Changing Technology and Security: The Small Reactor Challenge

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Presented by:
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About Bruce Power

2001
Bruce Power Formed

2013
All 8 units Operational

2015
LTEP Agreement with Province signed

Today
6,300Mw Clean, Safe & Reliable Energy through 2064

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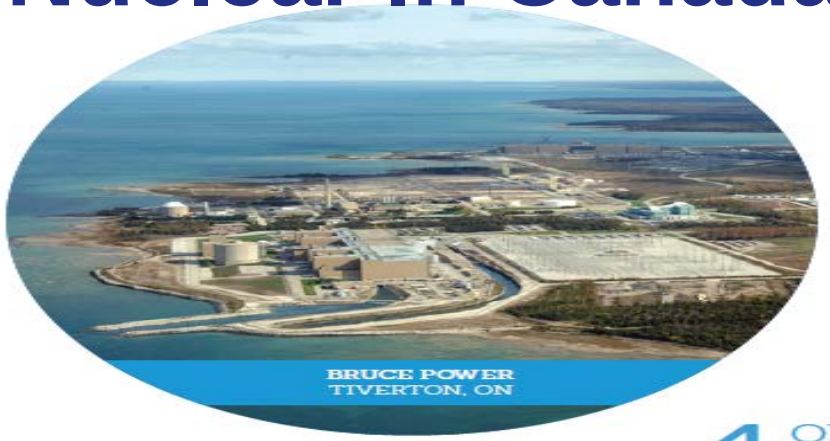
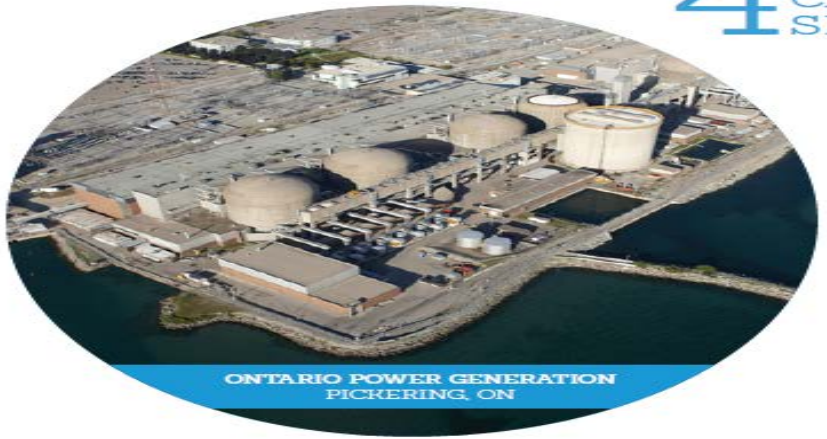
Nuclear In Canada Today



4 OPERATING CANDU SITES



Canada Today

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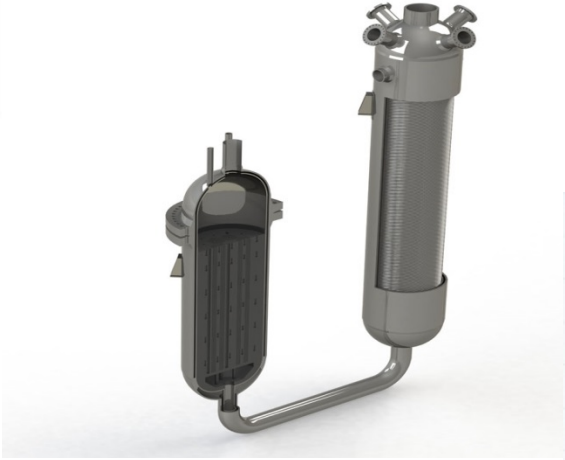
Canada Today

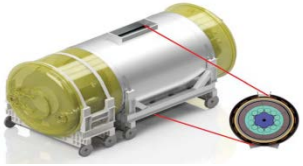
A Changing Landscape for Nuclear

U-Battery

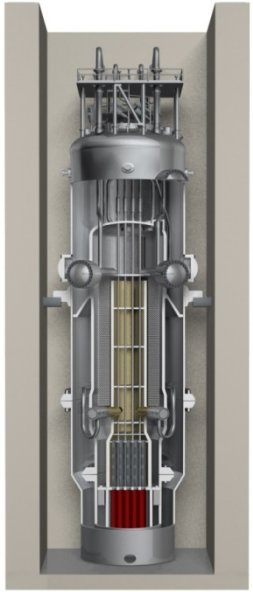
amec ATKINS UKAEA

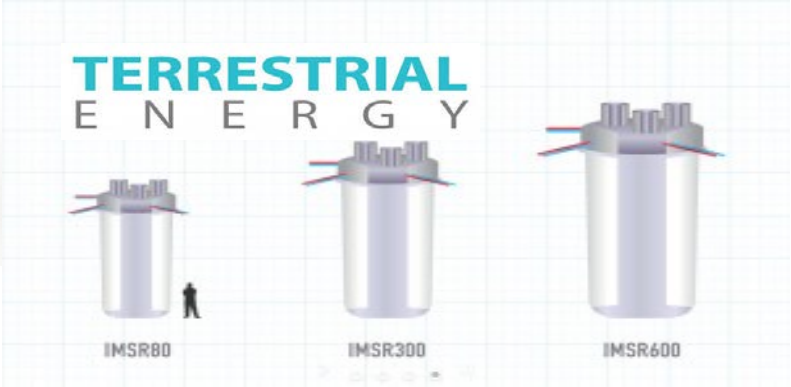


eVinci



NUSCALE POWER™





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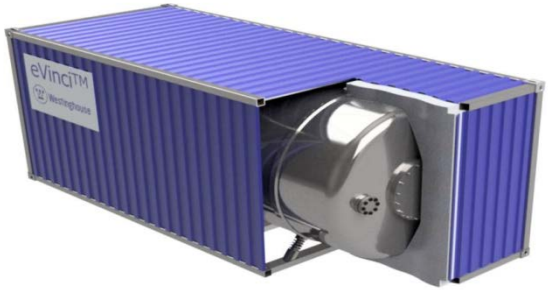
Small Reactors

NuScale Reactor

- Scalable Designs: <2 MW(e) to 300MW(e)
- .2% - 30% of nominal reactor unit
- Simple
- Greatly Enhanced Public Safety
- Many New Markets
- Fast Decommissioning
- No carbon

and .... **Portable**

eVinci



NuScale

Deployment Platforms

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Likely Deployment in Canada

- Smaller Canadian Markets:
  - Small Cities (Small Grid)
  - Natural Resource Extraction
  - Northern Communities
- Variety of energy uses:
  - Electricity
  - Process Steam
  - Heating Steam

Deployment in Canada

The Challenges:

- Remote locations
- Scalable, one solution doesn't fit all
- Much smaller cash flows
- Current industry approach to security not feasible

What about other industries?

San Bruno Gas Explosion

- 2010 Natural Gas Pipeline explosion
- San Bruno (San Francisco) CA
- 8 deaths, hundreds of injuries
- Crater 167 ft long, 40 ft deep in Glenview Drive
- Registered as 1.1 seismic event

- Thousands evacuated
- 35 homes destroyed, many damaged
- Victim settlements alone $565M

San Bruno Gas Explosion

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Toronto Propane Explosion (Sunrise)

- In 2008 Downsview Ontario
- Sunrise propane plant explodes

- 2 deaths
- 19,000 evacuated for several days (asbestos contamination)
- $1.9 M in cleanup costs and > $20 M in property damage

Sunrise Explosion

East Village Gas Explosion - NY

- March 26, 2015 in the East Village of Manhattan

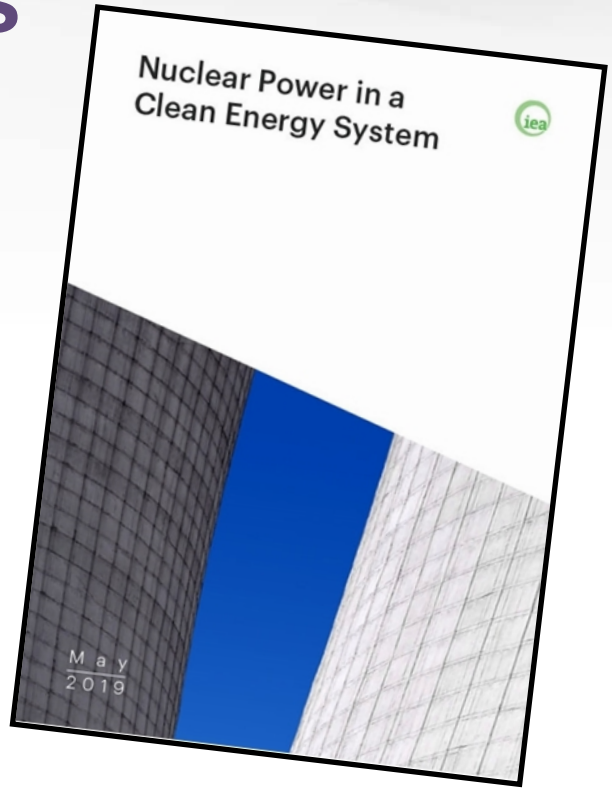
- 19 injured, 2 dead, 3 Bldgs destroyed
- Caused by tampering

Need and Urgency

The Challenge Before Us

World demand for energy is impacting the ability to achieve environment and climate change goals:

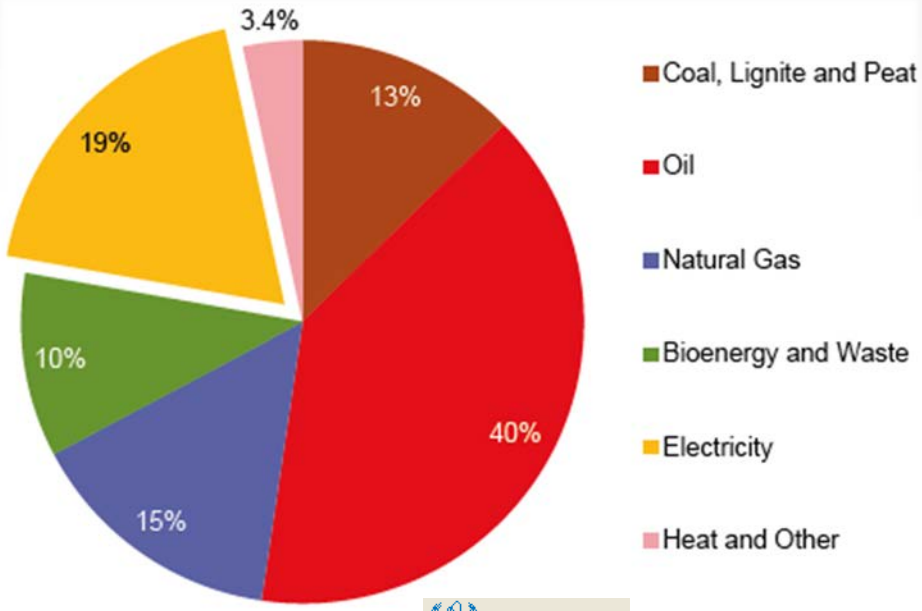
- Need to reduce fossil fuel consumption – coal, gas, diesel
- No single energy solution = more nuclear must be part of the mix to enable renewables and other new energy forms



2019 International Energy Agency report “Nuclear Power in a Clean Energy System”

The Need for Clean Energy

- Globally ~ 130,000 TWh total energy consumption:
  - Electricity 19% ~ 25,000 TWh
  - Fossil fuels ~ 70%
  - Bioenergy and waste ~ 10%
- Electricity consumption rising on average 571 TWh each year



IAEA International Atomic Energy Agency

2018 IAEA Energy Report

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Current Options

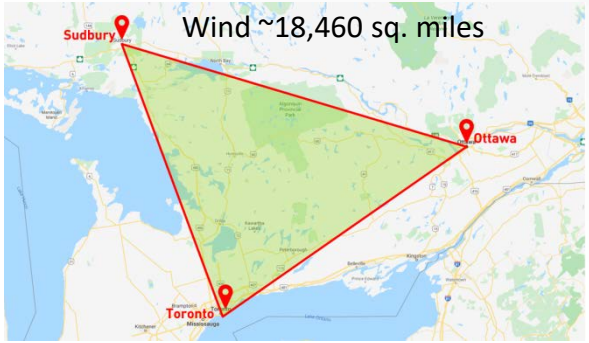
- Globally ~130,000 TWh total energy consumption
- Currently only about 1/3 of new generation is low carbon.
- Carbon levels continue to increase world wide.
- 570 TWh of new clean electricity required each year to maintain current carbon emissions levels.
- This is equivalent to addition of 1000 MW clean energy power plant every 5 days.
- Net zero carbon by 2050 requires 1000 MW every day plus retirement of equal amount of carbon emitting sources.
- Canada's 80 Mt carbon equivalent emissions reduction shortfall to 2030 target can be achieved by replacing coal generation with nuclear

570 TWh from Modern Sources	
Wind	• Intermittent - Capacity Factor 37% • ~56,800 - 3 MW units • Land usage - 18,460 sq. miles
Hydro	• Partially Intermittent - Capacity Factor -% • Land usage – 34,945 sq. miles
Solar	• Intermittent - Capacity Factor 26% • Land usage – 3,195 sq. miles
Nuclear	• 24/7 - Capacity Factor 93% • 71 -1000 Mw units • Land usage – 1,442 sq. miles

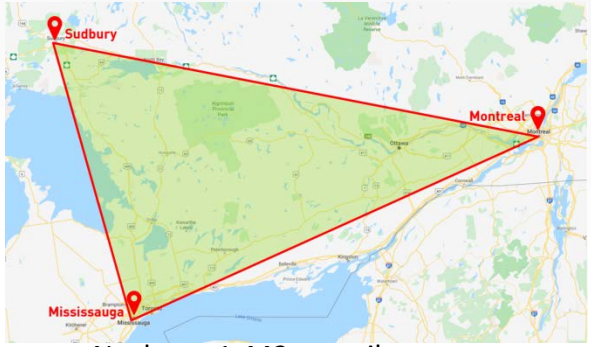
Land Usage by Energy Source

We need all of them

Wind ~18,460 sq. miles



Hydro ~34,945 sq. miles



Solar ~3,195 sq. miles

Nuclear ~1,442 sq. miles

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Conclusions

- Understand actual risks in relation to other risks in society, don’t look at nuclear in isolation
- Cost matters, reactor size matters, design matters
- One size solution will not fit all
- Make use of modern technology in security
- Delays in carbon reduction is itself a risk

The challenge for Regulators:

Innovation in…

Technology

Safety

Regulation

NuScale Power Module: shipped by Truck, Rail or Barge

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