# Utilities' Interest on SMR Technology: The OPG Case


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ONTARIO POWER GENERATION

Where a brighter tomorrow begins.

# Territory Acknowledgement

# Who are we?

- **Largest low-cost power generator in Ontario**
- **100+ years of operating experience**
- **18,900+ MW generating capacity in Ontario**
- **Industry innovator & leader**


2 **Nuclear** Stations

2 Leased **Nuclear** Stations

2 **Thermal** Stations

1 **Solar** Facility

66 **Canada Hydroelectric** Stations

87 **US Hydroelectric** Stations

4 **Atura Power Combined Cycle** Stations

# Safe, clean, reliable

There is no greater priority than public and employee **safety;** it guides everything we do.

As a publically-owned generator, we strive to contribute to the **well-being of our communities**.

OPG's electricity is about **40 per cent less expensive** than the average of all other Ontario generators.

Helps **reduce overall cost of electricity** for Ontarians while our profits return to the Province.

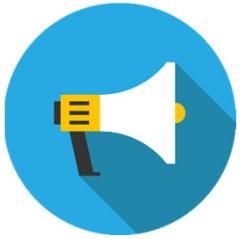
# Commitment to Community Engagement

- At OPG, we know our role in the community is about much more than safely generating electricity. It's about **being a good neighbour**.
- **Trust** and **support** are the foundations which allow large projects – particularly in nuclear – to be a success.
- OPG has developed a strong **Social Licence** through **consistent** and **meaningful** engagement with our communities through:
    - Educational programs and events
    - Environmental Stewardship
    - Councils and committees
    - Tours and presentations

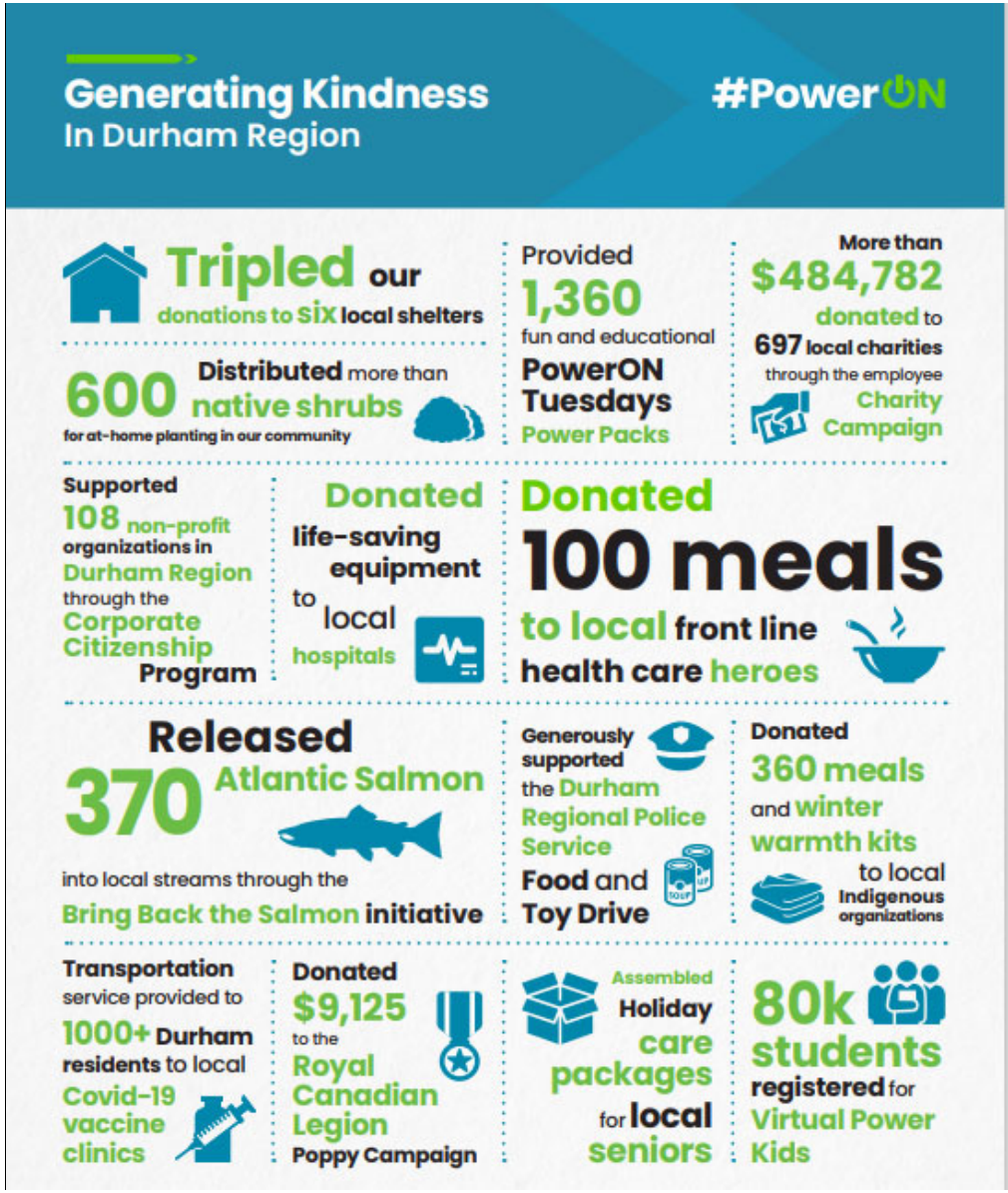
# Commitment to Indigenous Communities

- OPG is committed to working with Indigenous communities to develop positive relationships and generate shared social and economic benefits through our **Reconciliation Action Plan**.
- We strive to build relationships based on the principles of respect, integrity and mutual responsibility.
- While we have made progress, we also recognize that we still have a lot to learn.
- **Our project engagement with communities includes:**
    - Availability of capacity building
    - Environmental consultation
    - Employment and training opportunities
    - Business and procurement opportunities
    - The potential for investment in the project

# OPG's Social Licence



- Since 2000 OPG has worked with partners to plant more than **8 million native trees and shrubs** across Ontario.
- **Keep our communities informed** through community council and committees.
- **Community programming** and **partnerships** support fun, educational and environmental initiatives:
  - Bring Back the Salmon
  - PowerON Tuesdays
  - Virtual Power Kids

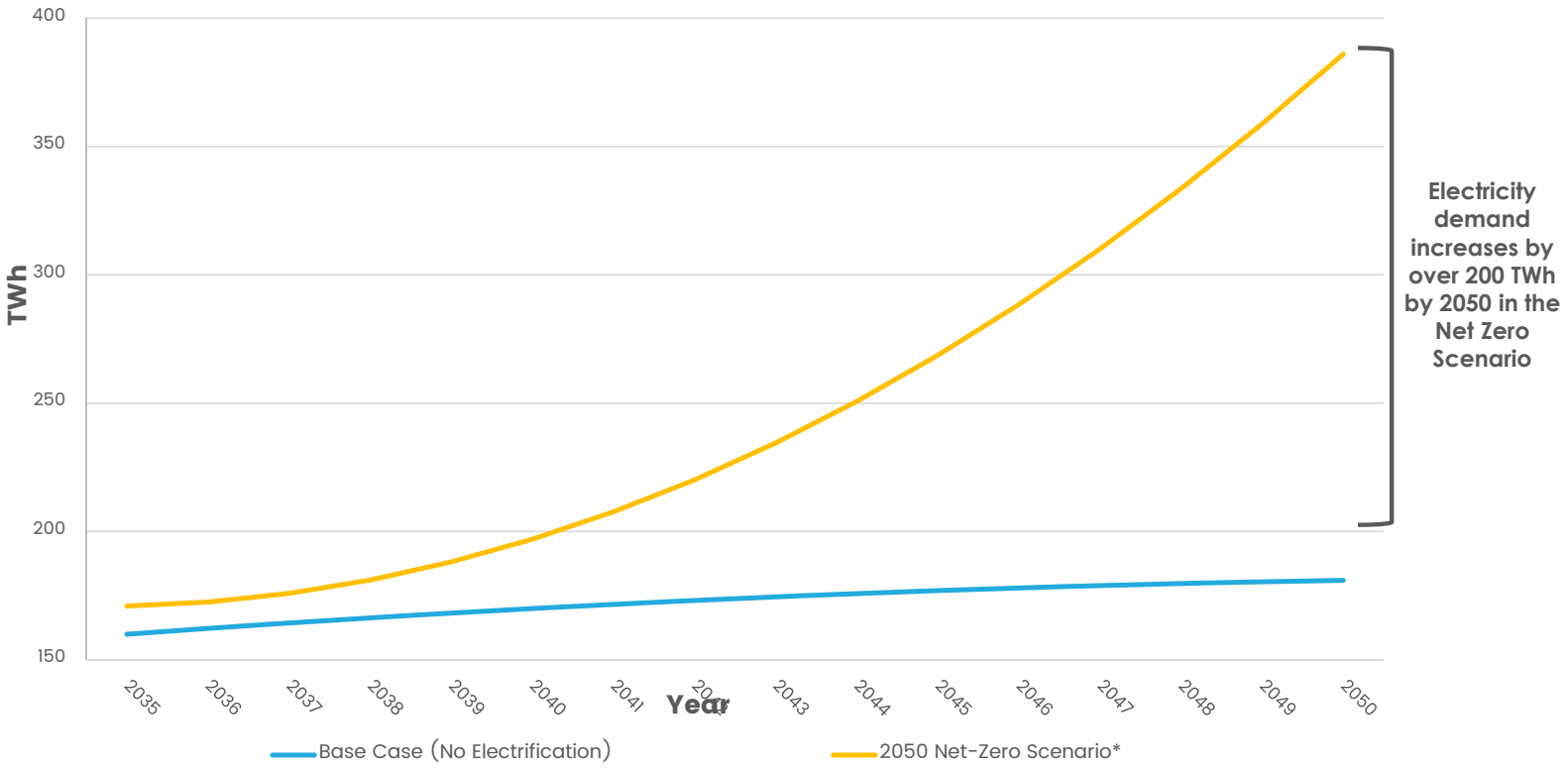


# OPG's Climate Change Action Plan

**A net-zero carbon company by 2040**

**A net-zero carbon economy by 2050**

# Ontario's Emerging Electricity Need




Source: OPG Modelling

*The 2050 net-zero scenario assumes electrification of a number of aspects of the economy including vehicles, heat pumps, water heaters, furnaces and industries that can transition to electricity. It assumes roughly 25% of Ontario's economy cannot be decarbonized through electrification.

**Fully decarbonizing the economy will more than double the electricity demand in the province**

The growing demand for electrical power in Ontario and the emerging capacity gap require new clean generation to supply this need.

Long lead times for new clean generation requires that **site selection and development start now.**

OPG's existing sites provide a **running start** for Ontario to advance this energy transition.

# Why Nuclear?

**Why not nuclear ?**

Energy security

Long-term growth in electricity demand

Advancements in safety

Achieve climate change goals

# Darlington Refurbishment Project

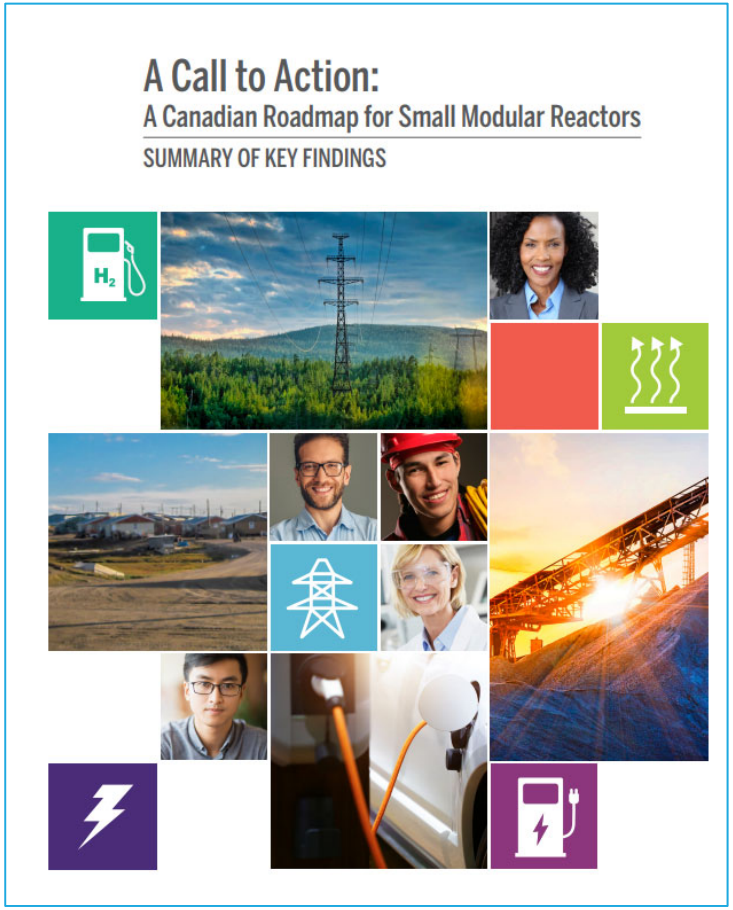
## *Demonstrating Project Excellence*

- **On-time and on-budget**
- **A 20-year project:**
  - 10 years of planning and 10 years of execution:
  - Unit 2 completed safely during pandemic.
  - Unit 1 & 3 progressing well at the same time.
  - Unit 4 scheduled to begin Q4 2023.
  - Replace major reactor components and upgrade key plant system.
- **A $12.8B investment**
  - 14,000+ jobs
  - $89.9B boost to Ontario's GDP
  - 30 more years of reliable, safe, low-cost power for Ontario.

**We've demonstrated we can change the narrative on large nuclear projects**

# Canadian SMR background

**In partnership with interested provinces, territories and power utilities, Natural Resources Canada has convened a roadmap to engage stakeholders on the future of small modular reactors in Canada. Through a series of expert working groups, and workshops held across Canada, the roadmap has gathered feedback on the direction for the possible development and deployment of SMRs in Canada.**



# Small Modular Reactors

***Helping us solve climate change***

- SMRs are a type of advanced nuclear reactor, the **next evolution of nuclear energy**.
- Designed to be smaller in size than a traditional reactor, but also produce **safe, reliable, clean energy**.
- Based on the **same science** as larger reactors:
  - Fission to create heat energy, for electricity or other heat applications (e.g. district heating, water desalination, hydrogen production, process steam)
- Same technology, **different applications** (e.g. on-grid, off-grid, advanced).
- **Based on technology** that has existed around the world for 50+ years.



# Small Modular Reactors

***Key features & benefits***

**Smaller** physical size and land footprint

Enhanced, passive **safety features**

**Modular**; components factory constructed and delivered to site

**Reduced** project **schedule** and **cost**

Some can operate for many years on initial load of fuel

Ability to **integrate** with other forms of energy (i.e. **renewables**)

Some are designed for **off-grid locations**

**Scale to fit** approach as demand changes

Some generate **high quality heat** for industrial applications

**Smaller by-product profile**

**Lower up-front capital investment**

# Applications in Canada

## On-grid SMRs

- 150 to 300 Mwe
- Reliable, baseload power
- Displace coal-fired generation
- Near term deployment; by the end of this decade

- GE-Hitachi BWRX-300

## Advanced Reactors

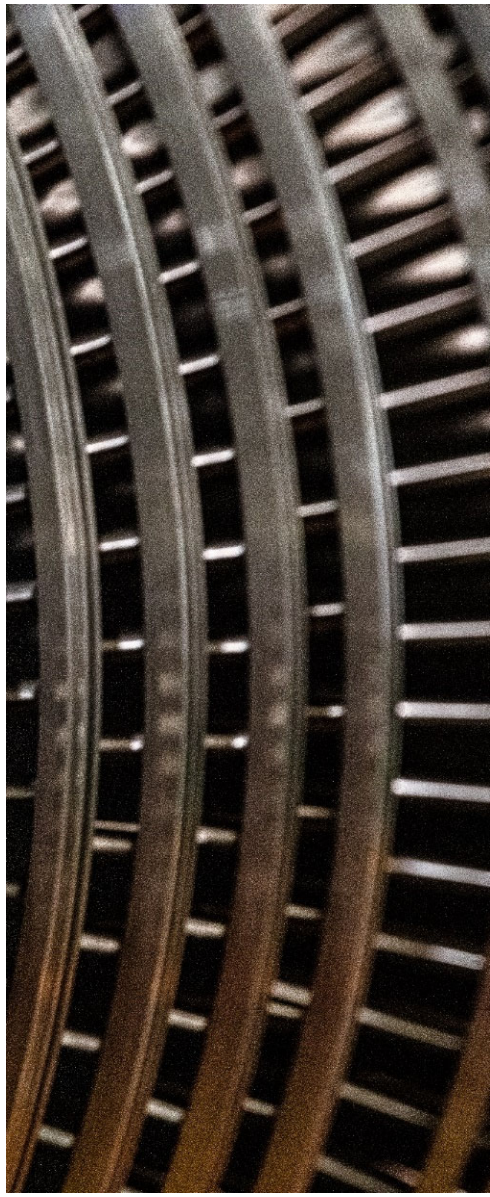
- 10 to 150 Mwe
- Advanced reactors
- Heavy industrial applications
- Expected to be deployed in mid-2030s

- ARC
- Moltex
- X-Energy

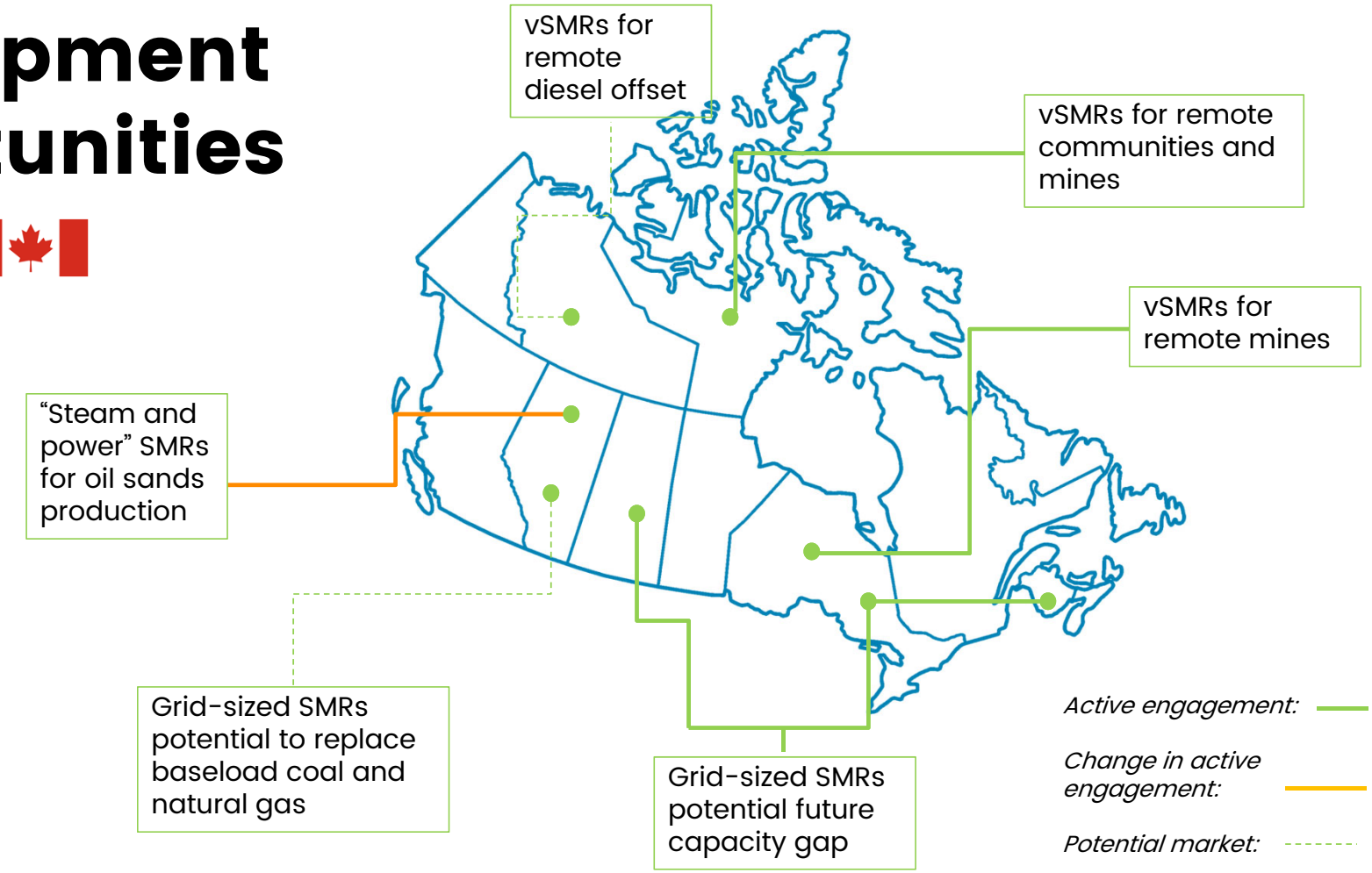
## Off-grid SMRs

- 1 to 10 MWe
- Ideal for remote industrial and off-grid communities
- Commercial demonstration in the mid/late 2020s.

- Global First Power MMR
- Westinghouse eVinci



# Development Opportunities SMRs



# Why OPG?

**Why not OPG?**

Highly trained staff

Project execution success

Strong nuclear supply chain

Operational expertise





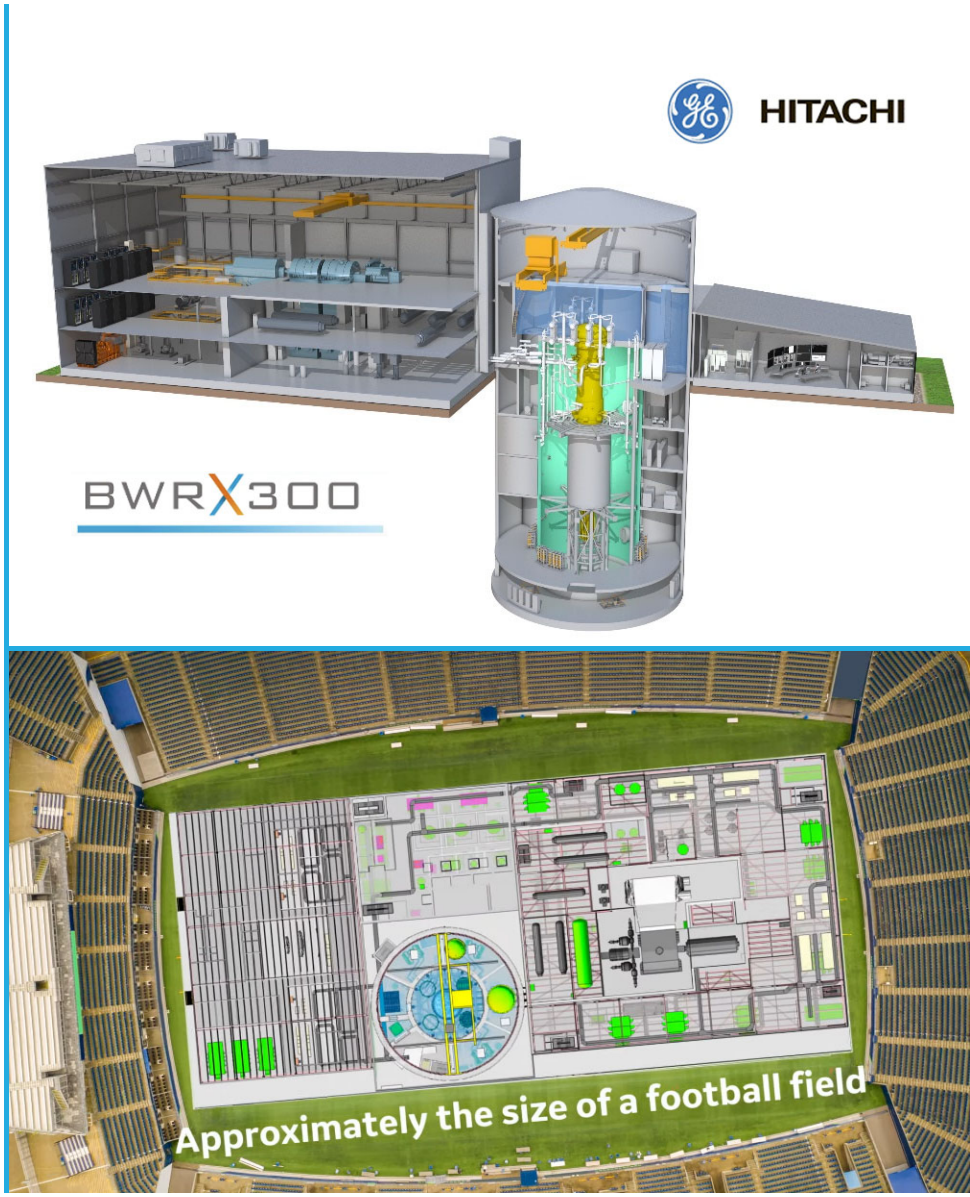

# Leading the world in new nuclear development

- On Dec. 2, 2021, we announced we will work together with **GE Hitachi Nuclear Energy (GEH)** to deploy a Grid Scale Small Modular Reactor (SMR) at the Darlington new nuclear site this decade.
- Additionally…
  - OPG is <u>also</u> working on a micro-reactor project, called **Global First Power**, which is 5 MW (electric), design **by Ultra Safe Nuclear Corporation**, to be in-service by 2027.
  - OPG is also evaluating a technology partner to deploy an Advanced high temperature reactor for industrial use. OPG will seek an industrial site to deploy this option by early to mid 2030's.

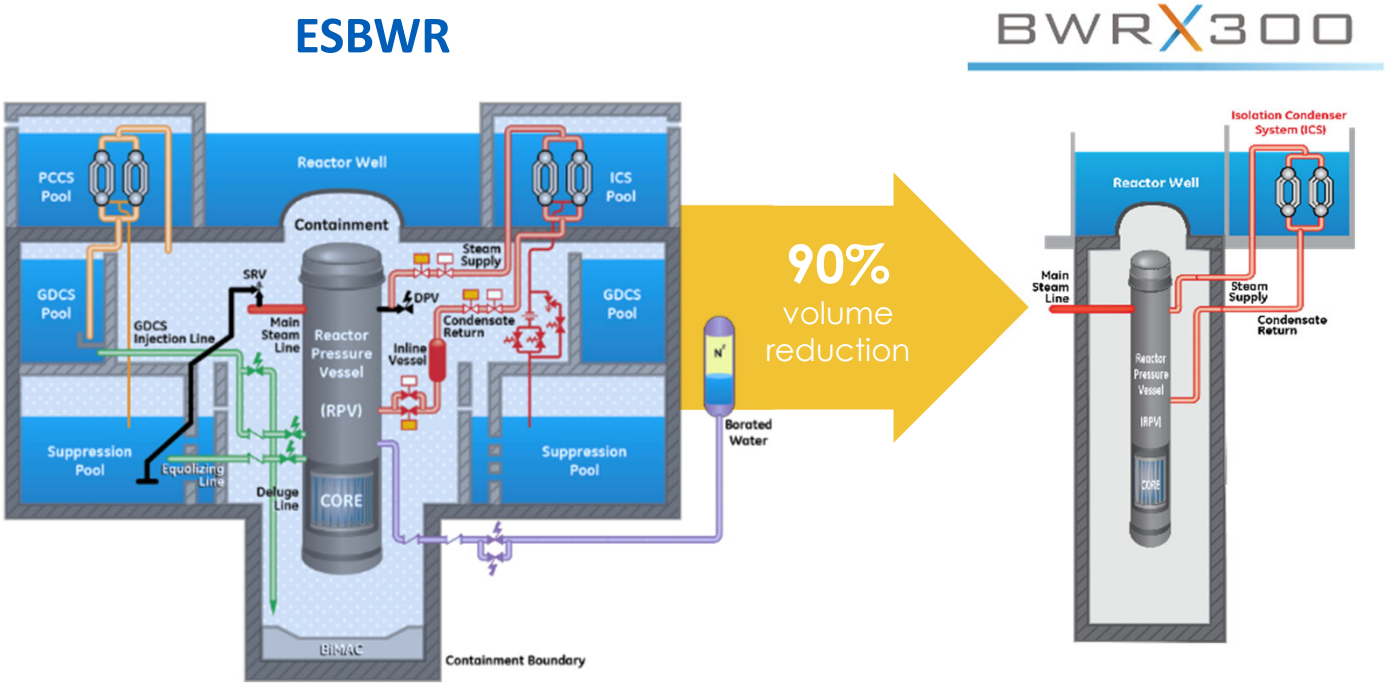
# Technology Overview

## *GE Hitachi: BWRX-300*

- **GEH SMR Technologies Canada** is the Canadian division of the world-leading provider of reactor technology and nuclear services.
- ~300 megawatt electrical (MWe)
- Light water, boiling water reactor technology
- Generation III+ Design
- Designed for a 60-year operational life, with high confidence in ability to extend to at least 80



# Simplicity of design




**Systems/components eliminated:**

- Suppression Pool
- GDCS Pool
- Safety Relieve Valves & Spargers
- Depressurization Valves
- BiMac (core catcher)

**Systems/components simplified:**

- Passive Containment Cooling (PCCS)
- Containment (use of SC)
- Boron injection
- Security (built into design)
- Turbine
- Generator (air cooled)

**>50% building volume reduction/MW**
**>50% less concrete/MW**

# 2022 DNNP Project Look Ahead

**OPG's goal** is to build the first on-grid SMR on-schedule and on-budget at the Darlington site, towards the end of this decade.

- Beginning of Site Preparation Activities
- Application to the CNSC for a Licence to Construct
- Further refine the cost estimate
- Continue collaboration with GE Hitachi on SMR design, engineering, planning and licencing.

**Conceptual rendering of BWRX-300 power plant design.**

# Technology Overview

## Global First Power

**Off-Grid SMR - Global First Power Micro Modular Reactor® Project at Canadian Nuclear Laboratories' (CNL) Chalk River Site**

- First SMR project in Canada - Target operation about 2026
- Partnership between OPG and technology developer Ultra Safe Nuclear Corporation (USNC)
- 15 $MW_t$ (5 $MW_e$) High-Temperature Gas Reactor (HTGR) using TRISO-based FCM® fuel; commercial demonstration project
- Will serve as a commercial demonstration model for SMR for heavy industry/mining; potential application in remote communities
- Host agreement with CNL
- Actively advancing design and licencing work

**An artistic rendering of the MMR® at Chalk River Project**

**Chalk River Laboratories**

# Technology Selection Methodology

OPG established **11 Assessment Areas** to identify risks/potential mitigations and opportunities.

## Assessment Areas

1. **Environmental Assessment (EA) Compliance**
2. **Project Management**
3. **Design Progress/Readiness**
4. **Safety Case**
5. **Fuel Supply & Security**
6. **Nuclear Materials & Used Fuel Management**
7. **Licensing Risk**
8. **Financial Review**
9. **Economic Development Potential**
10. **Economic Value to Ontario & Opportunity for Indigenous Communities**
11. **Contractual Agreements & Business Case Considerations**


No net-zero without nuclear
Achieve our climate change goals
Actively engage with Indigenous Nations and Communities
Deliver a world-class SMR, together.
Be a catalyst for SMR growth in other jurisdictions
Educate, inform and excite the industry, our partners & our communities
Be a world leader in SMR deployment

# In Conclusion

- We believe that **Net Zero will not be achieved without Nuclear**
- OPG has taken action to address the impacts of climate change and is
  - We are Refurbishing Darlington on time and on budget - providing 3600 MW for 30 years
  - Will deploy the first GRID scale SMR this decade,
  - We will evaluate and deploy high temperature steam reactors to decarbonize industry
  - We will deploy Micro Modular Reactors to decarbonize remote communities
  - We will evaluate options for additional SMR's and large Nuclear.
- We are an experienced nuclear operator and proficient project manager in executing mega-nuclear projects – we have the know-how to be successful
- We are showing **global leadership** supporting other jurisdictions as they deploy Nuclear