# Canadian Perspective: University Activities in Nuclear Research and Education

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# Outline

- UNENE Introduction
- Update on Canadian Nuclear Sector
- Canadian Nuclear Academic Initiatives
- Links between Canadian and UK Nuclear programs – research/E&T/academia
- Looking ahead

# UNENE: *University Network of Excellence in Nuclear Engineering;*

## UNENE: Created as a Partnership

## Main focus: Education and Research

Formed in Canada in 2002 to address industry gaps in staff development, R&D coordination, and knowledge management

UNENE is a partnership between industry, universities and government – founding objectives:

- Supply of  Highly Qualified Personnel (HQP)
- Support, fund and coordinate nuclear research in universities to address industry needs
- Create a respected pool of university-based expertise for independent industry and stakeholder consultation

# UNENE Today

UNENE coordinates and funds academic courses, university Industrial Research Chairs (IRC's) and individual Cooperative Research Projects (CRD's)

- M.Eng and Diploma programs: tailored for part-time/distance education allowing the students to earn credits while continuing in employment;
- Based on academic programs, UNENE delivers training courses tailored to member needs
- IRC's: Chairs lead investigations into key industry issues, and develop as independent authorities
- CRD's: Build specialized knowledge and insight and "fill gaps" in fundamental knowledge and capability, while developing HQP for industry

# UNENE Members

- Canadian Nuclear Labs (CNL) (formerly AECL-CRL)
- Bruce Power
- Ontario Power Generation (OPG)
- Canadian Nuclear Safety Commission(CNSC)
- CANDU Owners Group (COG)
- NWMO
- Kinectrics
- SNC-Lavalin-Nuclear (formerly Candu Energy Inc)

McMaster University
Queen's University
University of Ontario Institute of Technology
University of Saskatchewan
University of Toronto
University of Waterloo
University of Western Ontario
Ecole Polytechnique
University of New Brunswick
Royal Military College
University of Guelph
University of Windsor
University of Regina

# Canadian Nuclear Sector Update

The Canadian nuclear sector:

- *active and progressing over a wide range of scope*
- *Government(s) policy varies - always complex. Federal Government quietly supportive of nuclear.*

Important areas of activity:

- *Fleet operation and life extension*
- *Decommissioning and remediation*
- *Waste Management Solutions*
- *SMRs and vSMRs*
- *International Linkages*

# Canadian Nuclear Sector Update

## Important areas of activity

- *Fleet life extension;*
  - *Darlington Mid-Life refurbishment progressing to plan*
  - *Bruce Power units in operation to 2064*
  - *Utilities delivering medical isotopes in parallel with power production*

# Canadian Nuclear Sector Update

## Important areas of activity

- *Decommissioning*
  - *Active program of decommissioning and remediation for legacy facilities at Chalk River and Whiteshell research sites*
  - *Focus on R&D and innovation in preparing for power unit decommissioning – prototypes first up*

# Canadian Nuclear Sector Update

## Important areas of activity

- *Waste Management Solutions --Nuclear Waste Management Organization progressing with volunteer site approach and with spent fuel container technology*

- *SMRs and vSMRs – very active Canadian programs on several fronts:*
  - *2018 Pan-Canadian SMR Roadmap supported by government*
  - *Regulatory cooperation, e.g. recent MOU with USNRC*
  - *Demonstration build project(s) with Canadian Nuclear Labs*
  - *Utility studies of deployment*

# Canadian Nuclear Sector Update

Important areas of activity

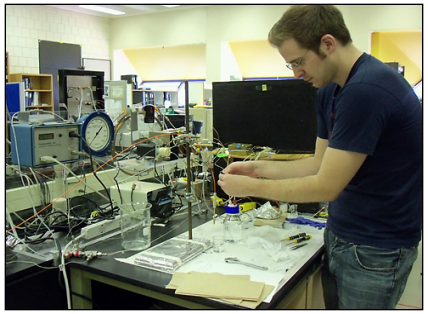
- *International Linkages – Canada active in promoting nuclear cooperation internationally, through government-to-government and institutional programs, bilaterally and through NEA and IAEA*

- *Canada-UK Cooperation: Government-to-government cooperation via NCA, with solid support from Canadian federal government*

# Canada and UK Nuclear relationships -- University and Related Sectors

Canadian and UK nuclear sectors have many common areas

- Evolving decommissioning and remediation scope – common history, touch points
- Strong and common interests in developing SMRs to real deployment
- Challenge of outreach from the technology practitioners to stakeholders, civil society, public
- History of government co-operation



# Canada and UK Nuclear relationships -- University and Related Sectors

- Points of contact in the university space:
  - Education:
    - *UNENE represents collaborative delivery of courses via member universities – parallel with NTEC*
  - Research:
    - *Topics of common interest, recent individual initiatives,*
    - *Directory of capabilities, programs, facilities*
  - Outreach:
    - *UNENE and member universities are active in cooperation with IAEA, OECD-NEA: NEST program initiative*

# Current research activities: UNENE Industrial Research Chairs

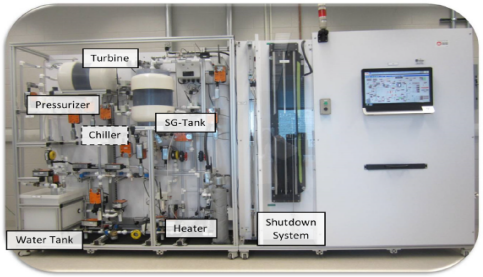
| RC Title | Location | Holder(s) |
|---|---|---|
| **Nuclear Materials** | Queen's University | M. Daymond |
| **Nuclear Safety/ Advanced Thermalhydraulics** | McMaster University | J. Luxat/ D.Novog |
| **Control Instrumentation and Electrical Systems** | University of Western Ontario | J. Jiang |
| **Corrosion Studies, Material Performance in Nuclear Systems** | University of Toronto | R. Newman |
| **Risk and Reliability based Life Cycle Management** | University of Waterloo | M. Pandey |
| **Radiation Physics and Environmental Safety** | University of Ontario Institute of Technology | A. Waker / E.Waller |
| **Radiation induced Corrosion** | Western University | C. Wren (IRC) |
| **High Temperature Aqueous Solutions** | University of Guelph | P. Tremaine |

# Canada and UK Nuclear relationships -- University and Related Sectors

Other emerging areas of research:

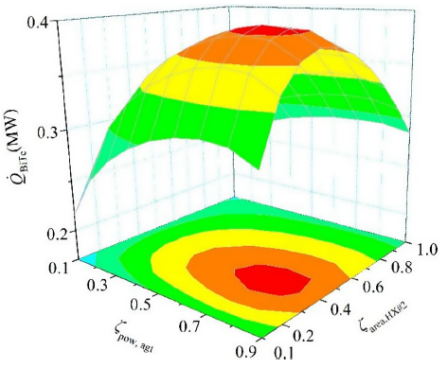
R&D Projects under way include….

- Eddy current testing innovations
- Studying I&C effects in a full-scope micro-grid
- Use of coupled drones for multi-parameter mapping
- Study handling of molten-salt coolants in maintenance
- Long-term corrosion in spent-fuel repository containers
- Corium behaviour within reactor vessels
- Etc. etc.



# Canada and UK Nuclear relationships -- University and Related Sectors

- Universities also involved in….




*Sup*port to SMR design and development

– *Moltex and ARC in New Brunswick*

*-- University studies supporting Terrestrial Energy*

*-- NEST Program of international fellowships pursuing SMR research*

*-- University participation in SMR demo planning at Chalk River*

Linking Social Science studies with nuclear technology

*-- Understanding community expectations for new facilities*

# Canada and UK Nuclear relationships – Looking ahead

- Common topics for consideration in university sector
  - *Student exchange possibilities*
  - *Joint student projects*
  - *Visiting lectures*
  - *Bi-lateral participation in symposia and workshops*
  - *Collaborative research projects*
  - *Working together on outreach – providing informed viewpoint into the energy debate*

UNENE
University Network of Excellence in Nuclear Engineering

# Thank you

Questions welcome!

# Typical Courses

- Nuclear Reactor Physics [McMaster]
- Nuclear Reactor Safety Design [McMaster]
- Nuclear Reactor Heat Transport System Design [McMaster]
- Nuclear Plant Systems and Operations [UOIT]
- Nuclear Fuel Management of the Reactor Core [UOIT]
- Control, Instrumentation and Electrical Systems in CANDU based Power Plants [Western]
- Nuclear Fuel Waste Management [Western]
- Project Management for Nuclear Engineering [Western]
- Engineering Risk and Reliability [Waterloo]
- Introduction to Operational Health Physics [McMaster]
- Nuclear Fuel Engineering [McMaster]
- Power Plant Thermodynamics [McMaster]
- Reactor Chemistry and Corrosion [McMaster]
- Nuclear Materials [Queen's]
- Nuclear Regulation (McMaster)

*Coming soon:*
*Course on SMR's and*
*Advanced Reactor technology*