

# Bruce Power's Role in Phasing out Coal in Ontario

## ISOE International Symposium

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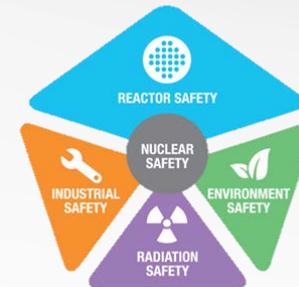
**Len Clewett – EVP & CNO**

**Bruce Power™**

*Innovation at work*

# Overview of Bruce Power

- Nuclear Safety is our core value
- Bruce Power is Ontario's largest independent power producer, generating 30% of the Province's total electricity supply in 2014, 2015, and 2016
- Located on the shores of Lake Huron, roughly 250 km northwest of Toronto



# Overview of Bruce Power

## Bruce Power L.P.

### The Issuer

- Canada's only private nuclear generator

### Ownership

- ~97% owned by OMERS<sup>1</sup> and TransCanada<sup>2</sup>
- ~3% owned by unions and employees

### Bruce Power Facility

- 8 reactors on a 2,300 acre site leased from OPG
- 2 physically separate stations (Bruce A and Bruce B)

### Installed Capacity

- ~6,300 MW

### Technology

- Reactors employ proven CANDU technology

### Regulatory Body

- Canadian Nuclear Safety Commission (CNSC)

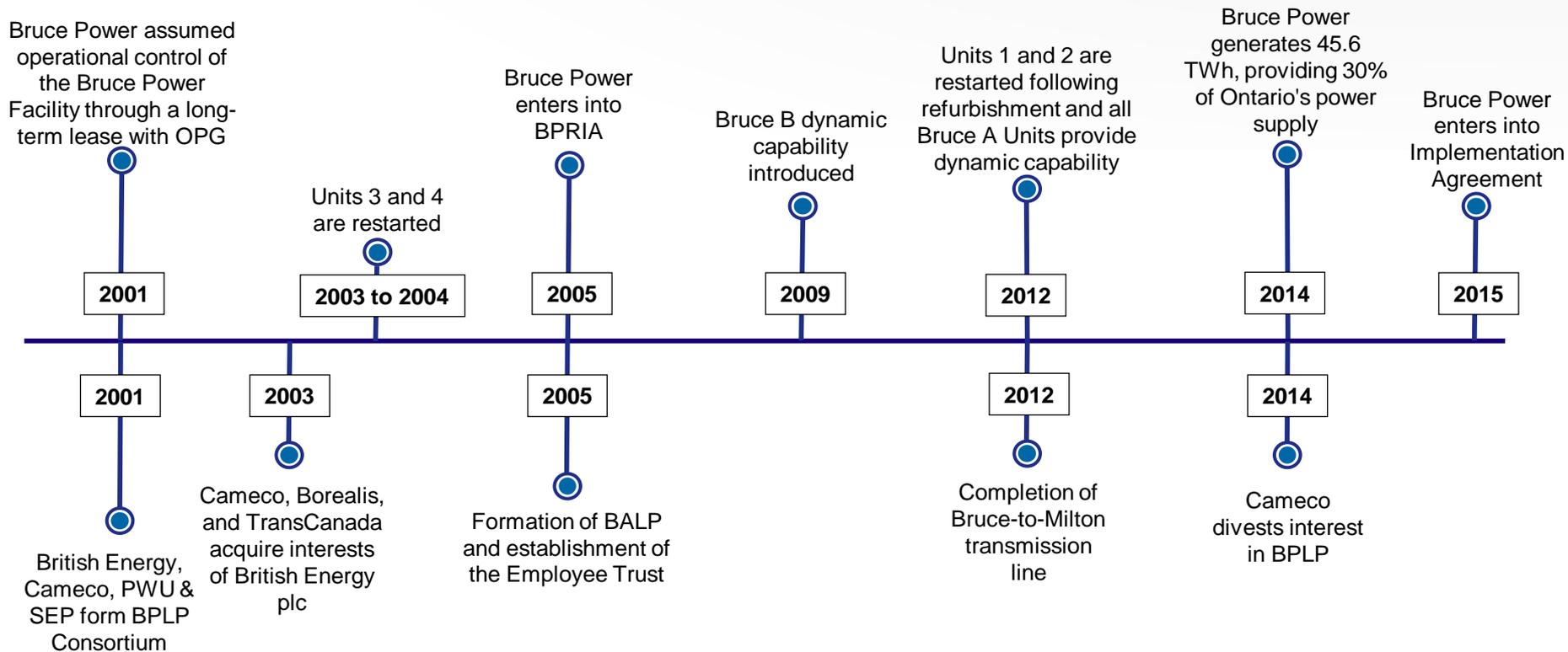
### Implementation Agreement

- Long-term agreement with the IESO expiring in 2064
- Fixed price (subject to escalation and periodic adjustments) for all electricity generation



# History of Bruce Power

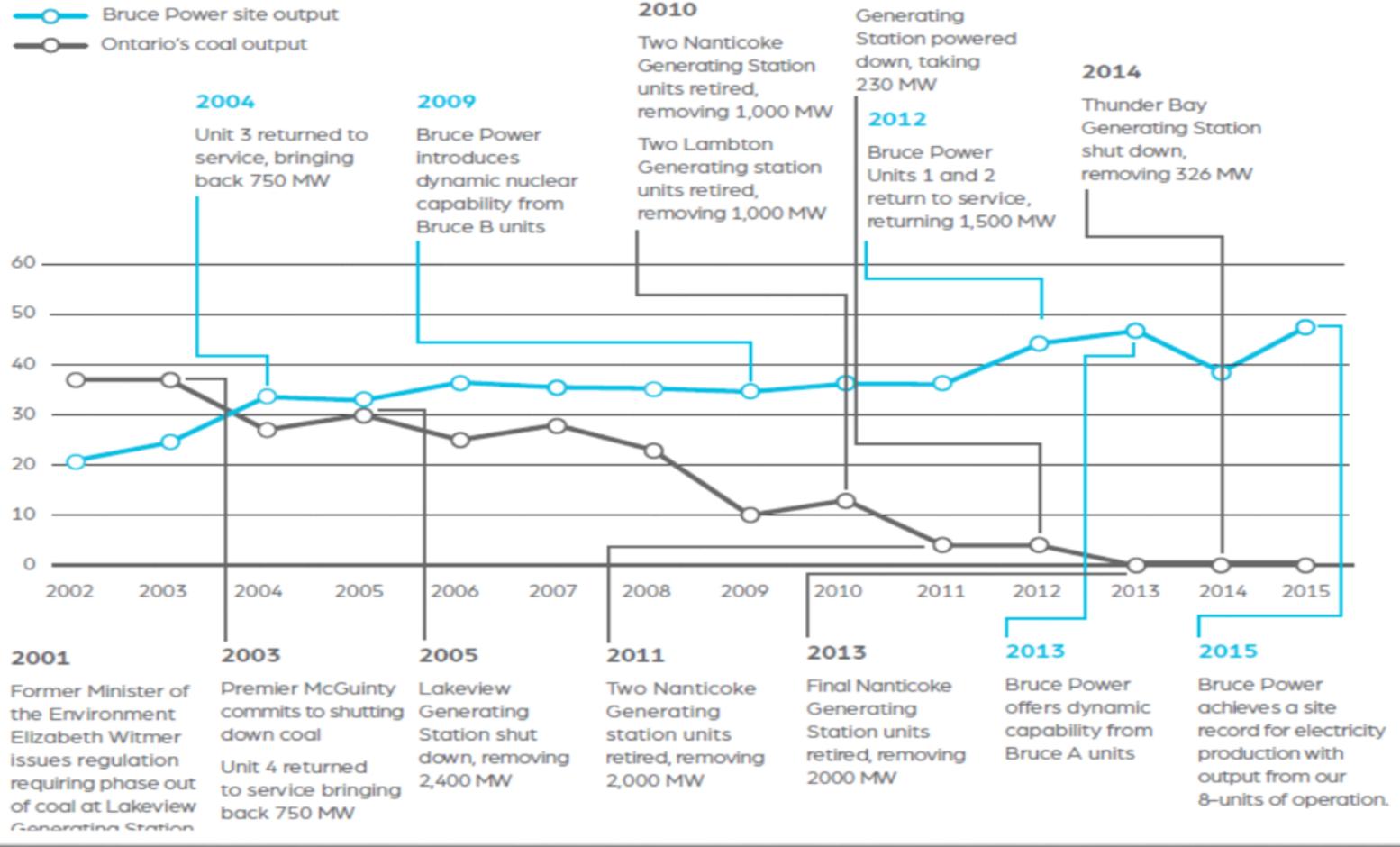
*Bruce Power began operating the facility in 2001; upon completion of the refurbishment of Units 1 and 2 in 2012, all 8 reactors were operational for the first time since 1995.*



# Phasing out Coal in Ontario

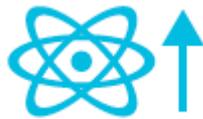
**FIGURE 10.0**

*Bruce Power Site Output and Coal Output 2002-2013*



# Bruce Power's Role in Phasing out Coal in Ontario

- By refurbishing Units 1-4 from 2003-2012, Bruce Power returned over 3,000 Megawatts of Carbon-free power to Ontario's electricity grid.
- This provided 70% of the energy the province needed to shutdown its coal plants.
- Coal use in Ontario went from 29% of the province's electricity in 2000 to zero in 2014.



# Bruce Power's Role in Phasing out Coal in Ontario (Cont'd)

- Smog days dropped dramatically as the Bruce Power units were returned to service.
- In 2005, there were 53 smog days in Ontario, while there have been none since 2013, the final summer of coal use in the province.



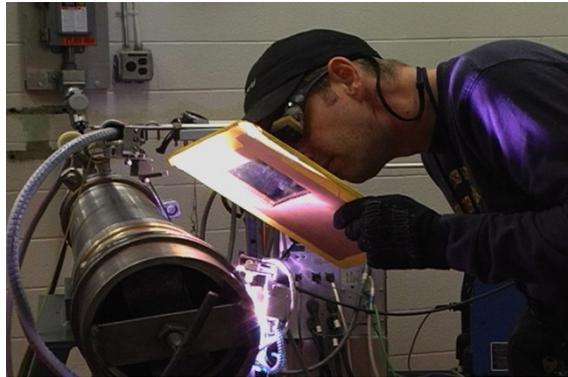
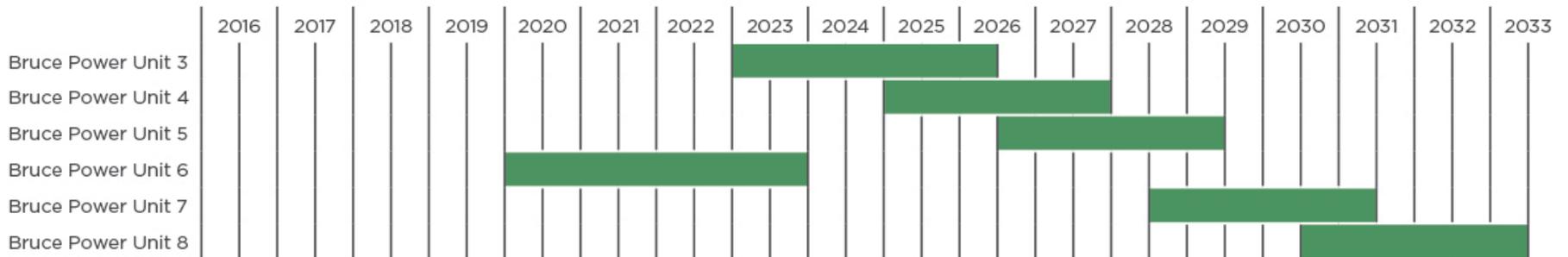
# Meeting Ontario's Long-Term Climate Change Goals

- In December 2013, the Ministry of Energy released its Long-Term Energy Plan (LTEP), which indicated that refurbished nuclear is the most cost-effective option available to meet Ontario's baseload requirements, while producing no greenhouse gas emissions.
- The plan assumes the life extension of remaining Bruce Units 3-8, equivalent of 5,000 MW.

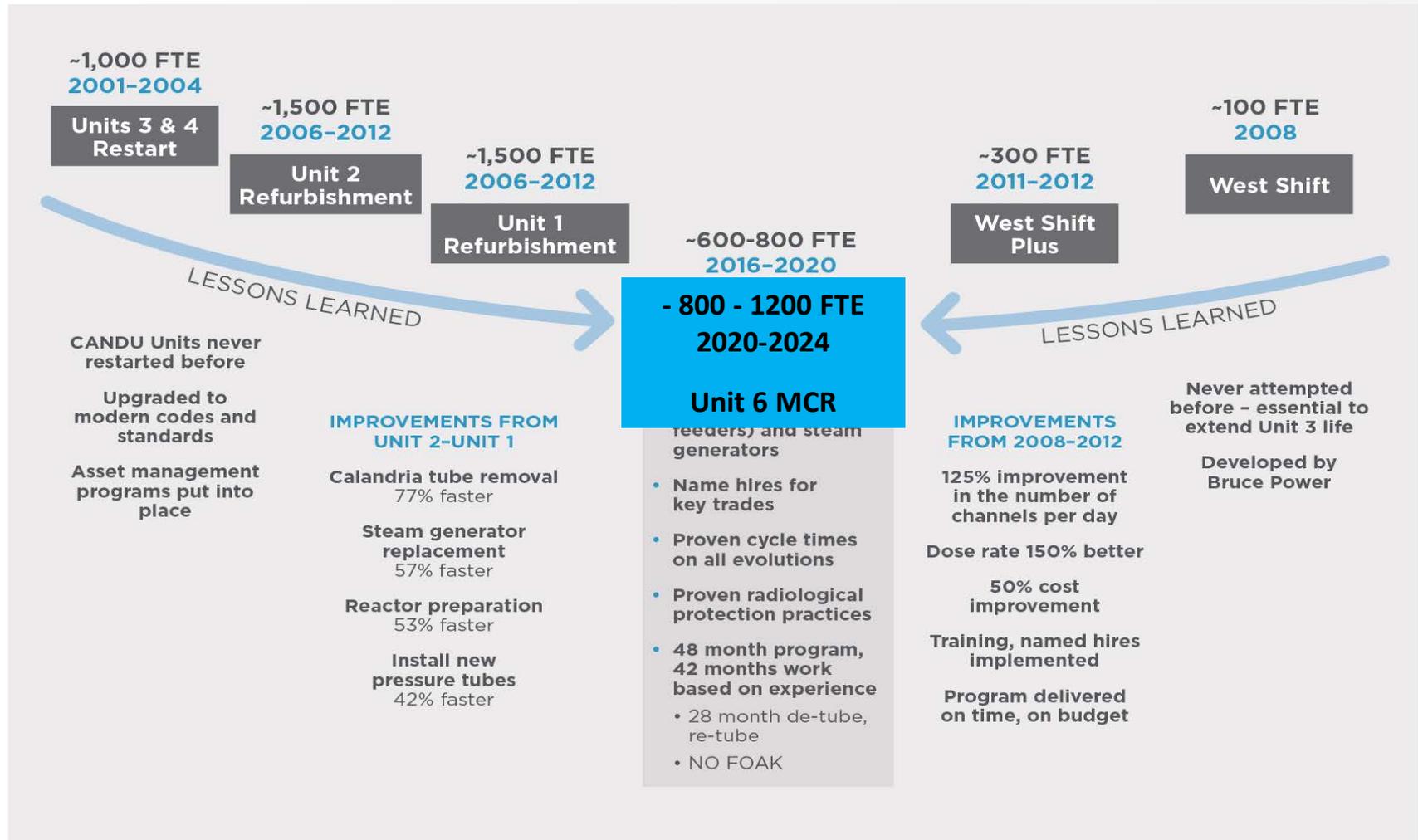
# Bruce Power Life-Extension

- Bruce Power will continue to play an important role in achieving Ontario's long term climate change goals through the life extension of Bruce Units 3-8.
- There will be a \$13 billion private investment program in six of its units over 20 years, extending their life another 40 years.
- This will help Ontario and Canada meet their carbon-reduction goals, as their focus shifts to a clean energy system.

# Life Extension Schedule



# Building on lessons learned



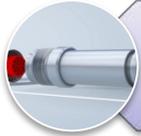
# What is MCR?

First of a kind?



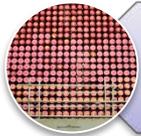
Facilities & Infrastructure

No



Pressure tube replacement

No



Calandria tube replacement

No



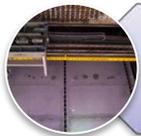
Feeder tube replacement

No



Steam generator replacement

No

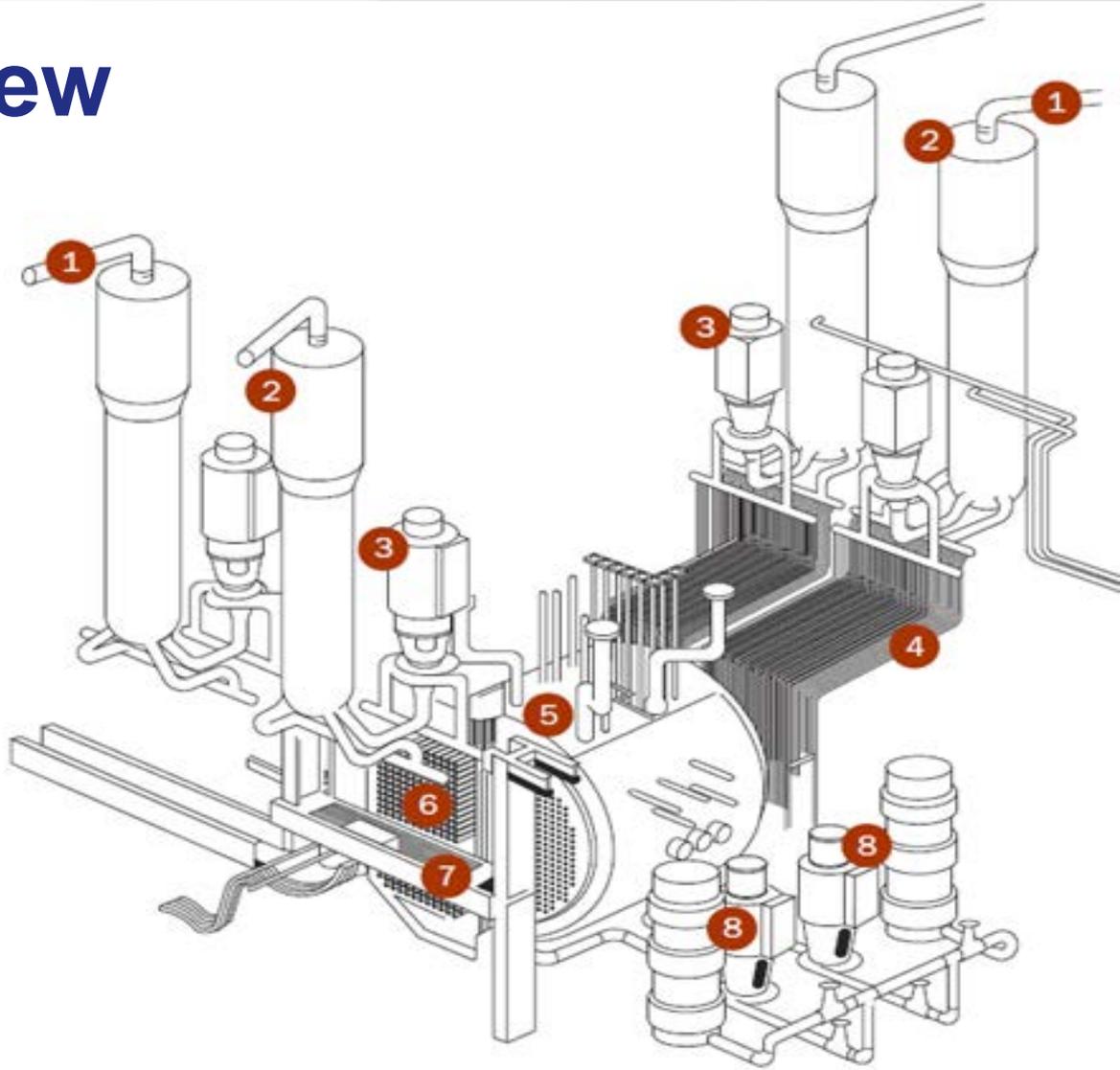


Bulkheads/infrastructure

No

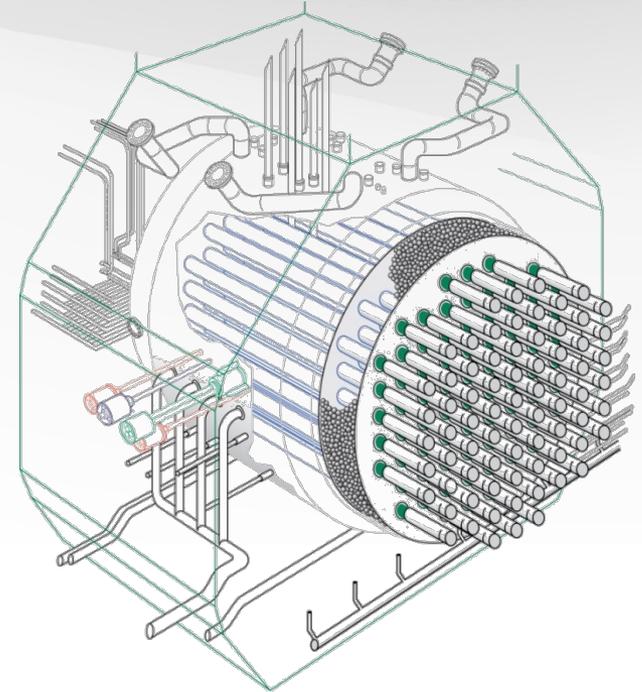
# Project overview

1. Main Steam Supply Piping
2. Steam Generators
3. Main Primary Supply Pumps
4. Feeders
5. Calandria Assembly
6. Fuel Channel Assembly
7. Fuelling Machine Bridge
8. Moderator Circulating System



# Detube / Retube Scope

- Safely remove & replace all 480 fuel channels & calandria tubes while meeting all relevant regulations, standards & codes
- Procure all reactor components & tooling to perform the work
- Train staff to execute the work



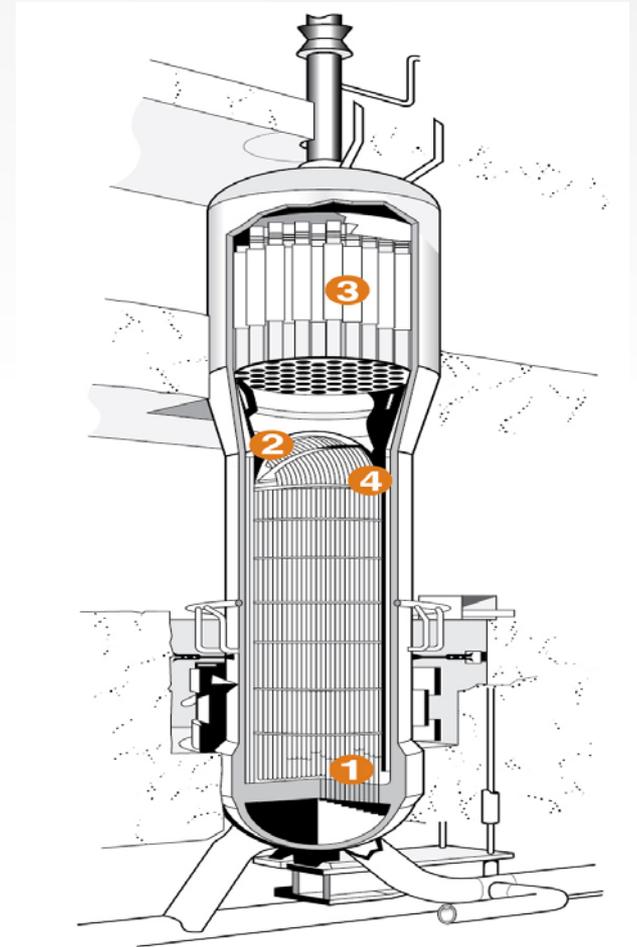
# Feeder Program Scope

- Feeder cabinet & feeder removals
- Upper feeder installation
- Lower feeder installation



# Steam Generator Replacement Scope

- Specify, design & buy replacement steam generator cartridges
- Prepare modifications for affected interfacing systems
- Create openings in the reactor building & steam drum enclosure roofs to facilitate steam drum & steam generator removal
- Remove, temporarily relocate & subsequently reinstall other defined interfering components
- Remove, inspect, refurbish & reinstall steam drum portions of steam generator assemblies
- Remove & replace steam generator cartridges
- Inspect and disposition of results



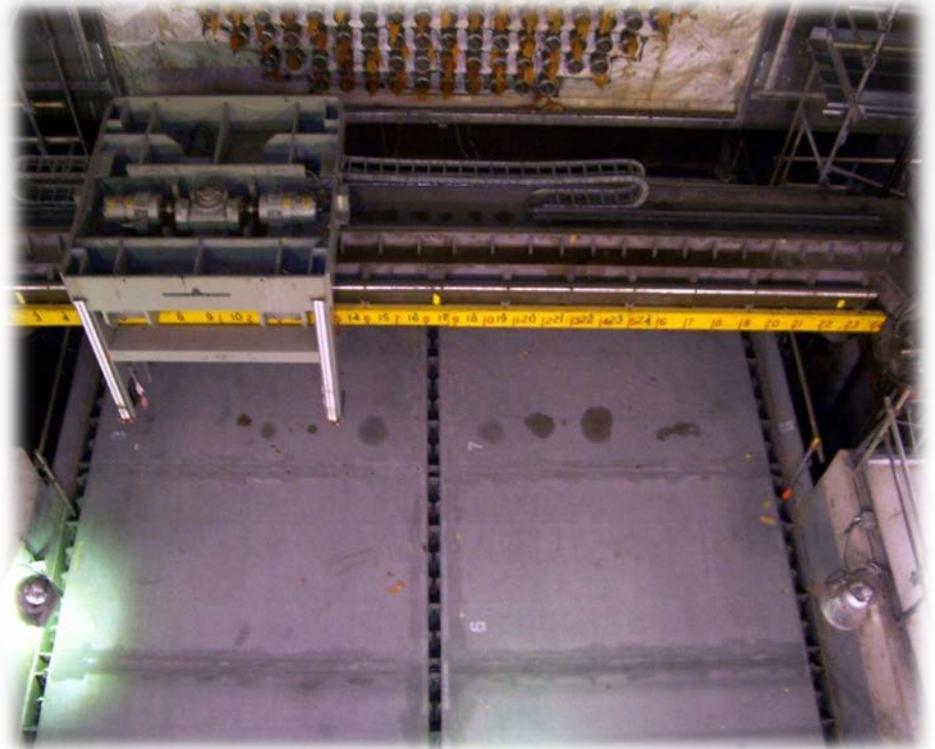
# Lead In / Lead Out Scope

- Transition from operations to construction
  - Defuel the reactor
  - Drain & dry moderator & primary heat transport systems
  - Install & remove the bulkheads (containment isolation)
  - Establish layup requirements
  - Return unit to service once construction complete

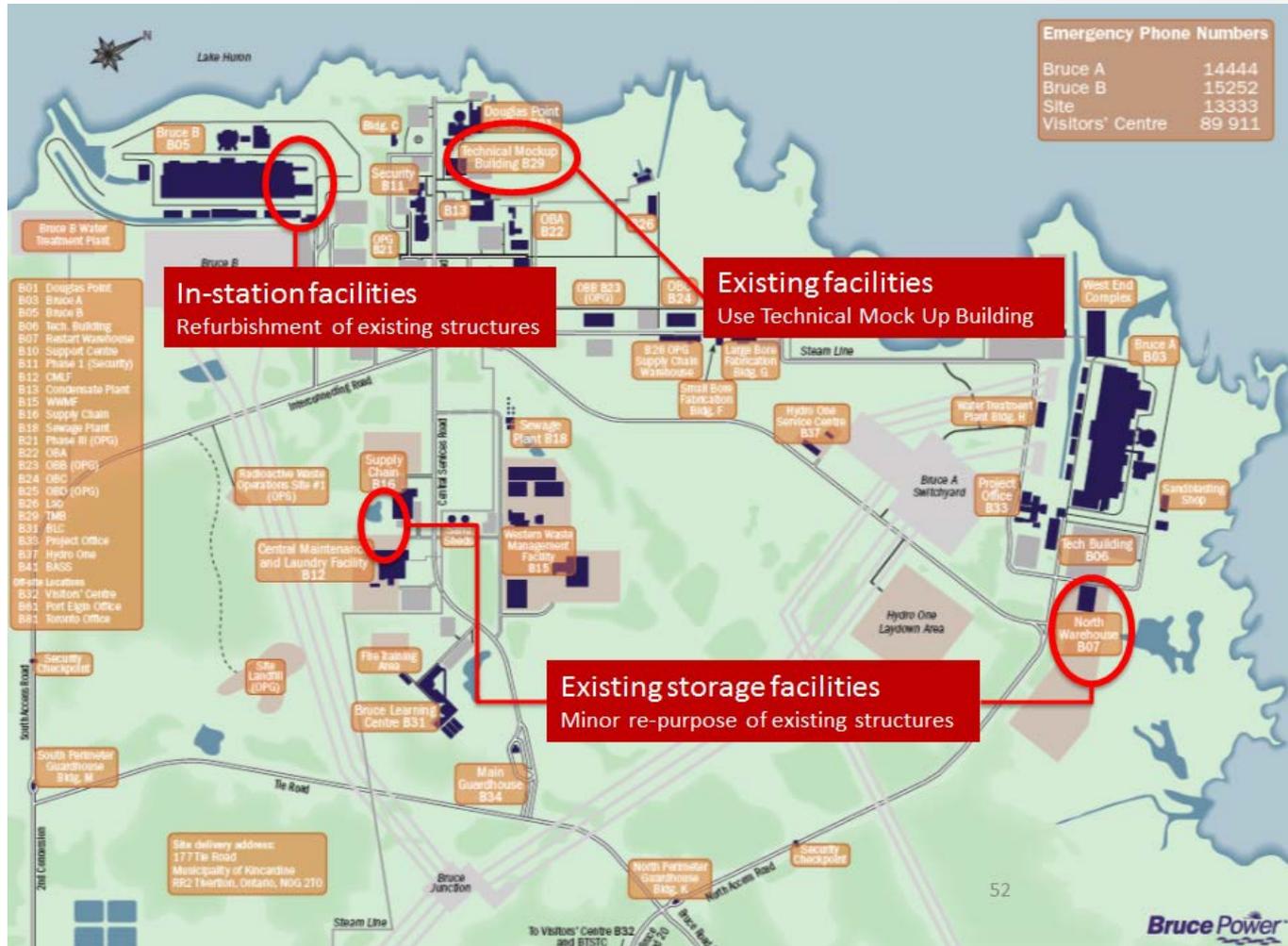


# Bulkhead Installation & Removal Scope

- Material procurement and fabrication of bulkheads
- Installation/ Removal of bulkheads



# Facilities & Infrastructure Scope



# Balance of Plant Scope

- 16 MCR recurring scopes
  - Calandria inspections
  - Preheater inspections
  - HT pressurizer inspections
  - PHT/boiler snubbers
  - PHT bellows
  - Other routine and PIP inspections
  - Heat Transport FB&R PLC
  - Start-up instrumentation
- ~ 50 Asset Management scopes
- Regulatory/improvements, Periodic Safety Review
- Normal outage maintenance

# Waste management & demobilization scope

- Manage & dispose all radioactive & non-radioactive waste generated as a result of MCR refurbishment activities
- This includes:
  - Low and intermediate radioactive waste generated from MCR projects (eg: PPE, components, IX resins)
  - Specific disposal of major components such as steam generators (low level), fuel channels (intermediate level)
  - Non-radioactive hazardous waste (chemical, asbestos)
  - Infrastructure waste (landfill, recycling)



# Questions?