



Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

CNL Involvement in International Efforts Supporting Small Modular Reactor (SMR) Safety

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Chair, OECD-NEA Expert Group on SMR
(Committee on the Safety of Nuclear Installations)

Advancing Small Modular Reactor Safety through Global
Collaboration: International Research and Regulatory
Research 2024 March 12



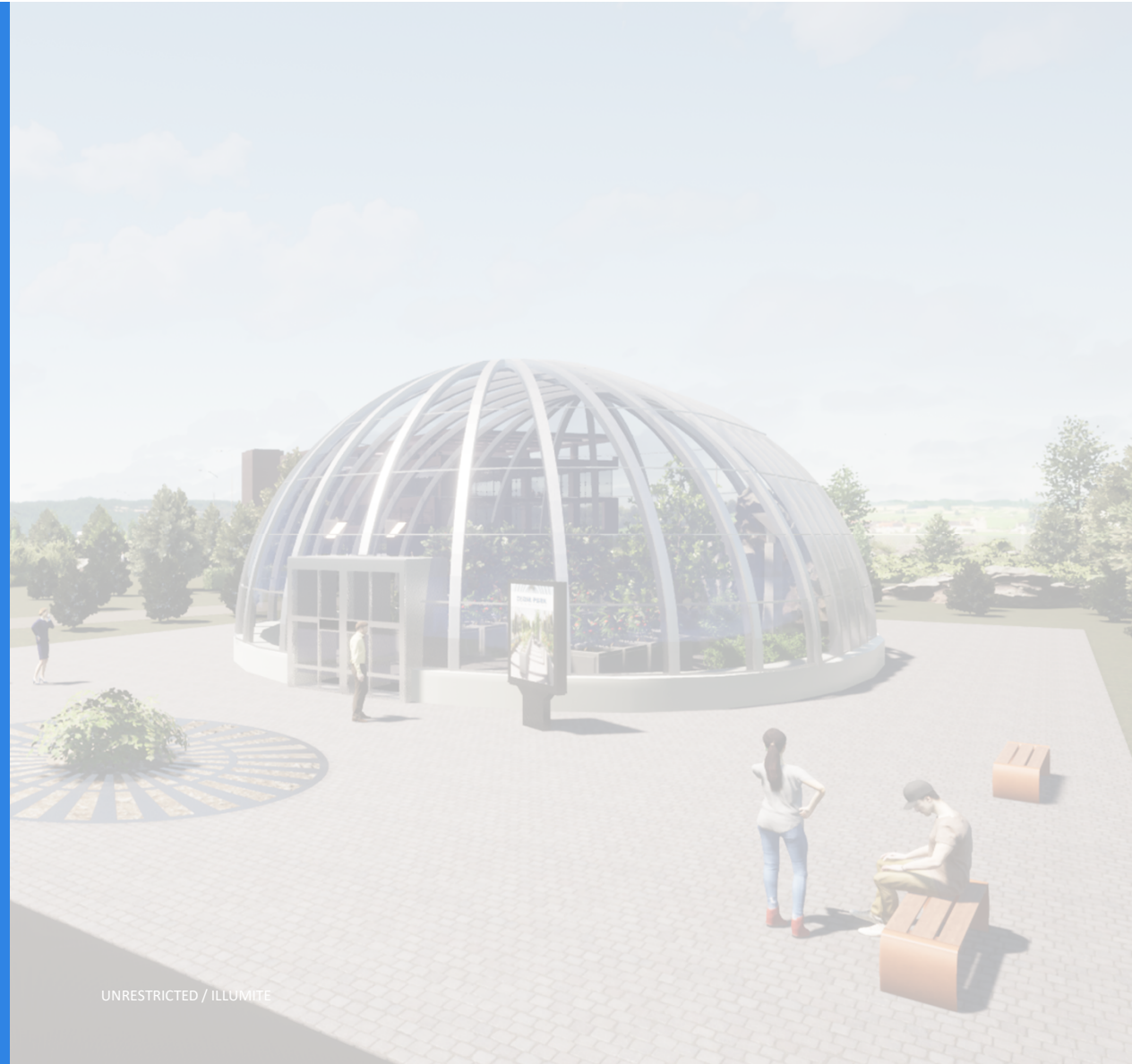
GE Hitachi BWRX-300 Single plant concept art:
- Successful bid for new SMR construction in Ontario, Canada

U.S. Nuclear Regulatory Commission (NRC)
2024 Regulatory Information Conference (RIC 2024)

As a national lab, our goals are to:

Meet our commitments to Canadians via our federal agency partners: support environmental stewardship, clean energy, and public health

Ensure science is able to confront the challenges of the 21st century



V2030



Restore and protect the environment

Conducting the largest and most complex environmental remediation in Canada, spanning three provinces



Clean energy for today and tomorrow

Support CANDU and LWR industry; SMR/vSMR demonstration and support for deployment; advanced fuel and materials; safety & security, hydrogen and fusion.



Improve the health of Canadians

Targeted Alpha Therapy program and radiobiology

SMR Deployment Landscape in Canada

Government support:

- Federal SMR Roadmap and SMR Action Plan
- Canadian Nuclear Safety Commission (CNSC) pre-licensing vendor design review (VDR); performance based regulation

Industry pursuing three development streams:

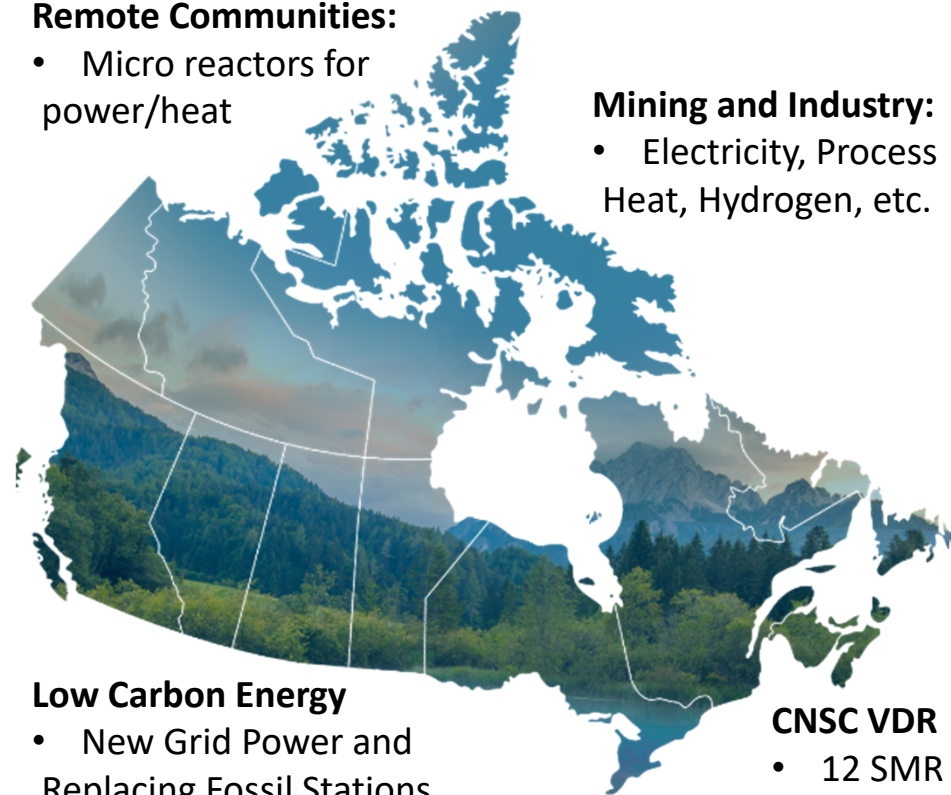
1. Grid-scale ($\approx 300 \text{ MW}_e$), demonstration by 2028
 - Ontario Power Generation (OPG) and SaskPower chose BWRX-300 (GE-Hitachi) for new-build
 - Capital Power partnering with OPG on SMRs in Alberta
2. Advanced SMRs and fuel cycle development
 - New Brunswick Power is pursuing two Advanced Reactors, Moltex SSR-W and ARC-100
3. Micro-SMR ($<15 \text{ MW}_e$), demonstration in 2020s
 - Global First Power demonstration project with USNC MMR underway at Chalk River Laboratories

Remote Communities:

- Micro reactors for power/heat

Mining and Industry:

- Electricity, Process Heat, Hydrogen, etc.



Low Carbon Energy

- New Grid Power and Replacing Fossil Stations

CNSC VDR

- 12 SMR designs

<https://smractionplan.ca/>

CNL Support for SMR Deployment

- Supporting Government of Canada in achieving its national target of net-zero emissions by 2050
- CNL is advancing clean energy technologies for today and tomorrow, including small and advanced nuclear reactors, hydrogen and fusion technologies.

Federal Nuclear Science & Technology (FNST)

- FNST Work Plan helps build a framework for SMR development & deployment in Canada

Canadian Nuclear Research Initiative (CNRI)

- Working with commercial companies to apply our nuclear capabilities to technical challenges

SMR Demonstration Siting

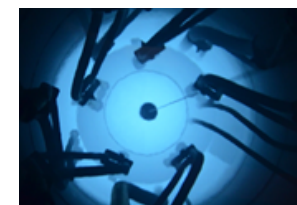
- Hosting a demonstration SMR on a CNL-managed site (e.g. GFP MMR at Chalk River)

Clean Energy, Demonstration, Innovation, and Research (CEDIR) Initiative

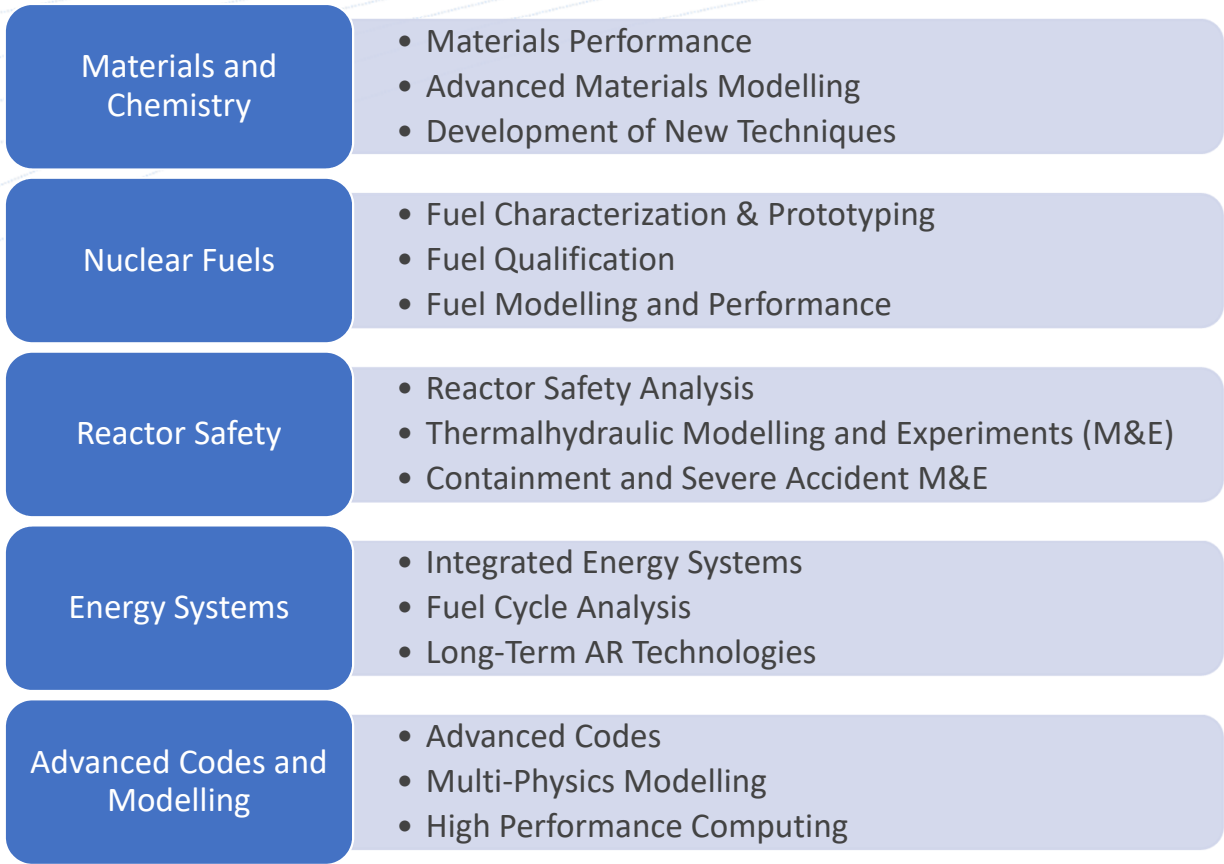
- Advancing technology readiness via a demonstration platform for clean energy systems and adjacent technologies

Fleet Support

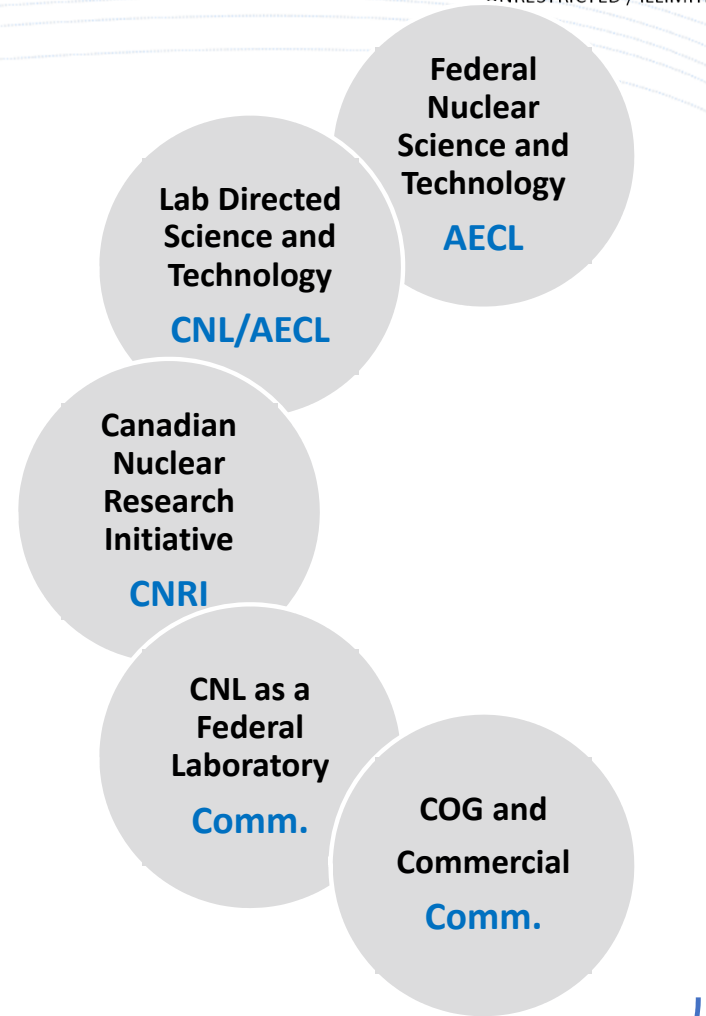
- R&D and services for current and future fleet (e.g. fuel and materials analysis, chemistry support, specialized equipment, reactor safety)
- Current and new facilities (e.g. ANMRC)



Advanced Reactors Directorate



Capabilities



Programs

CNL Research in Support of Safe Deployment of SMRs

- CNL's robust technical program supports SMR research, development, and deployment
 - Benefits from extensive experience supporting CANDU safety analysis for several decades
 - Objective is to investigate areas of interest and facilitate safe SMR deployment.
 - Identify important phenomena/knowledge gaps and investigate via experiments and modelling
 - Building experimental capabilities, analysis tools/codes, and identifying validation data needs
 - Research program is continually evolving and the focus is narrowing to more specific technologies and deeper analysis for designs that are moving closer to deployment.
 - Initial "technology agnostic" approach seeking to build a base level of knowledge and capabilities broadly covering a wide variety of advanced reactor technologies.
 - Increase efforts and detail for technologies moving towards deployment
 - Informed by SMR deployment in Canada and interests of utilities, vendors, and government.
 - Designs currently under exploration: iPWR, small BWR, HTGR, SFR, MSR, and heat pipe designs
- CNL values international involvement (IAEA, NEA, GIF, EU) and opportunities for collaboration (domestic and international; academia; commercial work with vendors)

International Atomic Energy Agency (IAEA)

CRP I31029 – Development of Approaches, Methodologies and Criteria for Determining the Technical Basis for Emergency Planning Zone (EPZ) for SMR Deployment (2018 February to 2021 August; TECDOC in publication)

Co-organized by Nuclear Energy and Nuclear Safety and Security, and focused on:

- i) Criteria on the events/technical aspects to be considered for EPZs sizing;
- ii) Methods relating SMR safety features to offsite arrangements needed;
- iii) Suitable technical basis for emergency preparedness and response.

IAEA Nuclear Harmonization and Standardization Initiative (NHSI) Industry Track Topic 3: “Experimental Testing and Validation for Design and Safety Analysis Computer Codes”

Collecting information on experimental facilities that can support SMRs and generate data suitable for code validation; to be contributed to a web portal and discussed at an upcoming workshop (2024 June). Conducted in partnership with the NEA.

NEXSHARE: is proposed as an international collaboration mechanism between design organizations, experimental facilities, relevant International Organizations, TSOs and applicable code developers.



CRP I31029 Participants: Argentina, Canada, China, Finland, Indonesia, Israel, Japan, Netherlands, Pakistan, Republic of Korea, Saudi Arabia, Tunisia, UK, USA.



2nd research coordination meeting, Beijing 2019 May



SHARE



Topic 3 Group Meeting 2023 July)

OECD Nuclear Energy Agency (NEA)

Committee on the Safety of Nuclear Installations (CSNI) Expert Group on Small Modular Reactors (EGSMR)

EGSMR was organized in 2021 and its membership includes 23 organizations (15 countries + international bodies). CNL is currently the chair of EGSMR.

- Assess CSNI activities on SMRs (high TRL/near-term deployment)
- Identify and rank safety knowledge gaps and provide recommendations to address the gaps (focus on safety issues crossing a number of designs)
- Identify any new technical areas CSNI needs to develop, and necessary experimental programmes and some of the key facilities.

NEA Joint Projects

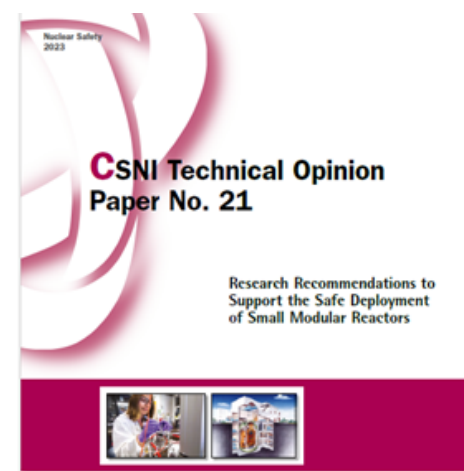
While most NEA joint projects are focused on current reactors, several are including components, testing, and future efforts targeted to support the safety of SMRs.

CNL is heavily involved in several NEA joint projects including ROSAU, FACE, THEMIS, TCOFF-2, PANDA, (and coming soon COPS and POLCA) as well as WGAMA.

- THEMIS (+ upcoming successor): aerosol behaviour in SMR containment
- PANDA will include experiments related to SMR containment (H₂ and FPs)



EGSMR-5 meeting, Ottawa 2023 October



https://www.oecd-nea.org/icms/pl_79842/expert-group-on-small-modular-reactors-egsmr

Generation IV International Forum (GIF)

Canada signed the GIF charter for development of the next generation of nuclear energy systems in 2001. CNL's work in the **FNST Work Plan** gives effect to Canada's multilateral partnership.

Risk and Safety Work Group (RSWG)

Formed in 2005 to promote a consistent approach to safety, risk and regulatory issues for Gen-IV systems and advise on evaluation methodologies. It is currently co-chaired by members from **Canada (CNL)** and the **European Commission (Joint Research Centre)**

RSWG activities:

- Risk-informed Framework for Safety Design of Generation IV Systems
- Investigation on mechanistic source term assessment methodologies.
- Investigation on identification of practically eliminated situations.

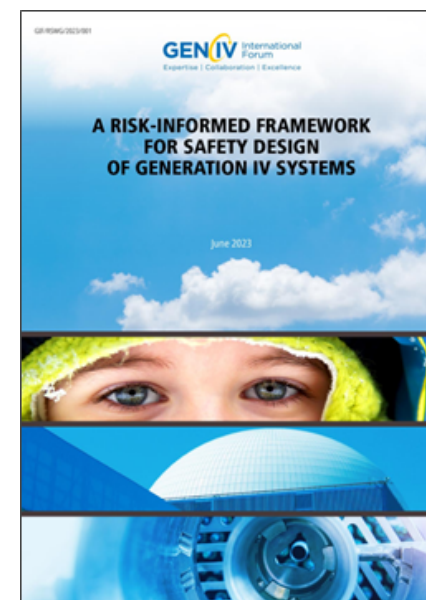
GIF Design Groups

CNL participates in multiple GIF design groups including VHTR, MSR, and SCWR

Gen-IV International Forum Goals, https://www.gen-4.org/gif/jcms/c_9502/generation-iv-goals



<https://www.gen-4.org/gif/>



https://www.gen-4.org/gif/jcms/c_212805/riapproachpositionpaper-final

European Union (EU)

NERIS: European Platform on Preparedness for Nuclear and Radiological Emergency Response and Recovery

“The mission of the NERIS Platform is to establish a forum for dialogue and methodological development between all European organisations and associations taking part in decision making of protective actions in nuclear and radiological emergencies and recovery in Europe.” (<https://www.eu-neris.net/>)

CNL is a NERIS support organization, and has made contributions to NERIS research in emergency preparedness and response, decision support, and disaster informatics.

SNETP (including SASPAM-SA, IPRESCA, AMHYCO, SEAKNOT, etc.)

The Sustainable Nuclear Energy Technology Program (**SNETP**) is the EU technology platform for research, development, and deployment of nuclear fission technologies.

CNL contributes to multiple projects (**SASPAM-SA, IPRESCA, AMHYCO**) under **FNST**.

SASPAM-SA (2022-2026) is a collaborative research project in SNETP’s Nuclear Generation II & III Alliance (**NUGENIA**) dedicated to the **study of Level 4 and Level 5 of defence in depth for small pressurized water reactors**. CNL is making broad contributions to SASPAM: i) severe accident modelling (source term assessment); ii) aerosol behaviour in iPWR containment; iii) atmospheric dispersion; iv) emergency preparedness and response methodologies.



<https://www.eu-neris.net/>



<https://snetp.eu/>



<https://www.saspam-sa.eu/>



Thank you for your attention

Questions?



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