Bruce Power: Canada’s Largest Public-Private Partnership

A CASE STUDY ON DELIVERING CLEAN, AFFORDABLE ELECTRICITY AND INVESTMENT IN INFRASTRUCTURE

2001-2015

August 2015
Canada currently has over 235 public-private partnerships (P3s), with the largest, and one of the more unique, being Bruce Nuclear Generating Facility.
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PUBLIC-PRIVATE PARTNERSHIPS

In 2001, the Bruce Power Public-Private Partnership received the Gold Award for Infrastructure by the Canadian Council for Public-Private Partnerships (CCPPP) in its National Awards for Innovation and Excellence in Public-Private Partnerships, and it has proven worthy of that gold standard over the following 14 years.

During that time, Bruce Power has invested $10 billion of private money into the publicly owned site, while doubling the number of operational units from four to eight. Having returned the site to its full potential, the company is now gearing up for a possible multi-year, multi-billion dollar investment program to extend the life of Units 3-8, so they can provide stable, safe, low-cost and reliable power to the province for decades. The long-term, annual economic impact of operating the facility will result in 18,000 direct and indirect jobs annually, and $4 billion in annual economic benefit. This vision is consistent with Ontario’s Long-Term Energy Plan (LTEP), which was released in 2013.

Bruce Power is Canada’s only private sector nuclear generator and the largest operating nuclear facility in the world. The company produces 6,300 megawatts (MW) – over 30 per cent of Ontario’s electricity – from its site on the shore of Lake Huron. It is a Canadian-owned partnership of the Ontario Municipal Employees Retirement System (OMERS), TransCanada Corporation, the Power Workers’ Union (PWU) and The Society of Energy Professionals. In addition, a majority of the employees on the site are also investors in the business.

The site is leased from the Province of Ontario under a long-term arrangement where all of the assets remain publicly owned, while the company is responsible for operating and investing in the units, including refurbishment and maintenance costs. Bruce Power is also responsible for waste management costs, while contributing to fund the decommissioning of the facilities at their end of life.

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This case study will review the successes and challenges over the last 14 years of this innovative arrangement, evaluating its value, and looking at its future role in Ontario’s LTEP.

A public-private partnership (P3) involves a joint venture between government and the private sector to deliver important services to the public. The vast majority of these tend to be focused on the delivery of large infrastructure projects. Canada currently has over 235 P3s, with the largest, and one of the more unique, being Bruce Power.

The Bruce Power P3 achieves a number of key goals for the province, including keeping electricity prices low for families and businesses, and investing private dollars into public assets without impacting the province’s balance sheet in the process. This allows the province to focus on meeting its own fiscal targets and supporting programs like health care and education. This is a model that has served Ontario well over the last decade and will be essential moving forward.

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The Bruce site is leased from the Province of Ontario under a long-term P3 arrangement, where all of the assets remain publicly owned and the company is responsible for operating and investing in the units.

87% of Bruce Power employees also invest in the site.

Over 30% of Ontario’s electricity comes from Bruce Power.

FIGURE 1 BRUCE POWER OWNERSHIP

BRUCE A
- OMERS (Borealis) 48.87%
- TransCanada 48.87%
- PWU 1.77%
- Society 0.22%
- Employee Trust 0.24%

BRUCE B
- OMERS (Borealis) 61.37%
- TransCanada 31.60%
- PWU 5.26%
- Society 1.75%

SITE AND ASSETS
- Province of Ontario 100%
The nuclear industry in Ontario has an impressive and dynamic past dating back more than 50 years when the provincial government, through Ontario Hydro, began an unprecedented period of construction on a reactor fleet of 20 units on the Bruce, Pickering and Darlington sites. All of the units on the Bruce site, when brought into operation beginning in the 1970s and ‘80s, had strong operational performance and were viewed as some of the best CANDU units in the world. From a cost-competitiveness point of view, they provided the province with a reliable source of low-cost electricity.

The build program – in Bruce and Pickering in the 1970s and ‘80s in particular – were viewed as a tremendous success, and the industry had built a strong capability to execute both operations and projects by leveraging its immense economies of scale.

In the early-1990s, a dramatic shift took place in Ontario’s nuclear industry, as demand slowed due to global economic factors and the performance of Ontario’s CANDU fleet declined. Ontario Hydro was challenged moving from a nuclear construction company to an operating organization. These factors led to a decision to lay up Bruce A’s four units, as well as the Pickering A units. It was a difficult time for the 1,800 employees at the station and their families as many employees had to leave the area to find employment. This caused economic devastation for local businesses, a decline in real estate prices, schools being closed and almost a general depression in the area. The lost output was replaced largely with coal-fired generation, which also assumed a role as a baseload supplier. In the late-90s, Ontario Hydro was divided into a number of successor companies and all generation assets were placed under the control of a new company called Ontario Power Generation (OPG).
When OPG was formed, it was given a mandate to ‘de-control’ its generating assets at a certain pace and the first site to be moved into this new model was the Bruce Nuclear Generating Facility.

In July 2000, after an extensive and competitive process lasting several months, an agreement was reached between OPG and Bruce Power, for the lease of the Bruce facility. One possible issue that had to be addressed was the fact there was no funding for the decommissioning of the facilities set aside for when the site reached end of life. This was something Bruce Power would support a solution to as part of the agreement. The transaction included a lease agreement for the facility and a series of ancillary agreements. In addition to leasing the power plants and related systems, Bruce Power also acquired nuclear fuel and other assets. The initial lease term was for 18 years plus options to extend up to an additional 25 years. It included lump-sum payments including the first one on the date Bruce Power was formed – May 11, 2001 – for $370 million.

The characteristics of this transaction included:

- The Bruce assets would remain owned by the province and leased to Bruce Power
- Bruce Power would assume operational risk related to the facility
- Private investment would be required to meet all capital requirements from the Bruce site
- Bruce Power would generate competitively priced electricity
- Bruce Power would fund long-term liabilities for waste management and decommissioning
- Like all nuclear facilities in Canada, the Bruce Power site would be federally regulated
- Both unions representing employees on site, the Power Workers’ Union and The Society of Energy Professionals, would have an equity position in the company
- Collective Agreements with the PWU/Society would be inherited by Bruce Power

Consistent with this, Bruce Power’s focus was to return additional generation to the power grid and the company embarked on a decade-long investment program to return the Bruce site to its 6,300 MW capability, significantly extending the operating life of the provincially owned assets.

However, early in this process there were those who were skeptical of a private company taking over the Bruce site. There was some concern that private participation would result in putting commercial success ahead of safety. From the very beginning Bruce Power set out a list of values the company would live by with an emphasis on people being key to Bruce Power’s success. These values guide the conduct, decision-making and relationships of the company to ensure business is carried out in an ethical, respectful, safe and professional manner. They have lived up to these standards ever since.

The source of 30 per cent of Ontario’s electricity and employing more than 4,000 people on a permanent basis, the Bruce Power site has been the single largest source of Building Trades work in Ontario over the last 10 years.
**HISTORICAL TIMELINE**

**2001**
Bruce Power assumes operational control of the site and confirms plans to restart Units 3 and 4. Terrorist attacks in the U.S. prompt the formation of a full-time, rapid-response, armed security force at Bruce Power.

**2002**
Ontario’s electricity market opens to competition. TransCanada Corp. and BPC Generation Infrastructure Trust (OMERS) join Cameco, the PWU and the Society in the Bruce Power partnership while British Energy withdraws.

**2003**
Units 5, 7 and 8 at Bruce B remain online to help restore power to the grid after a massive blackout leaves large parts of Ontario and the northeastern U.S. without power. Unit 4 is returned to service after being shut down by Ontario Hydro in 1998.

**2004**
Unit 3 returns to service after being taken off-line by Ontario Hydro in 1998.

**2005**
A multi-billion dollar agreement is reached between Bruce Power and the Ontario Power Authority to pave the way for the refurbishment of Units 1 and 2, shut down since 1997 and 1995 respectively.

**2006**
Bruce Power celebrates its 5th anniversary on May 11 when Lieutenant Governor James Bartleman officially opens a new Support Centre. Bruce B finishes the year as the top performing multi-unit nuclear plant in Canada.

**2007**
History is made in Unit 2 with the installation of the first steam generator ever to be replaced in a CANDU reactor. Bruce Power establishes a multi-year agreement to power the Rogers Centre in a marketing partnership with the Toronto Blue Jays.

**FIGURE 2** BRUCE POWER’S CUMULATIVE AMOUNT OF INVESTMENT ON THE BRUCE SITE

<table>
<thead>
<tr>
<th>Year</th>
<th>Investment (Millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>0</td>
</tr>
<tr>
<td>2002</td>
<td>2,000</td>
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<tr>
<td>2003</td>
<td>4,000</td>
</tr>
<tr>
<td>2004</td>
<td>6,000</td>
</tr>
<tr>
<td>2005</td>
<td>8,000</td>
</tr>
<tr>
<td>2006</td>
<td>10,000</td>
</tr>
<tr>
<td>2007</td>
<td>12,000</td>
</tr>
</tbody>
</table>
2008
A protocol agreement is signed with the Saugeen Ojibway Nation.

2009
Bruce Power introduces dynamic capability to support changing market conditions.

2010
Employees on the Bruce site achieve 22 million injury-free hours. The last of the Bruce B units, Unit 8, is up-rated to 93%.

2011
A Fukushima Response Program is launched on site after earthquakes and a tsunami in Japan cripple the Fukushima Daiichi nuclear facility. Bruce Power celebrates its 10th anniversary on May 11 with a site-wide barbecue and scholarship program for area students.

2012
Staff and contractors return Units 1 and 2 to service, while life-extension programs are completed in Units 3 and 4. A new Emergency Management Centre is installed in the Visitors’ Centre. Bruce Power is recognized as one of Canada’s top employers for young people.

2013
On April 22, for the first time in about two decades, all eight units on the Bruce site were providing electricity to Ontario’s grid.

2014
Entered 2014 having broken a site record for production from 1991, producing 30% of Ontario’s power and over half its nuclear in 2013.

2015
Canadian Nuclear Safety Commission renews Bruce Power’s operating licence for five years.
Nuclear and Ontario’s Long-Term Energy Plan

Ontario’s Long-Term Energy Plan (LTEP), entitled *Achieving Balance*, identifies a refocused, yet critical role for nuclear power in the province moving forward. The LTEP focuses on the following five principles: cost-effectiveness, reliability, clean energy, community engagement with an emphasis on conservation and demand management. Ontarians are currently benefiting from a clean, reliable and affordable energy system largely due to nuclear energy generation. Refurbishment received strong province-wide support during the 2013 LTEP consultation process mainly for the following reasons. First, refurbished nuclear is the most cost effective generation available to Ontario for meeting baseload requirements. Second, existing nuclear generation stations are located in supportive communities having access to high-voltage transmission, and third, nuclear generation produces no greenhouse gas emissions. The LTEP has pragmatically focused Ontario’s nuclear industry on the successful refurbishment of the Bruce and Darlington facilities, which will combine to meet 45 per cent of Ontario’s electricity supply needs.

This plan also indefinitely defers the construction of new reactors and begins to plan for the end-of-life of the Pickering units. This means that nuclear refurbishment will be a central focus to secure baseload nuclear in the long term. This is an area on which Bruce Power and OPG continue to collaborate. The LTEP clearly states that nuclear refurbishment will follow specific principles established by the government, including minimizing commercial risk to the government and the ratepayer, having appropriate and realistic off-ramps and scoping, and ensuring that operators and contractors are accountable for refurbishment schedules and price.

The government will encourage Bruce Power and OPG to find ratepayer savings through leveraging economies of scale in the areas of refurbishment and operations such as arrangement with suppliers, procurement of materials, shared training, lessons learned, labour arrangements and asset management strategies.

Nuclear power will continue to play a central role in the province’s energy system, providing a reliable source of affordable, clean electricity, largely meeting core baseload requirements. The role of nuclear will also provide price stability and predictability over the long term.

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*While Conservation First is an important element of the LTEP, a clean, reliable and affordable supply of electricity also requires a diversity of generation types.*

- *Ontario’s Long-Term Energy Plan*

*The nuclear industry generates $2.5 billion in direct and secondary economic activity in Ontario every year.*

*Retaining this nuclear expertise is crucial.*

- *Ontario’s Long-Term Energy Plan*

More information on Ontario’s Long-Term Energy Plan can be found here: [www.energy.gov.on.ca/en/ltep](http://www.energy.gov.on.ca/en/ltep)
Attributes of Bruce Power’s Public-Private Partnership

1. Investing in public assets
2. Management of long-term liabilities
3. Improving safety and the operational performance of the Bruce site
4. Provincial policy goals
5. People
6. Economic impact
7. Competitively priced electricity
8. Building public confidence
9. Independent Safety Regulator
10. Role of the IESO
1. Investing in public assets

One of the foundational attributes about public-private partnerships (P3s) is that they are always publicly owned. In the case of Bruce Power, this means the assets on the Bruce site remain owned by the Province of Ontario yet operated by Bruce Power, while the company’s partners meet all investment requirements. This ensures that all the investment required to secure the role of Bruce Power as outlined in the LTEP can be achieved without negatively impacting the balance sheet of the taxpayers of Ontario, allowing the government to stay focused on priorities like health care and education, while also working to manage the provincial budget.

This innovative economic engine also has an innovative ownership structure with TransCanada Corp. and OMERS, which represents about 500,000 plan members in the province’s public services.

While returning four dormant units to service over the past decade, Bruce Power and its industry partners have engineered and developed first-of-a-kind technology to do what many thought was impossible - breathe new life into reactors that were shut down by the former Ontario Hydro in the 1990s.

Bruce Power has made considerable progress in its first 11 years of operation in dramatically increasing the output from our site. In 2002, Bruce Power’s first full year of operation, the site produced just over 20 TWh of electricity. In 2012, the site generated 35 TWh, and last year, the site produced over 45 TWh. This is due to major investment programs completed in both Bruce A and B over the last decade. Ratepayers and homeowners have reaped the benefits of this private investment by getting low-cost, carbon-free power from the assets they continue to own, not to mention the secondary economic benefits felt across Ontario through jobs for contractors and an influx of money into local communities.

Through equipment investment and maintenance outages since 2001, the company has successfully carried out
hundreds of thousands of asset enhancement projects and investment programs, which have resulted in industry-leading success both in improving the performance of the Bruce Power units and extending their operational lives.

In 2013, the Ministry of Energy released its LTEP, which outlines the role of nuclear and the Bruce site in the future of the province’s energy supply mix. The LTEP stated Bruce Power would contribute 6,300 MW to the supply mix for decades to come. An innovative and highly technical refurbishment strategy for Units 3-8 will see billions of private dollars invested in these provincially owned assets over a 20-year period, extending their life providing stable, low-cost electricity.

This massive investment – most likely to be the largest ongoing infrastructure program in the province for upwards of two decades – will create about 5,000 direct and indirect jobs annually and $1 billion in annual economic benefit through equipment, supplies and materials. In addition, Bruce Power will continue with its planned renewal program, investing private dollars into publicly owned reactors, allowing them to safely and reliably produce 30 per cent of Ontario’s electricity at 30 per cent below the average price of power, while creating zero carbon emissions.

Since 2001, and through $10 billion of investment, the company has successfully:

- Enhanced the operational performance life of running units through strategic investments and ongoing investment in the plant.
- Made enhancements to Bruce A Units 3 and 4 to return the units to service and extend their operational life.
- Fully refurbished Units 1 and 2, replacing all major components such as the reactor core, steam generators, feeder tubes and electrical systems.

The investment Bruce Power has made – and continues to make – improves the operational performance of each asset, which is good for the company, the Province and taxpayers.

Since 2001, Bruce Power has invested $10 billion into public assets.
2. Management of long-term liabilities

As part of this innovative P3 model, Bruce Power has the responsibility for funding long-term liabilities of the nuclear site including waste and decommissioning. Under the current structure, Bruce Power pays OPG lease payments to ensure these are funded.

This means when the reactors reach their end-of-life, the cost to decommission the site has already been set aside. It also means Bruce Power sets aside funds to manage waste products from its operation. The company pays an ongoing fee to OPG to cover the low- and intermediate-level waste, as well as the used fuel stored at the Western Waste Management Facility, which is owned and operated by OPG and located on the Bruce site. In accordance with the Ontario Nuclear Funds Agreement (ONFA) between OPG and the Province, OPG established a Used Fuel Segregated Fund and a Decommissioning Segregated Fund (together the ‘Nuclear Funds’). The Used Fuel Fund is intended to fund expenditures associated with the management of used nuclear fuel bundles, while the Decommissioning Fund was established to fund expenditures associated with the disposal of low- and intermediate-level nuclear waste materials.

OPG maintains the Nuclear Funds in third-party custodial accounts that are segregated from the rest of OPG’s assets. Since Bruce Power was created, it has paid OPG over $3.5 billion in lease payments.
3. Improving safety and the operational performance of the Bruce site

Bruce Power has made considerable progress in its first 14 years to increase the output and operational performance from its site, while ensuring the highest level of safety. Given the nature of Bruce Power’s business, as with all nuclear facilities, a high percentage of its costs are fixed so it’s essential to get the most out of the generating assets through maximizing operational effectiveness. A key element to improving the operational performance of a nuclear site is a continuous focus on safety, which goes hand in hand with commercial success. The best performing and most efficient nuclear plants in the world all have strong safety performance. In 2001, Bruce Power established its number one value of Safety First and the focus on safety has never wavered despite a high level of activity on site. As the company increased its output and improved efficiency it has achieved industry-leading industrial safety performance.

Since 2001, Bruce Power has invested $10 billion into site improvements and Ontario’s economy. As part of its long-term vision, Bruce Power plans to continue its site revitalization work and will invest $1 billion a year over the next 15 to ensure its remaining units provide safe, clean and reliable electricity for generations.

Bruce Power has not only increased its output but demonstrated strong operating performance through improved equipment reliability, leading to low forced-loss rates. Industry best practice has shown that a strong equipment reliability program is directly tied to long, reliable and safe operations. As the company has increased its equipment reliability index through replacing and repairing equipment, it has realized record runs at both Bruce A and B.
The renewal of Bruce A, which began with the return of Units 3 and 4 in 2003 and the continued modernization of Bruce B, have proven that Bruce Power’s nuclear fleet can be revitalized.

With the revitalization effort operating performance has steadily improved across the site.

- Bruce B was the top performing multi-unit CANDU plant in the world in 2014 and was recognized internationally, being awarded the Institute of Nuclear Power Operators (INPO) award of excellence in recognition of its world-class performance. In doing so, Unit 5 also surpassed 500 days of continuous operation. The unit, one of the top performing CANDU reactors in the world, played a key role in the success of Bruce B in 2014, which provided over 15 per cent of Ontario’s electricity.

- Bruce A achieved its first full calendar year of four-unit operation since the units were removed from service in the 1990s. Over the past 10 years, Unit 4 has consistently been one of the top CANDU units in the world.
All eight units at Bruce Power now provide up to 2,400 megawatts of flexible, emissions-free generation to the Ontario market to manage changing supply and demand, duplicating many of the dynamic attributes that coal used to provide the Ontario market.

As Bruce Power moves forward to renew, consistently modernize and extend the life of its nuclear fleet, it will build on lessons learned and the experience gained over the last decade, ensuring a greater certainty and predictability in future projects.

More broadly, completion of the new Bruce-to-Milton transmission line, in combination with the successful revitalization of Bruce A and continued strong Bruce B operating performance, delivers 6,300 MW of carbon-free energy to the people of Ontario. This has assisted the province in its plan to shut down coal plants and improve the health of Ontario residents.

Bruce Power has continued to demonstrate it can improve the operational performance of the units on site, while carrying out asset management work in parallel as outlined in a number of key performance indicators, including the Forced Loss Rate (FLR). Bruce Power has made significant improvements in its FLR, which essentially measures the amount of time a nuclear unit is not producing electricity when it was planned to be operating. This is a standard and important metric across the nuclear industry and the FLR performance at both Bruce A and B has been improving consistently since 2004. At Bruce A, Units 3 and 4 were returned to operation in 2004 after being out of service for nearly seven years and the performance on average from these units has continued to improve.

Since the return to service of Units 1 and 2 in 2012, these units have demonstrated strong operational performance, especially recognizing these units had been out of service for two decades. It has been more than 10 years since Units 3 and 4 were returned to operation and their performance over the past decade has been very strong.

As outlined in Figure 8, through investments and focus on excellence in operations, the additional life added from Units 3 and 4 has been significant, providing additional flexibility related to the refurbishment timing for these units, which are likely to be the next units to be refurbished in the province. Also outlined in Figure 8, through investments and focus on excellence in operations, the additional life added from the Bruce B units has been significant, providing additional flexibility related to the refurbishment timing for these units. Bruce Power’s ability to effectively manage asset life is a key consideration to manage investments going forward.
### FIGURE 8 BRUCE A AND B ASSET LIFE MANAGEMENT RESULTS

<table>
<thead>
<tr>
<th>UNIT</th>
<th>ORIGINAL</th>
<th>REVISED</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>n/a</td>
<td>2043</td>
<td>+30 years</td>
</tr>
<tr>
<td>2</td>
<td>n/a</td>
<td>2043</td>
<td>+30 years</td>
</tr>
<tr>
<td>3</td>
<td>2009</td>
<td>2021</td>
<td>+12 years</td>
</tr>
<tr>
<td>4</td>
<td>2007</td>
<td>2021</td>
<td>+14 years</td>
</tr>
<tr>
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<td>+3 years</td>
</tr>
<tr>
<td>8</td>
<td>2018</td>
<td>2021</td>
<td>+3 years</td>
</tr>
</tbody>
</table>

*interim targets

+ 100 years
4. Provincial policy goals

The unique P3 structure of Bruce Power also allows the company to align itself with the energy policy goals of the Province. Since 2001, the provincial policy goals have been to phase out coal in order to lower greenhouse gas emissions and ensure the province has a reliable but flexible supply of electricity even though energy efficiency has reduced demand.

**COAL PHASE-OUT**

In the early-2000s the provincial government committed to phasing out coal from its energy mix portfolio – a goal met in April 2014. The phase out of coal saw a significant reduction in the province’s level of harmful GHG emissions, and the number of smog days plummeted from 53 in 2005 to zero in 2014. The people of Ontario now have cleaner air thanks in large part to cleaner energy sources, including a revitalized Bruce site, which provided 70 per cent of the energy the province needed to shut down coal for good. From a full life-cycle analysis, nuclear power and wind are similar in magnitude when it comes to GHG emissions – the lowest of all energy options.

Ontario was the first jurisdiction in North America to end its use of coal-fired electricity when it closed the Thunder Bay Generating Station in April 2014. This was a multi-year effort that not only decreased the average Ontarian’s environmental footprint, but also resulted in a financial benefit to the province. According to a 2005 Ministry of Energy report, phasing out coal could avoid 25,000 emergency room visits, 20,000 hospital admissions and 8.1 million illness cases, resulting in a financial benefit of $2.6 billion annually. Much of this success was made possible by Ontario’s nuclear industry – without it, phasing out coal and still having a reliable supply of energy would have been almost impossible.

Having a balanced supply mix that allows for the continued advancement of renewable technology, while ensuring clean air, can occur with the continued operation of Ontario’s nuclear fleet. This continued operation would allow Ontario to maintain, build from and realize its success of shutting down coal.
A study conducted by the Canadian Medical Association indicated that, in 2008, the economic costs of air pollution topped $8 billion, an annual cost expected to accumulate to over $250 billion by 2031. These associated costs include premature deaths, hospital admissions, emergency department visits, minor illnesses and doctors’ office visits. Therefore, if air pollution is causing an economic burden, there are opportunities for savings if the right decisions are made. Between now and 2040, the total accumulated savings to our health care system through the end of coal-fired generation will be $70 billion. To put this in perspective, $70 billion is nearly enough money to run Ontario’s entire health care system for 1.5 years.

The Bruce site provided 70 per cent of the energy Ontario needed to shut down coal for good.

SYSTEM RELIABILITY

As Ontario moves forward, it will be important to ensure a balanced supply mix, with emissions-free options, is pursued. Bruce Power provides more than 30 per cent of Ontario’s electricity every day from its site, which is fully serviced by new transmission infrastructure. When looking at the electricity infrastructure for the province, supply sources and demand, Bruce Power is the electricity powerhouse for virtually all of southwestern Ontario, spanning into central and northcentral Ontario. Additionally, through the new Bruce-Milton line, the site is a key supply to the western portion of the Greater Toronto Area. Bruce Power is an essential resource for the most populated area of the province, using existing infrastructure to deliver a third of Ontario’s electricity safely and reliably, 24 hours a day, 365 days a year. Bruce Power not only provides the province with baseload power, it is also capable of giving the market 2,400 MW of flexible capability from our eight nuclear units to back up renewable sources, which fluctuate with the weather.
AFFORDABLE, STABLE PRICES

Another goal for the Ontario government is keeping power prices low and stable. Bruce Power nuclear is affordable power that offers long-term price stability, providing the province with electricity at a rate 30 per cent below the average price in Ontario. The Bruce Power iPad app’s Cost and Clean Air Calculator measures what the impact would be on consumers’ electricity bills if nuclear energy were to be replaced by other sources. Following the refurbishment of the six remaining units at Bruce Power, nuclear will offer stable prices for decades. Once the Bruce Power facilities have been refurbished, they are not subject to large changes in price due to surrounding market changes or increases in fossil fuel costs.

NUCLEAR REFURBISHMENT AND INNOVATION

Innovation is key to Bruce Power’s success. The revitalization of the Bruce site is a story of hard work, innovation, investment and tremendous skill and expertise. The level of innovation over the last 15 years will be a major factor for the provincial government during the next refurbishment. Through the restarting of Units 3 and 4 in 2003/04, and Units 1 and 2 in 2012, the organization has developed many first-of-a-kind tools and processes to support refurbishment and outage campaigns. The workforce has demonstrated countless technical innovations to return the Bruce site to its full potential and Bruce Power will deliver a renewal program knowing it has the technology and know-how to do the work. As the company prepares for possible
future refurbishment projects on six of its units, these groundbreaking technologies will play a key role in infusing over 30 years of life into each of these reactors – providing safe, reliable and carbon-free electricity for generations.

Collaboration among Bruce Power and its suppliers, vendors and contractors has resulted in the creation of many specialized tools unique to the nuclear industry. These high-tech tools have been developed in an effort to increase worker safety and productivity. Probably one of the most important and innovative tools created was the Bruce Reactor Inspection and Maintenance System (BRIMS). BRIMS is a specialized tool system that will be deployed during outages to inspect and maintain fuel channels in the reactor core. The tool will help save time, reduce dose to workers, and overall, will be a faster, more predictable inspection tool. Another tool that is critical for monitoring and testing is Circumferential Wet Scrape Tool (CWEST), which obtains fuel channel samples to determine hydrogen levels in the metal. The tool is faster, reduces dosage to workers and increases nuclear safety margins. Finally, Modal Detection and Repositioning (MODAR) is used to move tight garter springs in Unit 8. The tool will adjust the garter springs in the annulus gas space between the calandria tube and the pressure tube. Overall, there is a proven track record of using high level technology and innovation for virtually every component of the reactors and all of the lessons learned will be beneficial as the company moves forward.

Unrelated to refurbishment, yet extremely innovative work that takes during planned maintenance outages, is the Cobalt-60 harvest. Working together, Bruce Power and Nordion provide a reliable, long-term, end-to-end Cobalt-60 supply, which fuels gamma processing operations such as irradiation facilities that sterilize single-use medical devices. Cobalt is mined like any other mineral. It’s removed from the ground and processed into pure Cobalt-59 powder. Once processed into powder, it’s compressed into slugs, which are coated with nickel. These slugs are then encapsulated and assembled into adjuster rods, which are used to control the reaction in Bruce Power’s reactors, where the cobalt is activated by absorbing neutrons to become Cobalt-60. The rods are in the reactor for a minimum of one year and maximum of 2.5 years. Bruce Power harvests the rods during planned maintenance outages on the units. The bundles are then received by Nordion and the Cobalt-60 is removed from its encapsulation and welded into a new double-encapsulated source called C-188. It is then shipped to the sites of Nordion’s customers for use in irradiators. In 2014, Bruce Power and Nordion signed an agreement for up to an additional 14 years to provide a long-term supply of Cobalt-60 that will support health care around the world. Cobalt-60 makes an invaluable contribution to the health care industry and is used to sterilize approximately 40 per cent of all single-use medical devices and equipment produced globally.

Bruce Power and Nordion provide a reliable, long-term, end-to-end Cobalt-60 supply. Cobalt-60 makes an invaluable contribution to the health care industry and is used to sterilize approximately **40 per cent** of all single-use medical devices and equipment produced globally.
5. People

In addition to returning four Bruce A assets to their full operating potential and extending the life of the Bruce site in general, another key focus has been on renewing the workforce for the long term. The company has established a rejuvenated workforce, recognizing the long-term view that has been established through investments in both generation assets and the Bruce-Milton transmission line.

In 2001, the Bruce Power site faced a serious demographic challenge following many of the decisions taken in the late-1990s related to the shutdown of Bruce A. Due to the shutdown, many of the younger employees and their families left the community to secure employment elsewhere. There was also little to no new hiring so what Bruce Power inherited when they took possession of the site was an older workforce that was not aligned, from a demographics perspective, with the opportunity to extend the life of the site. In 2001, only 10 per cent of staff was under the age of 35, with 44 per cent of staff between the ages of 46 and 55. Due to investment in the assets, the company knew it needed to focus on recruitment, training and apprenticeships to establish a workforce on the site for the long-term refurbishment plan. As of 2014, 33 per cent

![FIGURE 10 STAFFING AT BRUCE POWER](image)

**2001**

<table>
<thead>
<tr>
<th>AGE</th>
<th>EMPLOYEES</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNDER AGE 36</td>
<td>316 employees</td>
<td>10%</td>
</tr>
<tr>
<td>36-45</td>
<td>1,265 employees</td>
<td>40%</td>
</tr>
<tr>
<td>46-55</td>
<td>1,376 employees</td>
<td>43%</td>
</tr>
<tr>
<td>56+</td>
<td>173 employees</td>
<td>5%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>3,130 employees</td>
<td></td>
</tr>
</tbody>
</table>

**2014**

<table>
<thead>
<tr>
<th>AGE</th>
<th>EMPLOYEES</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNDER AGE 36</td>
<td>1,338 employees</td>
<td>33%</td>
</tr>
<tr>
<td>36-45</td>
<td>1,029 employees</td>
<td>25%</td>
</tr>
<tr>
<td>46-55</td>
<td>1,250 employees</td>
<td>30%</td>
</tr>
<tr>
<td>56+</td>
<td>474 employees</td>
<td>12%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>4,091 employees</td>
<td></td>
</tr>
</tbody>
</table>
of employees were under the age of 35, while the number of staff 46-55 dropped to 30 per cent. This move to a more balanced workforce has the company well positioned for long-term success. Over 90% of Bruce Power’s workforce is unionized and, through this transformation, the company and labour worked hand in hand.

Over the course of Bruce Power’s history, and as the workforce dynamic has changed, the company has won numerous awards including Canada’s Top Employer for Young People in 2013 and 2014, a competition organized by the editors of Canada’s Top 100 Employers. This award in particular is a great accomplishment given the state of the workforce when Bruce took over. In 2013, Bruce Power also won the Achievers 50 Most Engaged Workplaces award and was named one of Canada’s 10 Most Admired Corporate Cultures by Waterstone Human Capital.

As it continues its quest to remain among the best employers in Canada, Bruce Power offers top-notch wellness initiatives to ensure it retains employees and puts their health as a top priority. These initiatives include on-site medical clinics and fitness facilities, health screening for new hires, smoking cessation clinics and more.
6. Economic impact

One of the untold stories in Ontario is the contribution the nuclear industry makes to the province’s economy. By securing the future of the Bruce Power site, the long-term, annual economic impact of operating the facility will result in 18,000 direct and indirect jobs annually, and $4 billion in annual economic benefit through the direct and indirect spending in operational equipment, supplies, materials and labour income in Ontario.

Over the next 20 years, as Bruce Power refurbishes its fleet as outlined in Ontario’s LTEP, the following additional annual economic impacts will benefit the province:

- Over 5,000 direct and indirect jobs annually.
- $960 million to $1.2 billion in labour income into the Ontario economy annually.
- $735 million to $1.05 billion in annual economic benefit through equipment, supplies and materials both directly and indirectly.

There is no other single, well-established, privately funded project, facility or infrastructure program in Ontario that will have such a significant economic impact. The jobs, investment and economic impacts will make a significant overall contribution to Ontario’s economy, and are critical to providing a stable foundation for economic growth in southwestern Ontario. After having its economy disproportionately challenged – especially in the area of manufacturing – during the recent global economic downturn, refurbishing Bruce Power’s six remaining units will allow southwestern Ontario to emerge stronger than it has been in decades. Most of the supply chain manufacturing, engineering and specialty companies that will support the refurbishment and operation of Bruce Power are located in Ontario and many of them in the southwestern part of the province and the GTA.

“There is no other single, well-established, privately funded project, facility or infrastructure program in Ontario that will have such a significant economic impact. The jobs, investment and economic impacts will make a significant overall contribution to Ontario’s economy. The jobs, investment and economic impacts will make a significant overall contribution to Ontario’s economy. The jobs, investment and economic impacts will make a significant overall contribution to Ontario’s economy.”

Don MacKinnon
President, Power Workers’ Union
All nuclear facilities have ongoing annual costs required to maintain their assets, which is outside of the operational, maintenance and administration costs (costs borne by Bruce Power and not the ratepayer). This cost is often referred to as ‘sustaining capital,’ which is money spent to ensure optimal efficiency, production and longevity of the assets. Industry standards indicate that sustaining capital for a single nuclear unit is about $25 million annually. The Bruce Power site has eight nuclear units, as well as support infrastructure, and the facility annually spends about $225 million on sustaining capital projects, leading to another influx of investment in Ontario’s economy.

“The Bruce Power site has a tremendous economic reach with over 90 per cent of its current and future spend taking place throughout Ontario – supporting jobs and economic growth across the entire province.”

Ian Howcroft, Vice-President
Ontario Canadian Manufacturers & Exporters

“The Bruce Power project achieves a number of key goals for the province including keeping prices low for families and businesses, while investing private dollars into public assets and not impacting the province’s balance sheet in the process. This is a model that has served Ontario well over the last decade and will be essential moving forward.”

Mark Romoff, President and Chief Executive Officer,
Canadian Council for Public-Private Partnerships.

“FIGURE 11 2014 ELECTRICITY PRICES PER MWh

<table>
<thead>
<tr>
<th>Source</th>
<th>Average Price 2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar</td>
<td>$498</td>
</tr>
<tr>
<td>Gas</td>
<td>$175</td>
</tr>
<tr>
<td>Wind</td>
<td>$112</td>
</tr>
<tr>
<td>Nuclear</td>
<td>$60</td>
</tr>
<tr>
<td>Hydro</td>
<td>$46</td>
</tr>
</tbody>
</table>

“FIGURE 12 SHOWING THE OVERALL ANNUAL ECONOMIC BENEFITS OF OPERATIONS

<table>
<thead>
<tr>
<th>Benefit Description</th>
<th>DIRECT BENEFIT</th>
<th>SECONDARY BENEFIT</th>
<th>TOTAL BENEFIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ontario Employment (1)</td>
<td>4,600</td>
<td>13,892</td>
<td>18,492</td>
</tr>
<tr>
<td>Fuel Cost (2)</td>
<td>$117 million</td>
<td>$128 million</td>
<td>$245 million</td>
</tr>
<tr>
<td>Ontario Purchased Equipment, Materials and Supplies (including staffing costs) (3)</td>
<td>$1,794 million</td>
<td>$1,973 million</td>
<td>$3,767 million</td>
</tr>
<tr>
<td>TOTAL</td>
<td>$1,911 million</td>
<td>$2,101 million</td>
<td>$4,012 million</td>
</tr>
</tbody>
</table>

Notes:
(1) Bruce Power Annual Review 2013, NEI 2014 Local and State/Provincial Multipliers
(2) Canadian Manufacturers & Exporters 2010 and 2012. It is assumed 50% of the full cost is spent in Ontario because of refining and manufacturing. Secondary benefits are assumed to be 110% of direct spending on fuel is spent and re-spent in Ontario.
(3) Secondary impacts occur when other Ontario industries and businesses supply goods and services to meet the needs of operating the Bruce Power nuclear fleet. It is assumed that 110% of direct spending on equipment, materials and supplies is spent and re-spent in Ontario.
7. Competitively priced electricity

The Bruce Power site has been, and will continue to be, a key source in providing both price stability and a long-term source of affordable power that continues to be significantly below the average price families and businesses pay for electricity in the province. In short, Bruce Power makes over 30 per cent of the power in Ontario for 30 per cent below the average cost of electricity.

There is a perception the large capital requirements for nuclear projects also equate to a high price of power for consumers – this is not the case. Since nuclear plants generate a large volume of electricity, with a high degree of reliability, the capital requirements of the facility are spread over significant amounts of generation meaning the cost to ratepayers is affordable.

In the case of Bruce Power, the price paid for the electricity covers all costs, including decommissioning of the facility, when it reaches its end of life, the management of low-, medium- and high-level wastes, and capital investments in the facility. While there are many comparators available related to the economics of nuclear plants, the only one that matters to consumers is the price of electricity.

The price of electricity for the Bruce site, as of January 2015, is $64 a MWh under contract with the Ontario Power Authority. This a very competitive price for power for Ontario ratepayers.

From an overall supply mix perspective, the role of nuclear today and refurbished nuclear in the future will play a critical role in keeping electricity costs low for Ontario families and businesses. Figure 13 compares the relative cost of electricity from all the various sources, in a report recently released by the Ontario Ministry of Energy. As the figure illustrates, the cost of nuclear refurbishment remains highly competitive and a key element to keeping electricity costs low and bending the price curve.

**FIGURE 13 RELATIVE COST OF ELECTRICITY 2013**

| Source: Ontario Power Authority |
8. Building public confidence

One of Bruce Power’s core values focuses on social responsibility and being a good corporate partner to neighbouring communities. The company is also dedicated to communicating with the community, whether it be local or across Ontario, in an open and transparent manner. The support of our neighbouring communities is one of the keys to Bruce Power’s success and the company has earned an immense amount of support, though it never takes it for granted. Bruce Power makes information available to anyone who wants to know more about the business, and is committed to providing fact-based and verifiable information at all times.

This commitment has particularly helped build positive support around refurbishment.

Support for refurbishment across Ontario hit a high of 80 per cent in December 2014. This shows a very strong position for the refurbishment option and public opinion is an important consideration for any government. Overall,

Impressions of Bruce Power remain positive among residents of Bruce, Grey and Huron counties.

Eight in 10 residents continue to support refurbishment.

Nine in 10 residents feel that Bruce Power operates safely.

Studies commissioned by Bruce Power
Source: Ipsos Reid 2014 and Innovative Research Group
opinions about the refurbishment of the Bruce facility, and Bruce Power as an organization have not changed significantly since spring 2014.

Eight in 10 (79%) residents continue to support the refurbishment of the Bruce nuclear facility, statistically unchanged from spring 2014 (83%). Half of Bruce County residents ‘strongly support’ the refurbishment of the Bruce facility, significantly higher than among Grey (42%) or Huron (34%) county residents.

Residents are most likely to support refurbishment of the Bruce facility because it will create jobs (15%), unchanged from spring 2014. Other common reasons include that it is necessary (8%), because they like nuclear power (7%) and because it’s good for the economy (6%).

At two-thirds of residents (65%), knowledge of nuclear energy remains unchanged compared to in the spring (67%). The vast majority of residents feel they are ‘somewhat knowledgeable’ (57%) with only a small portion ‘very knowledgeable’ (8%) about the technology.

Impressions of Bruce Power remain positive among residents of Bruce, Grey and Huron counties and have not changed significantly since spring 2014. Overall, familiarity with Bruce Power remains strong with three quarters (76%) of residents who feel they are very or somewhat familiar with the organization. Compared to the spring, more residents feel they are ‘somewhat familiar’ (61% vs. 53%), while fewer indicate they are ‘very familiar’ (15% vs. 23%).

Bruce County residents are the most likely to mention that they are ‘very familiar’ with Bruce Power (20%), compared to Grey (14%) and Huron (11%) county residents.

Nine in 10, residents agree they have confidence the Bruce Power facility operates safely (92%) and that Bruce Power is a good community citizen (89%). This confirms previous analysis from CCPPP that indicates when citizens are familiar with a P3 project in their community, support for P3s increases (P3 Pulse, Nanos Research, 2013).

The refurbishment of the Bruce Power site in the province remains not only a strong proposition from an LTEP point of view, but is also strongly supported and recognized by people in the province. This continues to be an area of focus for the company as it’s important the public understand and are provided facts of both the low-cost nature of Bruce Power nuclear and its contribution to coal phase-out.
9. Independent Safety Regulator

In Canada, energy policy is the jurisdiction of the provincial government while safety is regulated by the federal government, specifically the Canadian Nuclear Safety Commission (CNSC). The CNSC is responsible, under the Nuclear Safety and Control Act (NSCA), for regulating all nuclear facilities and nuclear-related activities in Canada. The CNSC grants the stations’ operating licences, which set the legal requirements under which the stations must operate.

The CNSC has a presence at each nuclear station in Canada. CNSC staff members have continuous access to inspect each station and review its activities. CNSC staff report the company’s activities to the CNSC Commission Tribunal, an appointed body of individuals who provide further oversight on nuclear activities. In addition to Bruce Power’s own rigorous internal safety reporting and review process, the company is also required to formally notify the CNSC of activities that meet defined criteria. Event Reports are provided to CNSC staff when an activity meets the thresholds set out by the Commission. These reports represent a very small fraction of the activities undertaken in a nuclear station every year, but each is given scrutiny for causal factors, corrective actions and resolutions. Typically a handful of these Event Reports have enough significance to warrant further review by the CNSC Commission Tribunal at one of their regularly held public meetings. There the root cause, remedial actions and resolution of the event are discussed in a public forum with this further level of oversight and accountability.

On an annual basis the CNSC rates Bruce Power on its performance. It is a fully transparent system with the results published publicly shortly after. Canada’s regulatory regime
is regarded internationally and has demonstrated 50 years of safe reactor operations. Bruce Power achieved its strongest report card in 2014 with areas of excellence identified in conventional health and safety, security and waste management. The figure below provides an overview of Bruce Power’s 2014 CNSC ratings, which remain strong and are consistent with good industry performance. The CNSC has compared the Fully Satisfactory and Satisfactory marks to grades of A+ and A respectively.

This level of oversight and involvement at the federal level not only speaks to the rigorous safety regime Bruce Power abides by, but also make the people of Ontario feel confident in the company’s operations.

FIGURE 14 2014 BRUCE POWER CNSC RATINGS

<table>
<thead>
<tr>
<th>SAFETY &amp; CONTROL AREA</th>
<th>BRUCE A</th>
<th>BRUCE B</th>
<th>INDUSTRY AVERAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management system</td>
<td>SA</td>
<td>SA</td>
<td>SA</td>
</tr>
<tr>
<td>Human performance management</td>
<td>SA</td>
<td>SA</td>
<td>SA</td>
</tr>
<tr>
<td>Operating performance</td>
<td>SA</td>
<td>FS</td>
<td>SA</td>
</tr>
<tr>
<td>Safety analysis</td>
<td>SA</td>
<td>SA</td>
<td>SA</td>
</tr>
<tr>
<td>Physical design</td>
<td>SA</td>
<td>SA</td>
<td>SA</td>
</tr>
<tr>
<td>Fitness for service</td>
<td>SA</td>
<td>SA</td>
<td>SA</td>
</tr>
<tr>
<td>Radiation protection</td>
<td>SA</td>
<td>SA</td>
<td>SA</td>
</tr>
<tr>
<td>Conventional health and safety</td>
<td>FS</td>
<td>FS</td>
<td>FS</td>
</tr>
<tr>
<td>Environmental protection</td>
<td>SA</td>
<td>SA</td>
<td>SA</td>
</tr>
<tr>
<td>Emergency management and fire protection</td>
<td>SA</td>
<td>SA</td>
<td>SA</td>
</tr>
<tr>
<td>Waste management</td>
<td>FS</td>
<td>FS</td>
<td>FS</td>
</tr>
<tr>
<td>Security</td>
<td>FS</td>
<td>FS</td>
<td>FS</td>
</tr>
<tr>
<td>Safeguards</td>
<td>SA</td>
<td>SA</td>
<td>SA</td>
</tr>
<tr>
<td>Packaging and transport</td>
<td>SA</td>
<td>SA</td>
<td>SA</td>
</tr>
<tr>
<td>Integrated plant rating</td>
<td>SA</td>
<td>FS</td>
<td>SA</td>
</tr>
</tbody>
</table>

**FS:** Fully Satisfactory  
**SA:** Satisfactory  
**BE:** Below Expectations
10. Role of the IESO

The Independent Electricity System Operator (IESO) handles the coordination of all the parts of Ontario’s power system. It ensures there is enough power to meet the province’s energy needs in real time by balancing the supply of, and demand for, electricity in Ontario, and directing its flow across the province’s transmission lines. The IESO also plans and prepares for Ontario’s future electricity needs. It forecasts and assesses Ontario’s current and short-term electricity requirements, as well as the adequacy and reliability of the integrated power system. For the longer term, it forecasts energy demand up to 20 years and identifies sustainable electricity solutions for Ontarians well into the future. The province relies heavily on forecasts from the IESO to produce and continually update the LTEP. Bruce Power must work closely with the IESO in order to help plan generation day to day, month to month and for the future. They must work with nuclear operators like Bruce Power to develop a coordinated schedule for outages or refurbishments for the long term.

To meet the province’s energy needs, the IESO secures new supply to meet future demand for energy, whether through contracts or market-based approaches. It does this by procuring new generation, identifying transmission needs and developing conservation measures, while working toward a clean energy supply mix. The IESO oversees the wholesale electricity market, where the price of energy is determined. It establishes and manages thousands of contracts, with Bruce Power being one of the largest, and through contracts it controls the price of electricity procured. All of these activities are carried out consistent with Ontario’s LTEP. The low cost power through contracts means significant financial benefit to Ontario ratepayers. Finally, it administers the rules that govern the market and, through an arm’s-length market monitoring function, ensures that it is operated fairly and efficiently.
Sources

Independent Electricity System Operator
www.ieso.ca

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360 Bruce Power Annual Review 2014, 2014

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www.pppcouncil.ca/pdf/p3pulse.pdf