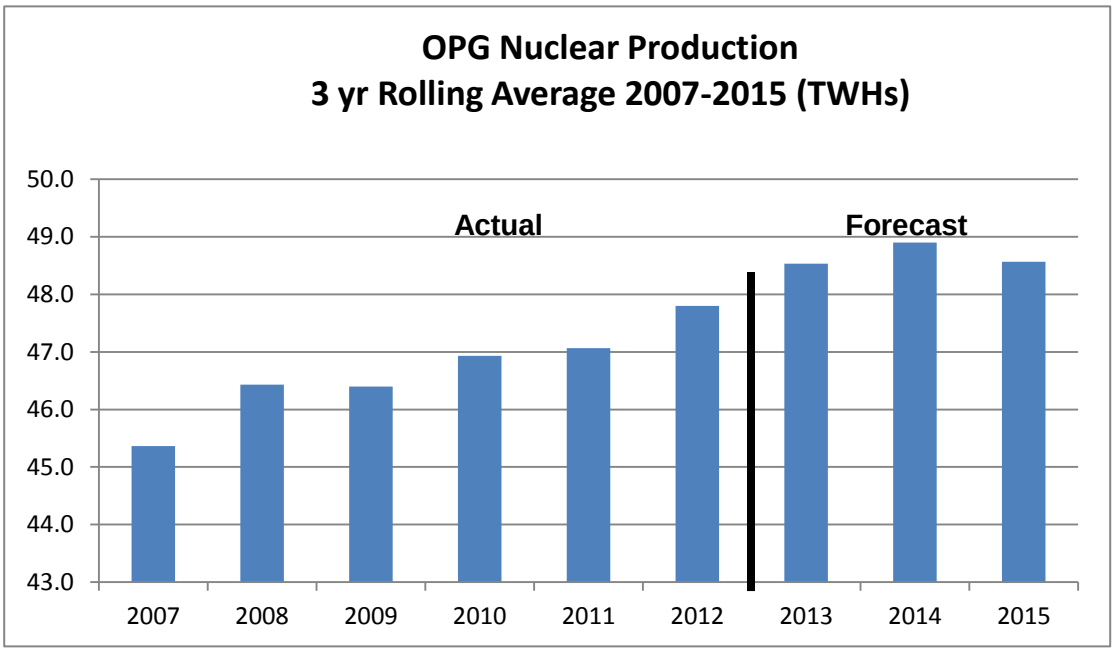
This evidence provides the production forecast for the nuclear facilities and a description of the methodology used to derive the forecast.

2.0 OVERVIEW

OPG is seeking approval of a nuclear production forecast of 49.7 TWh in 2014 and 48.0 TWh in 2015 for a total of 97.7 TWh during the test period. The nuclear production forecast for the years 2010 - 2015 is presented in Ex. E2-1-1 Table 1. A monthly nuclear production forecast for 2014 - 2015 is presented in Ex. E2-1-1 Table 2.

Nuclear production (3 year rolling average) over the period 2007 - 2015 is trending higher (see Chart 1) reflecting the success of OPG initiatives to improve planned outage execution and to reduce the number of forced outages by improving plant equipment reliability. Reliability improvement is addressed in the discussion of OPG's gap closure initiatives in the Benchmark and Business Planning evidence (Ex. F2-1-1).

Chart 1



Despite the upward trend in nuclear production, prior OEB approved nuclear production forecasts have historically projected greater generation than actual, as shown in Chart 2 below. The average production shortfall has been -3.1TWh from 2008 to 2013 resulting in a negative revenue impact of $151.9M annually over the same period. While OPG has used the same methodology (described in Section 3 below) to forecast nuclear production as that approved by the OEB in EB-2010-0008, the forecast reflects a change in OPG's performance expectations. OPG's projected FLR, planned outage days and Generation Losses[1] reflect reasonable and achievable targets that will improve forecast accuracy and avoid substantial production forecast variances as has occurred in the past.

[1] see Attachment 1 Glossary of Outage and Generation Performance Term for definitions

Chart 2

OPG Nuclear Production Variance and Revenue Impact
Chart 4; revised

OPG Nuclear Production Variances and Revenue Impact

	2008	2009	2010	2011	2012	2013	Average
Actual/Forecast -TWh (1)	48.2	46.8	45.8	48.6	49.0	48	
Board Approved -TWH (2)	51.4	49.9	50.7	50.4	51.5	51.0	
Variance -TWh	3.2	3.1	4.9	1.8	2.5	3.0	3.1
Revenue Impact - $M (3)	-159.9	-154.9	-242.4	-87.3	-121.3	-145.6	-151.9

(1) All amounts are actual with exception that 2013 is OPG Budget production forecast
(2) 2010 is average of 2008 and 2009 Board Approved; 2013 is average of 2011 and 2012 Board Approved
(3) Board Approved rates of $52.98/Mwh 2008-10 and $51.52/Mhw 2011-13 less fuel

The test period production forecast takes into account the following:

- Darlington will execute a Vacuum Building Outage (VBO) in 2015 in which all 4 units will be shutdown. The 2015 VBO eliminates a scheduled 4 unit shutdown Station Containment Outage (SCO) in 2015.
- A mid-cycle planned outage of 20 days on Pickering Units 1 in 2014 to focus on preventative maintenance and lessen the risk of future forced outages.
- An extended scope and duration for the planned outages at Pickering Units 5-8 as a result of the Pickering Continued Operations initiative (see Ex F2-2-3) equivalent to 0.5 TWh.
- Pickering's forecast FLR for 2014 is 7.8 per cent and 5.5 per cent in 2015. Pickering's FLR is trending lower (Pickering's actual FLR was 9.3 per cent in 2010, 11.6 per cent in 2011 and 7.0 per cent in 2012 as set out in Ex. E2-1-2, Table 1) reflecting expectations of improved performance due to reliability improvements.
- Darlington's forced loss rate (FLR) is 1.3 per cent in 2014 and 1.0 per cent in 2015.

- OPG has retained the 0.5 TWh allowance for major unforeseen events approved by the OEB[2] in EB-2010-0008 and has included this allowance in its production forecast.

3.0 NUCLEAR PRODUCTION PLANNING PROCESS

3.1 Methodology

Nuclear facilities are designed as base load generators. OPG's annual nuclear production forecast is equal to the sum of the nuclear generating units' capacity multiplied by the number of hours in a year, less the number of hours for planned outages, forced production losses (i.e., unplanned outages and unplanned derates, as these terms are defined in Attachment 1) and corrections for sources of Generation losses (i.e., lake temperature, grid losses, consumption (station service) as defined in Attachment 1).

OPG's nuclear planning process has not changed since EB-2010-0008 and is focused on establishing annual planned outage schedules and on calculating variances to planned generation due to forced production losses. Outage durations are determined based on the scope of work defined for each outage while considering recent benchmarking efforts and the nuclear commitment to continuous improvement. The objective is to establish a realistic and accurate annual nuclear production forecast based on the Nuclear Generation and Outage Plan, with the following deliverables:

- A planned outage schedule for all stations that includes unit outage start dates, end dates, and durations, as well as a summary of major elements comprising the scope of work that will be executed during each outage.
- Operational reliability targets such as unit capability factor and the level of forced production losses represented by the forced loss rate ("FLR").
- Generation forecasts in terawatt-hours ("TWh") for individual nuclear units and an aggregated forecast for each station.

[2] EB-2010-0008 Decision with Reasons, p. 39

The Nuclear Generation and Outage Plan is approved as part of the OPG business planning process. As discussed at Ex. F2-4-1, outage resource requirements and cost estimates for the outage OM&A budget are also tied to the Nuclear Generation and Outage Plan.

3. 1.1 Planned Outage Schedule

OPG's planned outage schedule identifies the number of days required for inspections and maintenance activities to ensure continued safe, reliable and long-term operation. The planned outage scheduled is prepared in accordance with OPG's aging and life cycle management programs and in compliance with OPG's nuclear operating licenses issued by the Canadian Nuclear Safety Commission ("CNSC").

Planned outages are complex, involving many OPG divisions and individuals working together. Outages require focus, expertise, high levels of coordination and a level of detail that exceeds major construction projects (due to regulatory complexity and constraints in work execution). The planned outage schedule also incorporates "lessons learned" from recent OPG outages and operating experience outside OPG.

Planned outages consist of a combination of "routine" inspection and maintenance activities and "non-routine" activities specific to a particular outage. Examples of routine activities would be preventive maintenance, feeder inspections and water lancing of steam generators. Non-routine activities include corrective and deficient maintenance, and replacements or modifications to the equipment or plant configuration that can only be done when the unit is shut down. The majority of work in an outage typically is routine preventative maintenance and inspection activities while the remaining work is non-routine breakdown maintenance and modifications.

Planned outages must be registered with and "time-stamped" by the IESO. OPG files its nuclear outage schedule in order to secure an early "time-stamp" date for its outages, which determines their standing in the IESO's outage queue. All outages in the queue are subject

to final approval by the IESO, which can deny this approval at any time up to the start of the outage.

For the test period, there is a single unit planned outage at Darlington in both 2014 and 2015. In addition, there is a VBO in which all 4 units will be shut down A station-wide 4 unit station VBO is required by the regulator every 12 years and a Station Containment Outage ("SCO") every 6 years. A SCO also requires that all 4 units be shut down, but for a shorter duration. A Darlington VBO was last conducted in 2009. The next planned VBO that was scheduled for 2021 has been moved forward to 2015, eliminating the need for a scheduled SCO in 2015 and a VBO in 2021. OPG is seeking regulatory approval to eliminate the need for SCO's going forward. This will shift these 4 unit station outages from a 6 year cycle to a 12 year cycle. This change will result in savings in the number of outage days in 2021 and beyond and will also reduce the complexity and resource demands during the Darlington Refurbishment Project.

The six Pickering units are on a two year planned outage cycle and therefore Pickering will be subject to 3 planned outages in both 2014 and 2015. In addition there is one mid cycle planned outage in 2014.

The outage durations include a station level allowance for uncertainty related to potential discovery work and a nuclear fleet level allowance under the control of the Chief Nuclear Officer to address risks to the completion of the outage on schedule, risks that could emerge from fleet aging issues, or the complexity in fleet level activities (e.g., availability of Inspection Maintenance Service resources to service multiple outages).

3. 1.2 Forced Loss Rate (FLR)

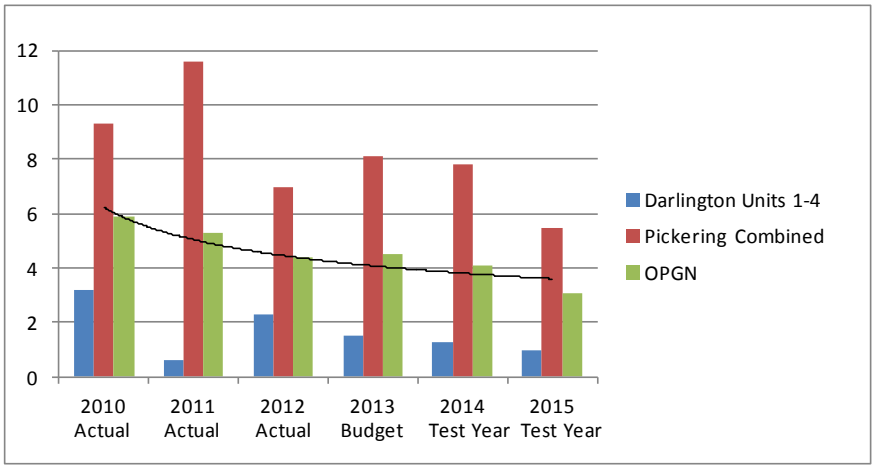
Variances to planned generation result from forced production losses (i.e., unplanned outages and derates). OPG projects FLR targets that reflect the risk of forced production losses at Darlington and Pickering. The FLR targets are based on the plants' historical performance, any known improvements or plant material condition issues, and initiatives to improve equipment reliability.

Darlington's forecast FLR for 2014 is 1.3 per cent and for 2015 it is 1.0 per cent (Ex. E2-1-2, Table 1). Darlington's FLR has been trending lower since 2010 when Darlington's FLR was 3.2 per cent mainly due to a forced outage caused by the fuel handling system. Darlington's forced outage performance is close to top quartile (calculated on a 3–year rolling average basis) for the most recent period (Ex F2-1-1, Attachment 2, 2012 Nuclear Benchmarking Report).

Pickering's forecast FLR for 2014 is 7.8 per cent and 5.5 per cent in 2015 (Ex. E2-1-2, Table 1) Pickering's FLR is also trending lower (Pickering's actual FLR was 9.3 per cent in 2010, 11.6 per cent in 2011 and 7.0 per cent in 2012) reflecting improved performance due to reliability improvements. Mid-cycle planned outages of 20 days were introduced at Pickering Units 1 and 4 starting in 2012 to allow for additional preventative maintenance which will lessen the risk of future forced outages. Another major initiative at Pickering is the 2013 - 2015 Equipment Reliability Plan to ensure Pickering's availability during Darlington refurbishment (see gap closure initiatives in the Nuclear Benchmarking and Business Plan evidence Ex. F2-1-1).

Chart 3 presents historical and forecast FLR for the nuclear facilities for the period 2010 - 2015.Chart 3

OPG Nuclear FLR (2010-2015)



LIST OF ATTACHMENTS

ATTACHMENT 1

GLOSSARY OF OUTAGE AND GENERATION PERFORMANCE TERMS

Consumption Losses: The electrical service energy consumed by a station and used to supply the electrical load for ancillary equipment and related on-site processes.

Derate: A derate is where a unit is delivering a portion but not all of its full electrical power. Derates include:

- **Planned Derate**, a planned reduction in available power generation, scheduled with the IESO at least 28 days in advance.
- **Forced Derate**, an unplanned reduction in available power generation, which can include deratings due to equipment, safety, or environmental reasons.

Forced Extensions to Planned Outages: An extension to a planned outage which is not scheduled with the IESO at least 28 days in advance, and is unavoidable because the unit is not capable of safe operation at the scheduled outage completion time (e.g., an unexpected condition discovered during the scheduled outage which drives critical path).

Forced Loss Rate ("FLR"): FLR is a WANO indicator of performance reliability. FLR is a measure of the percentage of energy generation that a plant is not supplying to the electrical grid during non-planned outage periods, because of forced production losses, i. e, and forced outages or unplanned derates. This indicator excludes forced production losses due to high lake water temperatures, and forced extensions to planned outages.

Forced Outage: a forced outage is an unplanned electricity system component failure (e.g., immediate, delayed, postponed, startup failure) or other condition that requires the unit be removed completely from service immediately and, per WANO industry performance

reporting guidelines, for which OPG did not provide at least 28 days advance notice to the IESO for the start of the outage.

Forced Production Losses: Forced production losses represent lost production due to forced outages and forced derates.

Generation losses: Represent the total generation losses that are outside of the control of plant management losses and are equal to the sum of **"**Consumption" + "Grid" + "Lake Temperature losses".

Grid Losses: Generation losses due to a reduction in electrical power generation because the grid is unable to accept the available power (due to a problem outside of the station boundary) or because of demand limitations.

Lake Temperature Losses: High lake water temperature losses result when reduced condenser efficiency results in lower generation output

Life Cycle Plan: Life cycle management is the integration of safety management, ageing management and business management decisions, together with economic considerations over the life of a nuclear power plant in order to:

- Maintain an acceptable level of performance including safety.
- Optimize the operation, maintenance and service life of structures, systems, and components.
- Maximize returns on investment over the operational life of the nuclear power plant.
- Take account of strategies for life cycle funding (including decommissioning), fuel management, and waste management.

Maximum Continuous Rating: The design, or demonstrated higher, maximum power of a unit operating continuously in MWs.

Planned Outage: A planned outage is an outage which has been scheduled with the IESO at least 28 days in advance of the start date. It is subject to final approval by the IESO, the starting time of which could be postponed up to the scheduled hour of shutdown. The schedule must include the planned completion date. The planned outage duration cannot be revised (increased or decreased) after the planned outage has commenced.

Unbudgeted Planned Outages: An unbudgeted planned outage is an emergent outage that was not included in the approved integrated nuclear outage and generation plan that underpins the business plan, but which OPG had sufficient time to notify the IESO at least 28 days prior to the start date. Although unbudgeted, this allows the outage to be categorized as 'planned' for performance reporting purposes as per WANO industry guidelines.

Unit Capability Factor ("UCF"): Unit capability factor is a standard WANO indicator of performance reliability. Unit capability factor is the percentage of maximum energy generation that a unit is capable of supplying to the electrical grid, limited only by factors within control of plant management. Unit capability factor is derived as the ratio of generation available from a unit over a specified time period divided by the maximum generation that the unit is able to produce under ambient conditions and at maximum reactor power during the same period. The available generation is reduced by planned and unplanned production losses deemed under station management's control. However, the derivation of available generation is not affected by losses due to events not under station management's control including environmental conditions (e.g., loss of transmission, lake water temperature derates, labour disputes, and potential low demand periods). While these events do impact production, they do not penalize unit capability factor as the units are considered available to produce at these times.