# Powering Ontario Together

## 2018 Report on Nuclear Collaboration

Bruce Power™

Innovation at work

ONTARIO POWER GENERATION

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# Powering Ontario Together

## A MESSAGE FROM MICHAEL RENCHECK AND JEFF LYASH

The path to success is one best taken together. With this edict in mind, Ontario Power Generation (OPG) and Bruce Power continue to build on our long-standing relationship by collaborating on initiatives that support Ontario's Long-Term Energy Plan and our Memorandum of Understanding, which outlines how our organizations will improve efficiencies during the province's nuclear refurbishment programs and throughout station operations.

Since 2016, when the first interim report on our collaboration was published, OPG and Bruce Power have experienced significant progress on the Darlington Refurbishment Project and the Life Extension Program, respectively. OPG has safely completed more than 60 per cent of the work on the Unit 2 schedule and has started the complex work of rebuilding the reactor. The project is progressing on time and on budget. At the same time, Bruce Power is more than two years into its Life Extension Program, and has signed a number of key supplier agreements as it prepares for its first Major Component Replacement (MCR) project starting in 2020. Planning for the program remains on track.

Together, OPG and Bruce Power have been engaged with the Construction Switch Initiative, an OPG program designed to streamline refurbishment activities and facilitate efficient field execution with safety and quality in mind. With the demand for skilled trades on the rise, our organizations have also been heavily focused on efforts to build skilled trades capacity in nuclear, helping to ensure a steady supply of highly qualified workers will be available to complete the work.

During all these efforts, the province's support has remained steadfast and, in a report released in 2017, the Financial Accountability Office (FAO) validated the benefits of extending the province's nuclear fleet. In the report, the FAO cites Ontario's Bruce and Darlington nuclear refurbishments as the best generating option to keep costs low for electricity customers and to protect the environment.

With contracts signed with hundreds of local suppliers and the creation of thousands of jobs in the province, the Darlington Refurbishment Project and Bruce's Life Extension Program are Made in Ontario ventures that are generating billions of dollars in economic and environmental benefits for Ontarians.

As OPG completes Unit 2 refurbishment and Bruce Power advances its Life Extension Program, we look forward to building on the relationship we have established over the years, powering Ontario together to provide clean, reliable and affordable energy for the province.

**Michael W. Rencheck**
President and
Chief Executive Officer
Bruce Power

**Jeff Lyash**
President and
Chief Executive Officer
OPG

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ONTARIO POWER GENERATION

# OVERVIEW OF Bruce Power and OPG Operations

## About Bruce Power

Bruce Power is the world's largest operating nuclear facility and is the source of approximately 30 per cent of Ontario's electricity. Formed in 2001, Bruce Power is Canada's only private sector nuclear operator and is a Canadian-owned partnership of Borealis Infrastructure Trust Management (a division of the Ontario Municipal Employees Retirement System), TransCanada, the Power Workers' Union and the Society of United Professionals. It operates eight CANDU units under long-term lease from OPG.

In December 2015, Bruce Power signed a long-term agreement with the province to refurbish six of its units over the next two decades, investing billions of private funds in these publicly owned assets.

## About Ontario Power Generation

Ontario Power Generation (OPG) operates a diversified portfolio comprising numerous generating stations: two nuclear (Darlington and Pickering), 66 hydroelectric, three thermal and one wind turbine. Through these facilities, OPG generates clean, reliable and low-cost energy, delivering about 50 per cent of Ontario's electricity.

In October 2016, after a decade of detailed planning, OPG began work on Unit 2, the first of the four units at Darlington that will be refurbished over the course of 10 years. In February 2018, the provincial government green lit refurbishment of Unit 3. And in June 2018, 60 per cent of the work on Unit 2 refurbishment had been completed on time and on budget.

As well, Pickering is a critical generating asset to the province. OPG's technical work shows the station can be safely operated to 2024 and that doing so would save Ontario electricity customers up to $600 million, avoid 17 million tonnes of greenhouse gas emissions and protect 4,500 jobs across Durham Region.

*Bruce Power Nuclear Site*

*Darlington Nuclear Generating Station*

*Pickering Nuclear Generating Station*

## Economic and Environmental Benefits

The refurbishment and continued operation of the Darlington reactors through to 2055 will see an average of 14,200 direct and indirect jobs created per year. Every dollar invested into the station results in a $1.40 increase to the province's Gross Domestic Product, thus providing an $89.9 billion boost to Ontario's economy through the project and subsequent 30 years of station operation.

At its peak, the refurbishment of the Bruce Power site will create 22,000 direct and indirect jobs annually while also securing the organization's future. The project will provide $3-$4 billion in annual economic benefit with 90 per cent of the expenditure taking place within Ontario.

The continued operation of Pickering during the Bruce and Darlington refurbishments will ensure a safe, reliable supply of electricity and will help the province avoid 17 million tonnes of greenhouse gas emissions annually, the equivalent of taking 850,000 cars off Ontario roads, over four years.

## Ontario's Refurbishment Plan

### An Overview of Bruce Power and OPG's Integrated Schedules

Ontario's 2017 Long-Term Energy Plan outlines the continued role for nuclear in the province, with the refurbishment of the units at the Bruce and Darlington sites. The successful refurbishment of Ontario's nuclear fleet will require investment in Units 3 through 8 at Bruce and Units 1 through 4 at Darlington between 2016 and 2033.

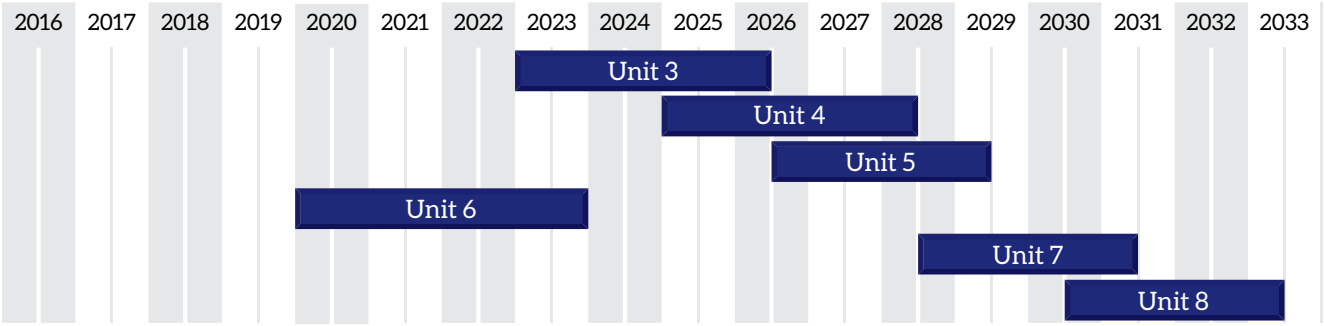
### Benefits of Collaboration

The provincial Long-Term Energy Plan encourages Bruce Power and OPG to work together to share knowledge and leverage economies of scale. The value generated through this ongoing collaboration includes improvements, risk reduction, dose reduction and more.

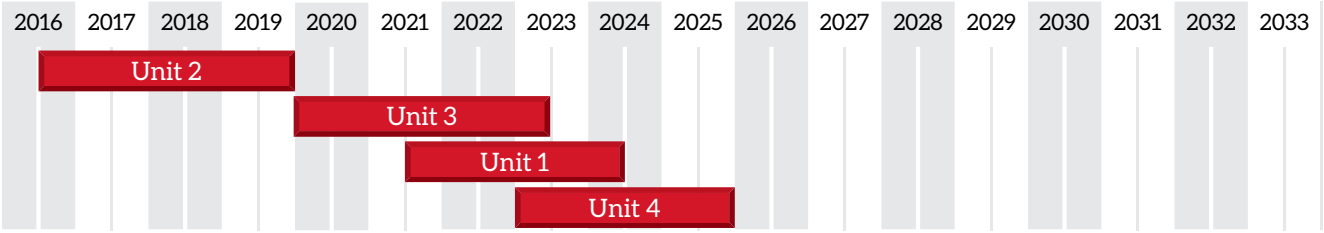
*On November 12, 2015, Bruce Power and OPG signed a Memorandum of Understanding (MOU) that was facilitated by the Ministry of Energy to formalize the collaboration between the two organizations on nuclear refurbishment and power plant operation.*

*The MOU addressed a key objective: the two companies will identify efficiencies and innovation that lower costs for ratepayers, share lessons learned on refurbishments and leverage economies of scale to ensure Ontario's refurbishments remain on time and on budget.*

## Bruce Power Refurbishment Schedule




## Darlington Refurbishment Schedule



# AREAS OF Collaboration

Bruce Power and OPG have identified a number of collaborative areas that have improved efficiencies in the planning and execution of our individual refurbishment programs.

## Asset Management and Inspection Programs

### Leveraging operational experience in Inspections

Bruce Power's Outage and Maintenance Services (OMS) and OPG's Inspection and Reactor Innovation (IRI) organizations have a long-standing relationship, having worked together to share operational experience and insights on various aspects of each other's inspections programs. IRI specializes in the inspection and maintenance of CANDU nuclear power plants in Canada and around the world. OMS delivers safe, predictable outages at optimum cost to achieve Bruce Power's commercial objectives.

Both organizations target meeting three to four times a year to discuss successes, resource training, research and development, and insights on refurbishment activities. At these meetings, they also discuss key focus areas, such as:

- fuel channel inspection programs (tooling, inspection methods and technology)
- steam generator inspection programs
- resource training and supervisor development (an exchange program is being contemplated)

*"Bruce Power and OPG are simplifying documentation and developing a streamlined approach to governance that will apply to refurbishments. Eliminating inefficiencies through our governance updates will result in millions of dollars in savings per unit."*

— Roy VanBeek, Bruce Power

## Procurement

### Aligning on parts supply

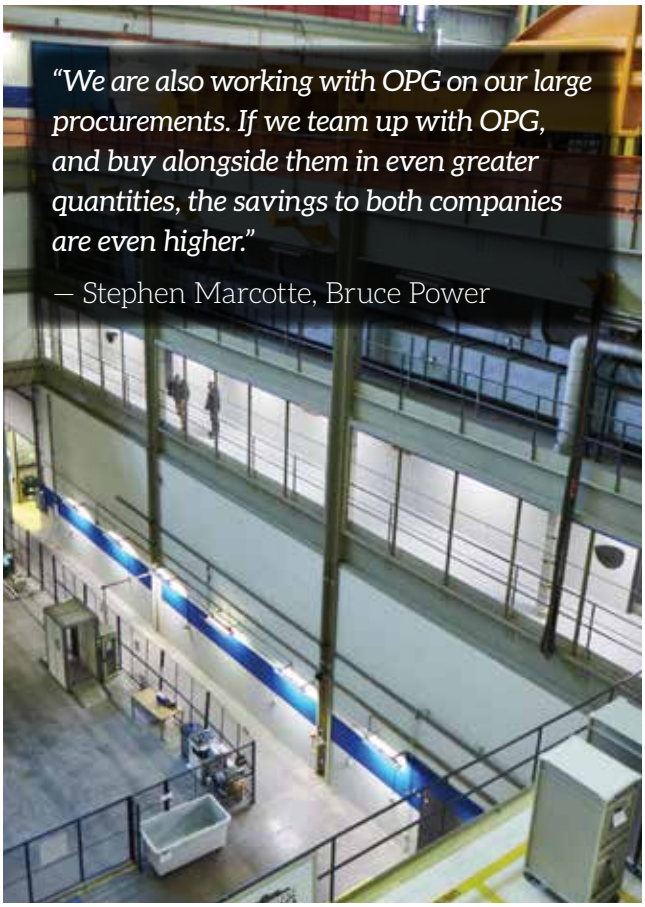
The need for similar parts along overlapping timelines has offered OPG and Bruce Power a number of opportunities for alignment, which translates into savings to the Ontario ratepayer.

"By ensuring that OPG and Bruce Power have the same component design specifications and requirements, we're enabling manufacturers to continuously produce components without changing specs or tooling; thereby, ensuring the parts can be sent where they're needed, when they're needed," says Carla Carmichael, OPG Vice President of Project Assurance and Contract Management.

The organizations have identified opportunities for savings through alignment in shared procurement and inventory of items.

The goal is to develop plans and processes that support steady supply for all nuclear fleet work while leveraging economies of scale.

> *"Using the same vendors provides assurance of the quality and supply of critical components to both organizations."*
>
> — Ken Brown, Joint Venture Group on the Darlington Refurbishment Project.



*"We are also working with OPG on our large procurements. If we team up with OPG, and buy alongside them in even greater quantities, the savings to both companies are even higher."*

— Stephen Marcotte, Bruce Power

## Common Tooling

### Optimizing calandria tube installation

OPG and Bruce Power have identified potential efficiencies in calandria tube installation through the Darlington Unit 3 Innovations Project, which was established to improve re-tube and feeder replacement performance and shorten critical path on subsequent units.

"We'll be able to increase production by adding an installation work table to each work face, doubling the number of tools available to install calandria tubes," says Greg Ferguson, OPG Project Manager of Re-tube and Feeder Replacement Tooling Innovations. "This will allow for parallel work , and support more efficient transitions between work series."

OPG will introduce these additional work tables during Unit 3 refurbishment. By adopting this change, 16 days critical path days should be saved per unit, the equivalent of 48 days over the course of the Darlington Refurbishment Project.

## Replacing Major Components

**Minor improvements promise major time and cost savings**

It's a fact — foreign material, such as metal shavings from feeder tubes and steam generator nozzles, can result in costly complications during refurbishment, which would lead to delays.

"The MCR project is operating on a firm, fixed cost and duration," says Brock Leighton, Bruce Power MCR = Balance of Plant Senior Program Manager. "Predictable delays like this cannot happen [on the project]."

The prevention strategy is simple: install strainers in fuel channels to catch all foreign material before they damage the fuel or the fuel channels themselves.

The strainer solution was first implemented at Bruce Power during the commissioning of Unit 4. To prevent potential complications or costly delays on the MCR, Bruce Power has opted to install the strainers in each of the 480 fuel channels. Since they haven't been used on site for more than 20 years, the team has been reviewing past designs, installation/removal strategies and prototype testing to determine the best path forward.

Bruce Power has also consulted with OPG for lessons learned.

"Operational experience allowed us to make incremental improvements," says Martin Taylor, Bruce Power Owner's Engineer. "Those improvements will mean the difference between remaining on schedule and on budget, and experiencing delays and cost increases."

## Waste Management

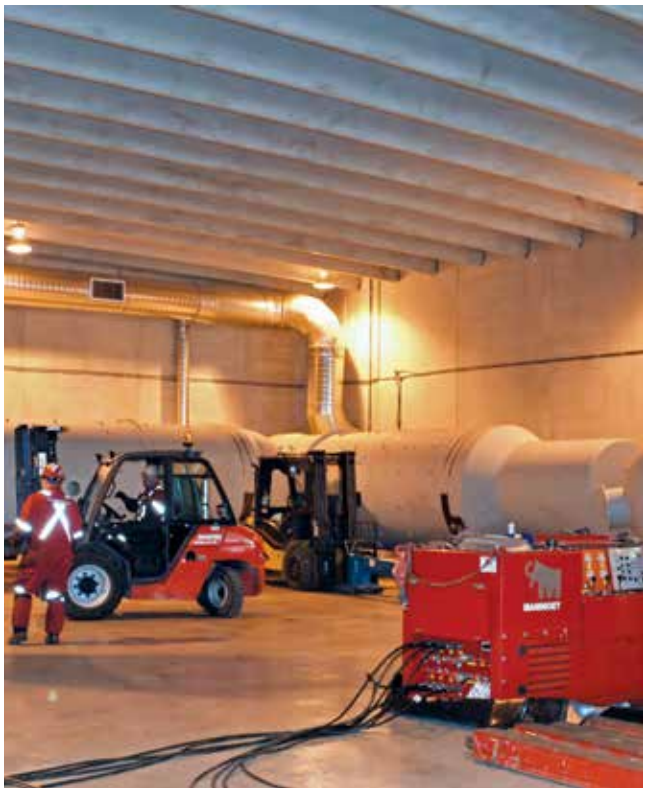
### Space optimization avoids costs

"It's a bit like Jenga," says Dwayne Sommer, Bruce Power MCR Construction Front Line Manager, about the process used to create extra storage space for 16 steam generators inside their Steam Generator Storage Building at OPG's Western Waste Management Facility.

"The time and money that would go into building a new storage facility would be significant," says Jeff Phelps, Bruce Power Vice-President of Major Projects. "Instead, we reviewed all potential options and came up with a simple solution that would save money, space and time."

To make space, the team reconfigured the generators currently on-site by safely jacking up the 110-tonne steam generators and placing them on skates, then repositioning them onto storage saddles.

Lise Morton, OPG Vice-President of Nuclear Waste Management reported: "It's a great demonstration of teamwork and cooperation among five different companies: including OPG and Bruce Power, to ensure the safe execution of work in the field."



## Labour Arrangements

### Filling the gap in skilled trades

As of 2020, OPG and Bruce Power will have parallel refurbishments underway, which will mean concurrent demand for highly skilled tradespeople to complete the work.

And with various disciplines of trades soon to be in short supply and the nuclear industry projecting further shortages, planning is underway to ensure the right people are available for work at the right time on both mega-projects.

"It demands a multi-pronged approach," says Carla Carmichael, OPG Vice President of Project Assurance and Contract Management.

First, the two companies are working together to optimize schedules to minimize having the same trades in demand at both sites at the same time, where budget and timelines allow.

Second, work is being done to build capacity within the current skilled trades workforce.

Third, efforts are being made with industry stakeholders to increase the number of people entering the trades, in part, by encouraging women, members of Indigenous communities and people who are new to Canada, to join the nuclear workforce.

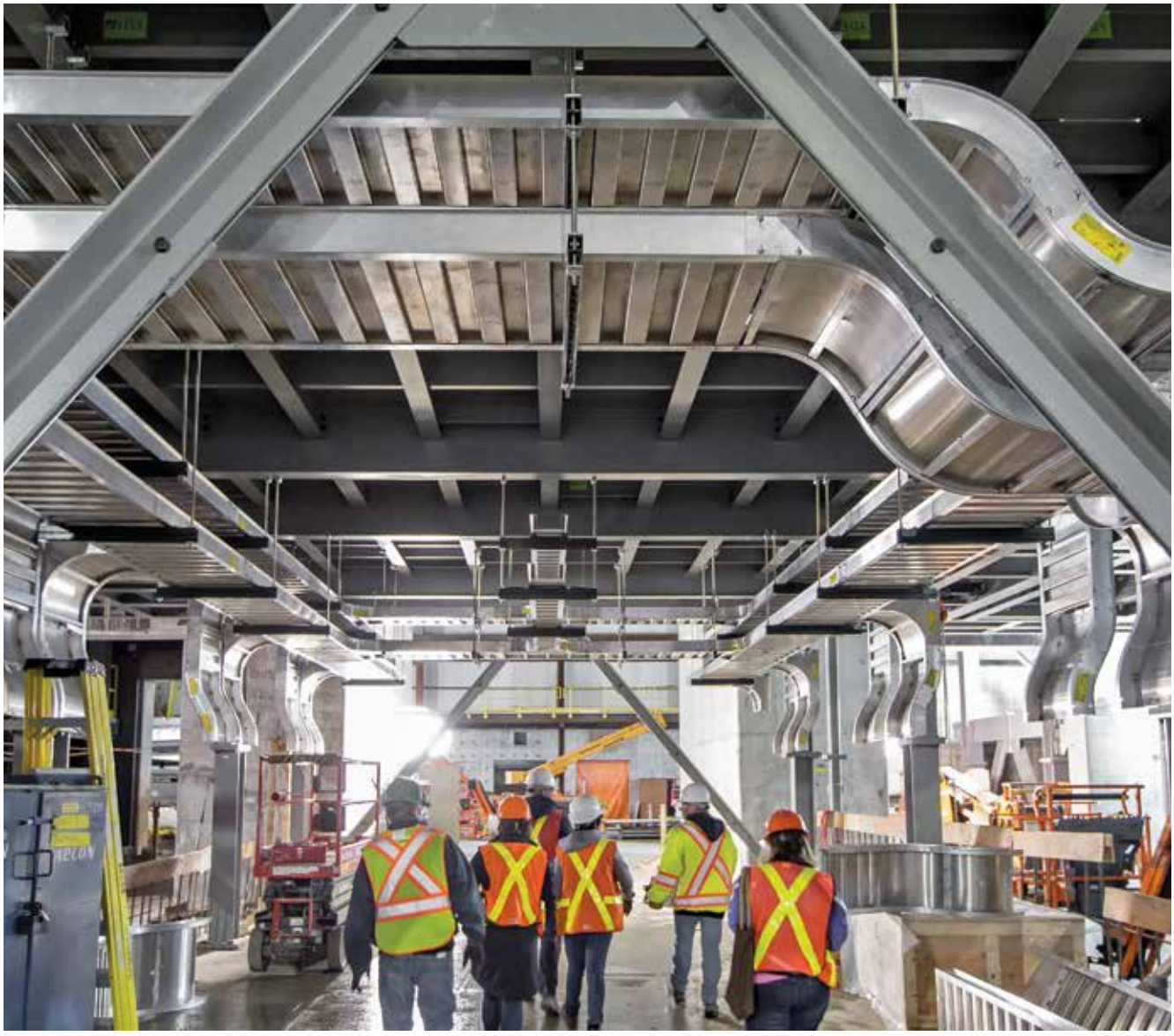
"Diversity and inclusion are key to this plan," says Carmichael. "It's a diverse workforce that will get these jobs done."

## *Building capacity for the future*

*OPG and Bruce Power recently launched two programs aiming to build skilled trades capacity within the nuclear industry.*

*OPG's Indigenous Opportunities in Nuclear program (ION) is recruiting and placing members of First Nations, Inuit and Métis communities in positions at OPG, union halls and vendor partner organizations. Partnered with Kagita Mikam Aboriginal Employment and Training agency, ION aims to increase the OPG Nuclear Indigenous complement from 1.7 per cent to 2.4 per cent, mirroring the provincial workforce availability.*

*Meanwhile, Bruce Power has established a four-year, $100,000 Indigenous scholarship program, which will trigger another $100,000 in matching funds by the Government of Canada. The scholarship will benefit First Nation and Métis students in their region, by promoting, supporting and celebrating the achievement of First Nations, Inuit, and Métis people — youth in particular.*



# Bruce & Darlington Refurbishments

Collectively leveraging an investment of $26 billion, the refurbishments at Bruce and Darlington represent the two largest infrastructure projects in Canada.

A study conducted by the Conference Board of Canada concluded that the refurbishment of Darlington would contribute $15 billion to Ontario's GDP over the course of the project, with employment increasing by an average of 8,800 jobs and peaking with 11,800 jobs between 2014 and 2023.

Operating Darlington post-refurbishment will secure approximately 5,700 resident jobs in Durham Region until the 2050s.

A similar study conducted by the Canadian Council for Public-Private Partnerships for the Bruce site concluded that during normal operations, Bruce supports 18,000 direct and indirect jobs every year and delivers $4 billion in annual economic benefit.

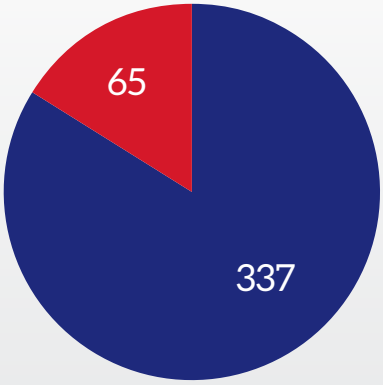
During Bruce Power's Life Extension Program, the sites will support an additional 5,000 jobs per year and contribute an additional $1.7 billion — $2.3 billion in economic benefit annually, through direct and indirect spending on operational equipment, supplies, materials and labour in the province.

Darlington Nuclear

# 2017 SUMMARY OF Document Sharing

This diagram illustrates the ongoing interaction between Bruce Power and OPG in 2017.

## OPG Documents Shared with Bruce Power

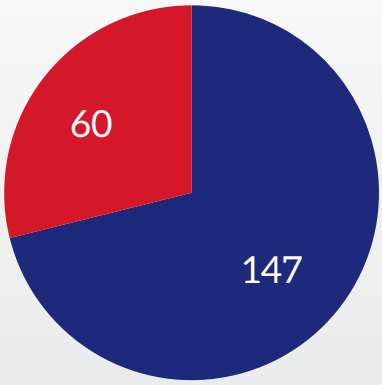



OPG Documents disclosed to Bruce Power

OPG Documents not disclosed to Bruce Power

Total # of Documents Requested by Bruce Power in 2017 = 402

## Bruce Power Documents Shared with OPG




Bruce Power Documents disclosed to OPG

Bruce Power Documents not disclosed to OPG

Total # of Documents Requested by OPG in 2017 = 207

* Documents requested includes all types of documentation, including refurbishment procedures, technical aspects, project management, and some cases designs, and lessons learned.

** Not all documents could be shared because of commercial or intellectual property restrictions. Also some requests were being processed at the time this report was prepared.

# Looking Ahead

OPG and Bruce Power's long-standing relationship is built on a strong spirit of collaboration, driven by our individual innovative efforts.

Through another collaborative partnership, Darlington Nuclear will become the first large-scale commercial nuclear power station world-wide to produce molybdenum-99 (Mo-99), ensuring the world's long-term supply of the critical medical isotope used in more than 30 million life-saving diagnostic and medical treatments each year. Along the same lines, Bruce Power produces cobalt-60, which sterilizes medical equipment and is used in the treatment of brain tumours for millions of patients worldwide.

As we progress on the province's refurbishment programs, each organization is applying collaborative and innovative approaches to ensure we deliver the best value to Ontario's ratepayers.

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