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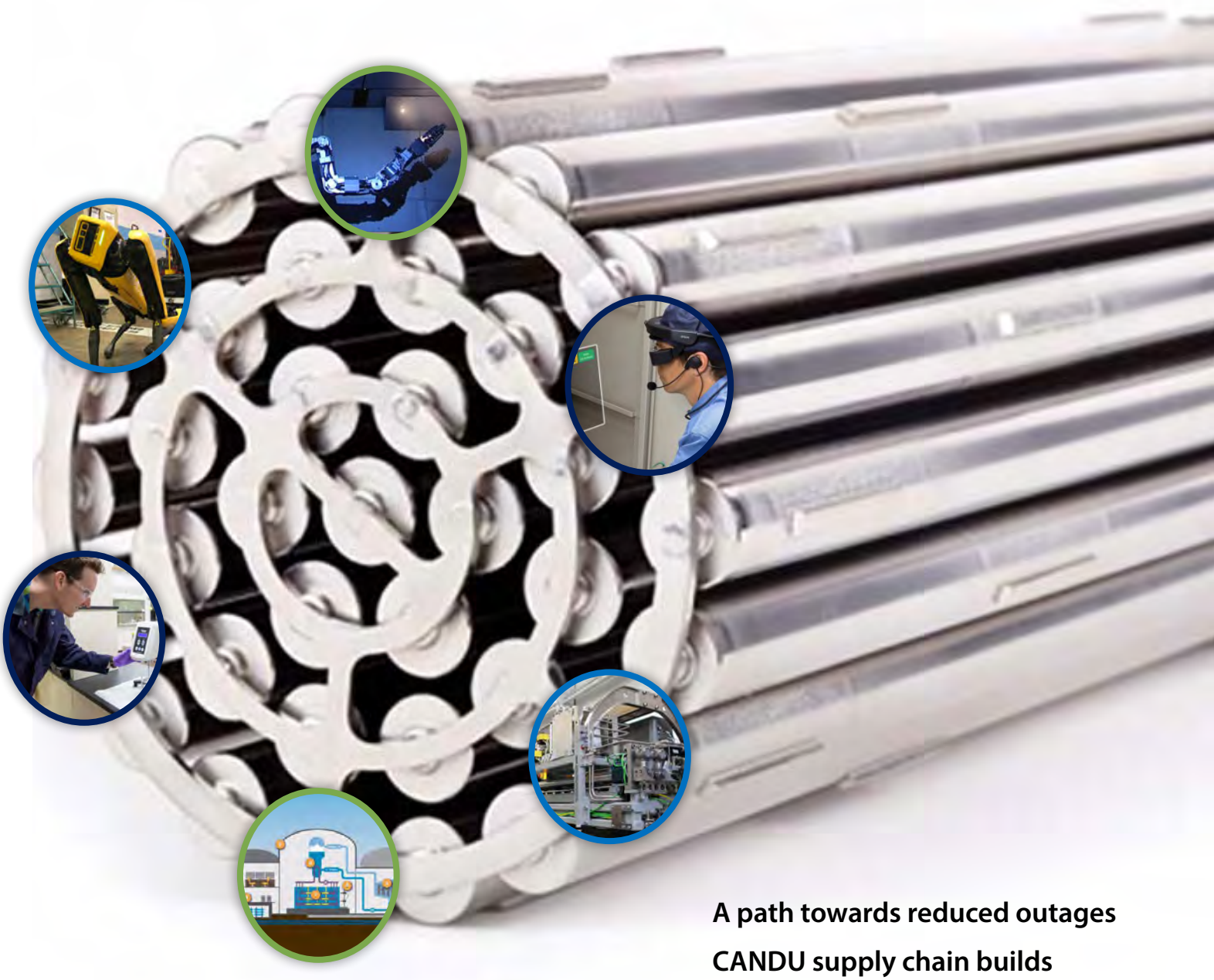
COGNIZANT

A magazine of the CANDU Owners Group

Celebrating innovation in CANDU and beyond



A path towards reduced outages

CANDU supply chain builds human performance

Hydrogen tool monitors corrosion

Progress on the SMR roadmap

...and more innovations in CANDU and beyond

CANDU Owners Group Inc.

"Excellence Through Collaboration"

Innovation starts with people

Stephanie Smith
President & CEO

Disruption has always been a part of the human experience. But, right at this moment we are living through some of the fastest pace of change in history. In fact, we are managing the impacts of three major disruptors, simultaneously: climate change, the digital technology revolution, and the influences of the COVID-19 pandemic. Add to that, real change in social expectations.

I am a glass half-full person and as such, while I recognize the challenges, I am focusing on the opportunities resulting from these disruptors. Today, I see the important role nuclear can play to advance a more sustainable future with clean energy infrastructure and quality of life.

In this issue of COGnizant, you will find stories about how the COG community is contributing through the innovative technologies and processes developed through COG, by our employees, members, supply chain and partners, working together.

The tools we use, the methods of our collaboration and even the people themselves are changing. We are embracing digital technologies for CANDU plant modernization, we are exploring new reactor designs and, importantly, we are committing to more equitable, diverse, and inclusive workforces and stakeholder engagement that will make us wiser in our decision-making and more agile in our approach.

What has not changed in more than 35 years since COG was created is the reason we are here: To achieve stronger results through a robust, well-managed collaboration mechanism.

COG's well-established structures of information sharing, peer groups, forums and collaborative research and project development allow us to pool resources and learn from each other. Together, we create, retain, and transfer our knowledge across our industry and into the next generation. Together, we use this knowledge to build a sustainable future. And, through it all, what remains constant is our unfailing commitment to ***excellence through collaboration***.

- Steph

Click here to read more about the COG Management Team, pictured above.

Innovation through collaboration

The CANDU Owners Group is a knowledge management organization that drives innovation and continuous improvement through four lines of business on behalf of its members, CANDU operators worldwide. Through COG, our members collaborate to manage, share, and strengthen knowledge through four lines of business:

- Research and Development
- Joint Projects and Services
- Information Exchange, (including Learning and Development) and
- Nuclear Safety and Environment Affairs

Our Team

Our diverse and expert workforce brings subject matter and project management expertise to ensure continued improvement and innovation in CANDU technology and beyond. But COG is more than just our employees. Through the COG collaboration model, the expertise of our members, supply chain and partners helps make us stronger.

Learn more at www.CANDU.org

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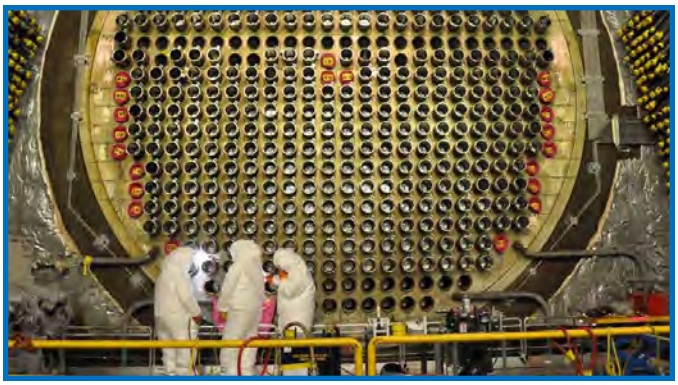

THE INNOVATION ISSUE

Working with members, partners, researchers, and suppliers in Canada and internationally, the CANDU Owners Group team drives innovation and continuous improvement in CANDU technology and beyond.

Read about the latest achievements and the newest tools and processes in this issue.

INNOVATION - Technology

See more content, *next page*

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INNOVATION - Collaboration

COGnizant Magazine

COGnizant is a publication of the CANDU Owners Group (COG), a private, not-for-profit corporation funded voluntarily by CANDU operating utilities, Canadian Nuclear Laboratories and supplier participants.

For more information, visit us online.

www.COGonline.org *(member site)*
www.CANDU.org *(public site)*

Produced by Querencia Partners Canada Ltd.

On the cover: COG members and suppliers are working together to innovate the future. Clockwise from far left: OPG, MDA, Alithya, Bruce Power, Kinectrics, CNL.

INNOVATION - It's the people

Innovative Technologies

Solutions for CANDU's future

OPG Pickering Nuclear's use of a robotic dog for hazardous jobs parallels work being done in COG's Strategic R&D program studying the use of robotics in CANDU decommissioning. ***Image: OPG***

COG's Strategic R&D program, now in its sixth year, is focused on developing technologies and other solutions for the current and refurbished CANDU fleet to keep units operating safely and reliably, over the next several decades

While CANDU technology has nearly 70 years of history in Canada, COG's Strategic R&D (SRD) program is interested in its future.

Launched in 2015 and funded by Ontario Power Generation (OPG), Bruce Power, New Brunswick Power (NB Power) and Canadian Nuclear Laboratories (CNL), SRD works to meet long-term goals such as industry sustainability and improved plant life expectancy, over the next 25 years and beyond.

The COG SRD program has approximately 70 on-going projects in areas such as decommissioning and long-term waste management; outage reduction; low dose radiation; enhanced computer codes to improve safety margins; improved materials to extend reactor life as well as work packages in advanced manufacturing and human performance.

"The SRD program looks at entirely new fields of research and creating forums where our members can discuss emerging issues."

It works in partnership with members, nuclear suppliers, academia and international nuclear organizations like EPRI and the U.S. Department of Energy. It is advancing program goals which were developed in response to a set of "grand challenges" identified by industry leaders in 2015. A year later, the goals were validated by the chief nuclear officers and engineers from OPG, Bruce Power and NB Power and built into eight strategic focus areas.

Over the last two years, the SRD program developed roadmaps to chart its work in these areas and in March 2020, formed strategic technical committees to manage execution of the focus area roadmaps.

COG's Holly Anderson, who has spent more than 40 years in the nuclear industry, and currently serves as COG's Senior R&D Program Advisor says SRD anticipates tomorrow's issues and opportunities, today.

"The SRD program looks at entirely new fields of research and creating forums where our members can discuss

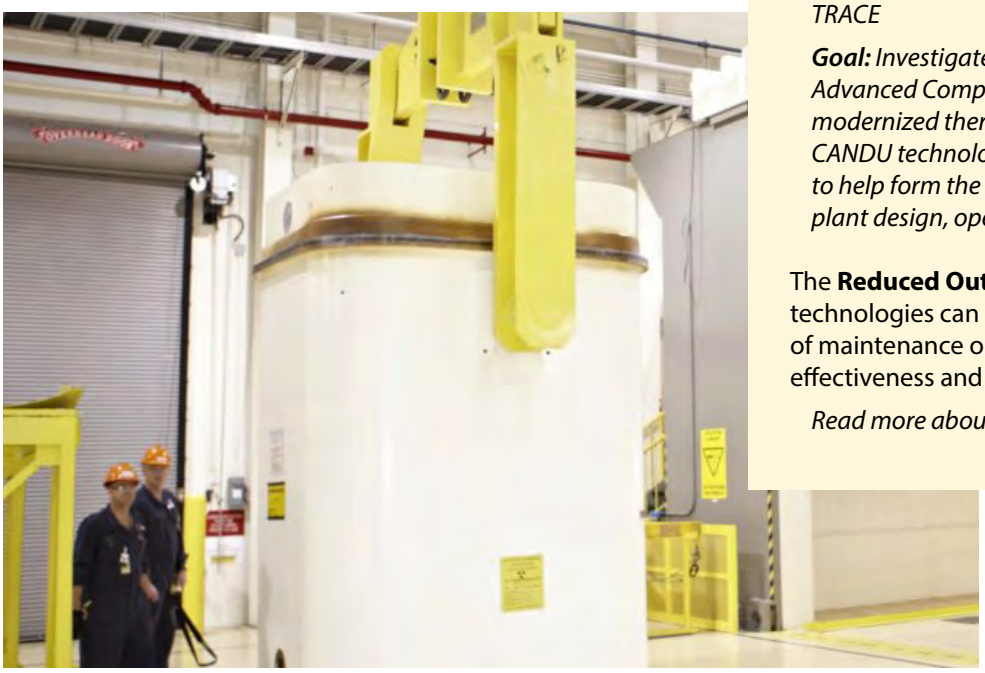
emerging issues," she says. "From societal acceptance of low dose radiation to public acceptance of where you put waste, COG is trying more and more to anticipate the needs of its members."

Anderson believes similar to the way individual COG members pull together through the R&D base program to address the current needs of the industry, the same collaborative approach can benefit them in finding solutions to future challenges.

On Jan. 4, Virgini Donaldson joined COG as its new SRD Program Manager (see related story here). A veteran engineer with long-standing nuclear industry experience and PMP (project management) and PMI-RMP (risk management) designations, Donaldson also sees high value in the SRD program.

"COG's SRD Program is working with members and participants to investigate new tools, materials, methodologies and progressive solutions, in the short-and-long-terms, keeping CANDU technology safe, reliable and in use, for years to come," says Donaldson.

"The innovations we are witnessing within the program are truly exciting. Some are benefiting the CANDU industry, today, while others are just on the horizon."



COG's Strategic R&D program is investigating new tools, materials, methodologies and solutions, in areas such as decommissioning and long-term waste management, among others. ***Image: OPG***

Highlights of the COG SRD program

The **Materials Properties** area focuses on improved understanding of material properties of reactor core components to provide longer overall reactor life.

Project: *Feasibility Study for Long Life Fuel Channel: Thick Wall Pressure Tube with Chromium Plated or Alloy Rolled Joint*

Goal: *Reduce hydrogen entry into pressure tube to increase pressure tube life.*

The **Decommissioning and Waste** area focuses on technology and infrastructure to minimize waste and reduce dose.

Project: *Robotics and Automated Systems Application to CANDU Decommissioning Activities*

Goal: *Study and advance technologies to efficiently and safely disassemble reactor component parts while minimizing worker dose.*

The **Enhanced Computer Code** area focuses on developing enhanced safety analysis codes and reduce cost and effort in computer code verification and validation.

Project: *Implementation of CANDU Functionality in TRACE*

Goal: *Investigate the adoption of the TRAC/RELAP Advanced Computational Engine (TRACE), a modernized thermal-hydraulics computer code for CANDU technology. Thermal hydraulics codes are used to help form the basis for decisions made concerning plant design, operation and safety.*

The **Reduced Outages** area focuses on how new technologies can reduce the time and frequency of maintenance outages while increasing their effectiveness and safety.

Read more about this work in the adjoining story.

Workers at Ontario Power Generation's (OPG) Pickering Nuclear during a planned maintenance outage. ***Image: OPG***

Building a better outage

COG's Reduced Outages Program is working with members and suppliers to explore how new technologies can reduce the time and frequency of maintenance outages while increasing their effectiveness and safety

Across the CANDU fleet, strong, efficient and continuous performance, with less frequent and shorter outages, has become increasingly common even as many reactors have reached several decades of lifetime operation.

Case in point, in February, Ontario Power Generation's (OPG) Darlington Nuclear Plant Unit 1 reached 1,106 continuous days of operation or just more than three years, since going online Jan. 26, 2018.

This was the longest period any nuclear power reactor in the world had been in continuous operation by nearly 150 days. The record-breaking achievement in uninterrupted power generation was possible thanks in part to innovations and developments in inspection and maintenance outage technologies and processes.

Many CANDU stations are making progress towards longer lengths of time between maintenance outages with similar advancements.

Through CANDU Owners Group's (COG) Reduced Outages Program, COG member utilities are collaborating with Canadian Nuclear Laboratories (CNL), COG supplier participants like MDA, Alithya and Kinectrics, and University Network of Excellence in Nuclear Engineering (UNENE) to develop and employ advanced technologies and methods to achieve significant reductions in planned outage maintenance work, outage duration, cost and worker dose.

The goal of this area of Strategic R&D (SRD) is reducing costs and returning plants online faster, resulting in greater earnings from increased generation and better overall performance.

Opportunities to apply some of the latest technologies are being explored as part of the reduced outage effort including machine learning, robotics, digitalization, automation, online monitoring, new and improved sensors, probes and advanced analytics. Coupled with initiatives in human performance and process improvements such as the on-going advancements in condition-based maintenance, CANDU stations are expecting to see stronger performance results with less time offline.

"The recent record-breaking performance by Darlington's Unit 1 demonstrates the outstanding performance capabilities

"The impetus for this new and higher level of COG collaborative research, which reduces risks and shares costs and benefits, has never been stronger."

of a well-managed CANDU reactor," says John de Grosbois, COG SRD Reduced Outages Program Lead.

"In the near term, there is a wave of new technologies upon us, such as augmented and virtual reality, among others," he says. "Collectively, these so called 'disruptive' technologies are creating significant and impactful innovation opportunities," he says.

The Reduced Outages program actively engages site specialists as an active part of the COG R&D team, with suppliers and university researchers, to identify, prototype and deliver new transformational solutions.

The use of technology to reduce maintenance effort during outages was identified as a strategic focus area and a top priority by COG member CNOs when the SRD program first launched in 2016. The goal was to minimize work associated with inspection and monitoring during outages and to develop strategies to avoid or shorten them all together.

As well, the program seeks to find ways to improve outage-related planning, logistics and training along with tools and delivery systems.

"We are actively pursuing information exchange and cooperation with EPRI's Plant Modernization Program and other partners, like Halden and INL (Idaho National Lab), to leverage their excellent research and technology capabilities into our research and development initiatives," says de Grosbois.

"The impetus for this new and higher level of COG collaborative research, which reduces risks and shares costs and benefits, has never been stronger."

Highlights of COG's Reduced Outages program

COG's Reduced Outages program is exploring application of a number of different technologies to reduce maintenance effort during outages and reduce time offline for CANDU plants.

Online monitoring and condition-based maintenance

Supplier participant: MDA

This work area focuses on improved and proactive monitoring and maintenance of equipment, components and systems.

Automated analysis and data analytics

COG member: CNL

This area looks at using artificial intelligence and advanced analytics to process outage inspection data faster and more accurately.

Advanced sensors, probes and scanning technologies

COG member and supplier participant: CNL and Kinectrics

This work focuses on development of improved inspection technologies, such as ultrasonic and electromagnetic sensors, focusing on faster, more accurate scans of steam generators, feeders and fuel channels.

Improved fuel channel inspection

Supplier participant: MDA

This research focuses on tooling to enable transition toward inspections outside of traditional outage windows and in the longer term, possibly some fuel channel inspections and monitoring online.

Digitalization and modernization

Supplier participant: Alithya

This work focuses on use of a range of new technologies including mobile computing and semantic information technology to improve data collection and integration to make maintenance work more efficient and coordinated with other plant activities.

Robotics and automated tooling

Supplier participant: MDA

This research area investigates use of autonomous or remotely-controlled robots for use in hazardous or physically-constrained environments or in key outage systems like feeders. The goal of this work is reduce worker time and dose and improve inspection quality.

Advanced manufacturing

COG member: CNL

This work looks at use of additive manufacturing and high-strength as well as radiation-tolerant materials to improve component reliability and performance or replace obsolete and difficult to manufacture parts.

Augmented and virtual reality

Supplier participant: Alithya

This area focuses on advanced visualization and simulation technologies and their applications to inspections and maintenance. These tools can strengthen training as well as maintenance work planning processes.

New fueling machine ram seals, developed through COG Joint Projects & Services, have been deployed at NB Power's Point Lepreau (above) and OPG's Pickering Nuclear (below). ***Images: NB Power and OPG***

Innovations improve performance life of critical plant components

Working through COG, members are leveraging the shared results of research and joint projects to strengthen plant performance

Equipment reliability (ER) is fundamental to safety and economic performance.

By deploying research and tools developed through a CANDU Owners Group (COG) joint project, Pickering Nuclear and Point Lepreau, have strengthened performance in fueling machine ram seals. The results have improved equipment reliability and reduced maintenance effort at the plants.

At Darlington Nuclear, collaborative research between COG and Electric Power Research Institute (EPRI) has been applied to validate fitness for service of steam generators allowing operators to get a longer operating life from the components.

New ram seals improve performance life

Fuel machine ram seals are performing better and reducing maintenance thanks to innovative work through COG's Joint Projects & Services (JP&S) area.

In 2015, New Brunswick Power (NB Power) requested COG initiate a joint project to develop, design and qualify a reliable ram seal with improved performance life and endurance. The new seal would replace the existing version (OEM 'Type 3' FM) and supply sufficient quantities to participating plants, Point Lepreau and Ontario Power Generation's (OPG) Pickering Nuclear.

The first phase of the joint project involved development and qualification testing of the new ram seal which simulated station fueling operational and maintenance cycles. This process took place between 2016-2018 to ensure the new seals demonstrated the reliability needed by the COG members.

The new seals were developed in part by COG supplier participant, BWXT Canada, with support from EagleBurgmann Canada. Following the successful completion of the tests, NB Power and OPG authorized COG to procure the new Type 4 seals for deployment.

In 2019, the first batches of seals were completed and the upgraded Type 4 seals were shipped, installed and began fueling at Point Lepreau and Pickering.

Both Point Lepreau and Pickering have been fueling with the new seals for the past year and they have shown good performance to date. Importantly, they have performed beyond the point where the Type 3 seals had a high failure rate. Station OPEX showed that failure of Type 3 seals typically occurred after 500 fueling cycles.

The final project milestone will be to achieve no seal failures between fueling machine rebuilds (up to 2,000 cycles).

A 145-tonne steam generator. ***Image: Bruce Power***

New fueling machine ram seals were developed through a COG joint project that tested for long-lasting performance before they were put into service at two COG member plants.

Steam generator fitness for service analysis ensures safety and reliability

Steam generator analysis is critical to enabling CANDU plants to operate safely, efficiently and without interruption.

As CANDU reactors age, fitness-for-service assessments of critical components like steam generators (SGs) are required for continued long-term operation.

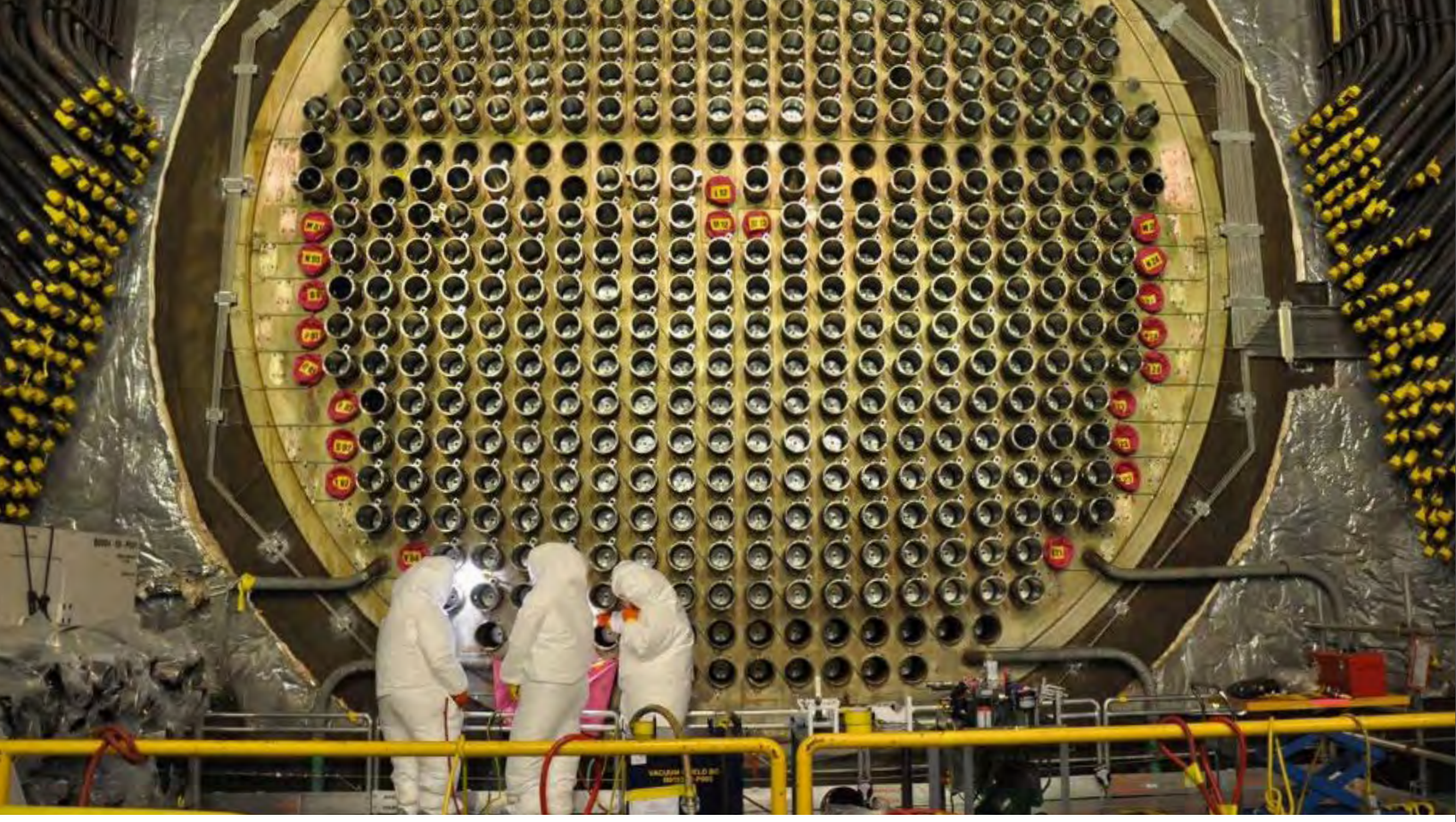
COG research, in collaboration with the Electric Power Research Institute (EPRI), has been focused on analysis of the SGs and to provide assurance these units can be operated safely and reliably.

There is also a regulatory need to provide evidence that inspection and data analysis tools are delivering accurate results and information. Steam generator research has looked at the condition of the SG tubes along with development of better inspection tools and methods to make fitness-for-service assessments more efficient and cost effective.

A COG R&D work package analyzed an SG tube from Darlington Unit 4. The tube had been in service for 26 years and was examined for degradation. The examination confirmed the good health of the Darlington tube and supported continued safe and efficient operation of the steam generator.

As well, other COG R&D work has included research into ultrasonic inspection tools, magnetic biasing array probes and faster manual techniques for SG inspection. Developing new inspection probes could be beneficial to SG flaw detection and sizing performance.

Development of these new inspection tools could prove directly beneficial for the pre-emptive condition assessment of SG tubes and decrease risk of forced outages.



Research from COG's Fuel Channel Life Management (FCLM) program has contributed to extended operation of Ontario's nuclear plants including Bruce Power (pictured). FCLM deliverables have helped confirm fitness for service and extended licensing of all Ontario plants. ***Image: Bruce Power***

Fuel channel innovation: A mark of CANDU pride

COG's Fuel Channel program, launched in 2009, was built on a foundation dating back to COG's earliest days and exemplifies the value of the collaboration model in achieving both innovation and cost efficiency

In the 37-years of CANDU Owners Group (COG) research and joint projects, there may be no bigger development for the nuclear industry than the gains made in the area of fuel channels.

COG's Fuel Channel (FC) program provides confidence to CANDU utilities, such as Ontario Power Generation (OPG) and Bruce Power (Bruce A and B), and the industry regulator, that the province's three nuclear plants can safely operate for years to come by demonstrating safety margin and technical basis for continued operation.

This reality would not have been possible a little over a decade ago.

Fuel Channel Life Management (FCLM) research has shown the fitness-for-service of CANDU pressure tubes and led to improvements in industry standards used worldwide to confirm pressure tube integrity.

The work currently includes accelerated aging and subsequent testing of actual CANDU reactor components that were removed to evaluate late life material properties. This

"For Ontarians, the result has been billions of dollars of additional revenue from the publicly-owned assets and a continued supply of low-carbon electricity."

validation phase has seen COG supporting CANDU utilities with model development, CSA (Group) standard updates as well as data and test results about the expected behaviour of CANDU fuel channels.

These predictive models benefit post-refurbishment reactors and may do the same for new-builds. They could also be applied to support cost reductions in future reactor maintenance, operations and surveillance procedures.

New analysis tools

Innovations in research analysis equipment and software have also contributed to the success of the fuel channel safety case. New instruments such as the Fixed Ion Beam (FIB) Spectrometer have allowed scientists to analyze materials at a much more detailed, microscopic level.

Similarly, Canadian Nuclear Laboratories' (CNL) Transmission Electron Microscopy (TEM) facility, which houses the Philips CM30, a computer-controlled, intermediate voltage electron microscope, is used for the analysis of microstructures down to the nanometre level. Combined with FIB, the equipment has become critical to effective materials research and development.

Fuel channel successes reflect a commitment to collaboration across the industry including ongoing program involvement from COG members as well as CNL, academia and contributions from suppliers such as Kinectrics and SNC-Lavalin.

A game-changing result

Historically, COG's FC program has focused on improving plant performance and supporting life cycle management, including life extension and timeframes for refurbishment.

The Ontario electricity sector is a prime example of the exponential value received from COG's multi-year FC project efforts.

OPG's Pickering and Darlington Nuclear Plants as well as Bruce Power have all benefitted from demonstrating fitness-for-service through the results of this work. The plants earned relicensing, in 2018, for operating beyond initial design-based estimates and, as a result, gained thousands of additional hours of generation.

For Ontarians, the result has been billions of dollars of additional revenue from the publicly-owned assets and a continued supply of low-carbon electricity even as refurbishment projects are underway.

A Fuel Channel Timeline: A history of innovation

1985 Single Fuel Channel Replacement (SFCR) tooling becomes one of COG's first joint projects

2009 COG initiates the Fuel Channel Life Management (FCLM) program

2013 FCLM supports the extension of original fuel channel life by four to five years

2015 Canadian Nuclear Safety Commission (CNSC) authorizes OPG to operate Darlington Nuclear beyond 210,000 EFPH to a maximum of 235,000 EFPH (a 10-year license), based in part on FCLM results

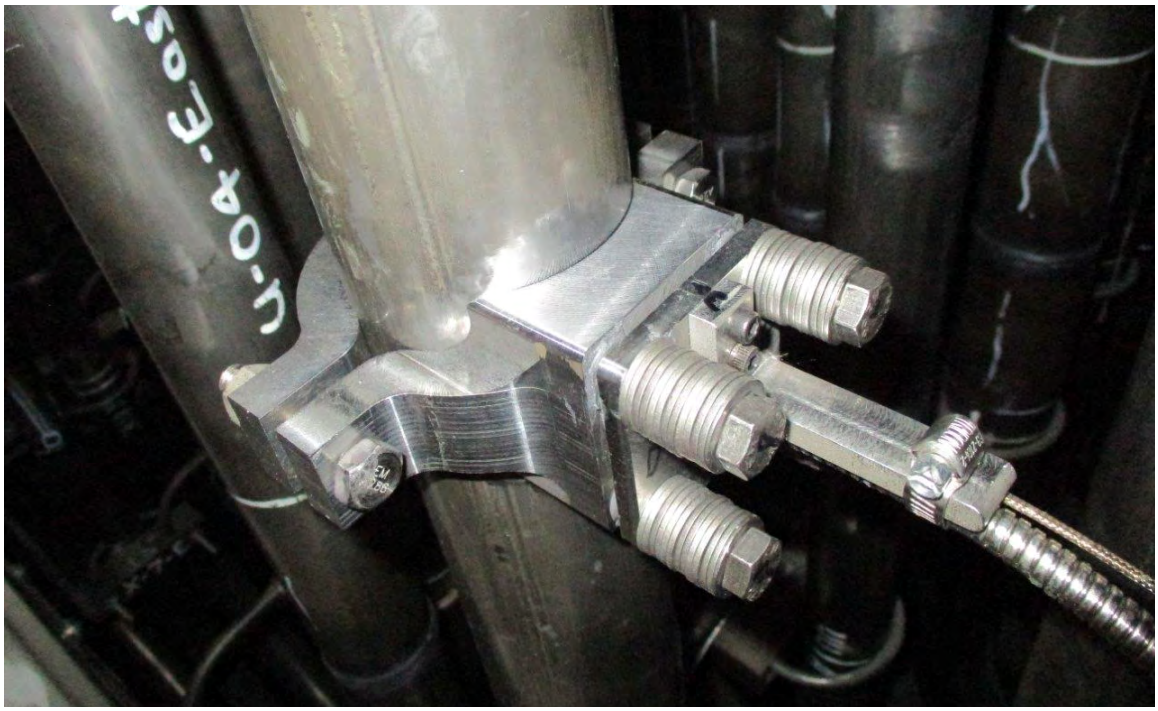
2016 Completion of Phase II of FLCM: In addition to the extension of operations, improved life cycle management plans and increased confidence in operations and business plans, the revenue resulting from the extra years of operating multiple units amounts to billions of dollars for the utilities involved

2018 OPG Pickering and Bruce Power conditionally receive regulatory greenlight to extend reactor operation to 295,000 EFPH and 300,000 EFPH, respectively, providing Ontario with years of additional clean, reliable electricity

2020 Completion of Phase III of FCLM

2021 Continuation and expansion of Phase IV which focuses on finalizing and validating predictive models

This provides OPG and Bruce Power with additional flexibility in their respective refurbishment and major component replacement programs and the information to make strategic business decisions



The HEPro tool (pictured) at Ontario Power Generation's (OPG) Darlington Nuclear Plant helped reduce corrosion inspection time by 30 per cent. ***Image: OPG***

Hydrogen-based tool keeps tabs on corrosion

The "HEPro" tool is an innovative example of how COG R&D supports improved online monitoring

A tool that uses hydrogen to assess the condition of the Primary Heat Transport (PHT) system is improving online inspection and monitoring while reducing time and cost for operators.

The hydrogen effusion probe (HEPro), developed through the CANDU Owners Group (COG) Chemistry, Materials and Components (CM&C) research area, is used for online corrosion measurement in the PHT system. Most recently, the tool helped Ontario Power Generation's (OPG) Darlington Unit 2 return to service faster by reducing the time required for corrosion measurement by approximately 30 per cent.

HEPro has gained attention from CANDU utilities within the Canadian nuclear industry. Continued testing through this COG program, and results achieved through other HEPro deployments, have shown the benefits of this technology.

Sensitive online corrosion monitoring tools like HEPro contribute to reduction in inspection requirements since the tool gives an ongoing, real-time indication of corrosion that is occurring, not just a snapshot between inspection periods.

The tool was first introduced at Point Lepreau Generating Station (PLGS) in 2006 to monitor Flow Accelerated Corrosion (FAC) on feeders. Since then, it has been refined and improved through collaborative innovation of COG members.

At PLGS, the unit has also been used to continue measuring feeder corrosion and confirm efficacy of new A106 chromium-rich feeder material, providing significant benefit to the station.

As well, the HEPro tool identified the impact of lithiated resin changes on increased corrosion and it is being tested for secondary system corrosion monitoring.

FAC is an on-going issue in feedwater piping and steam extraction lines and is a significant maintenance burden for utilities requiring frequent inspection and occasional replacement.

In future, HEPro could also provide nuclear stations with additional operational data to allow for corrective actions to take place during plant operation.

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Read the latest industry trends reports and quarterly reports at our member-only website

www.COGonline.org

Hydro-Québec workers engage in decommissioning activities at the Gentilly-2 CANDU station, which ceased operations in 2012. Hydro-Québec is a participant in COG collaborative decommissioning studies. ***Image: Hydro-Québec***

Innovation post-operation

A CANDU path to decommissioning

COG's decommissioning program is supporting members as they use innovative technologies and shared knowledge to meet decommissioning needs

Decommissioning is an end-of-life activity but excellence in decommissioning is also essential for future industry sustainability.

When it comes to maintaining reputation and public confidence, demonstrated capability to responsibly manage decommissioning and nuclear waste management are table stakes along with safe, reliable nuclear operation.

As some CANDU units come to the end of their operational life, the industry is turning to innovative technologies, shared knowledge and new processes, developed collaboratively through COG, to meet the need for cost-effective and environmentally-responsible decommissioning.

Units at several CANDU electricity generating stations are approaching or have begun decommissioning activities:

- Hydro-Québec's Gentilly-2;
- Korea Hydro and Nuclear Power's Wolsong (Unit 1);
- Ontario Power Generation's Pickering Nuclear; and
- Pakistan Atomic Energy Commission's KANUPP (Unit 1).

As well, Canadian Nuclear Laboratories' (CNL) research reactor at Chalk River and other CNL-managed assets are actively being decommissioned as part of the company's cross-Canada decommissioning, site remediation and legacy waste management work.

Several COG joint projects are focused on decommissioning work including calandria segmentation and fuel encapsulation.

In addition to work through current joint projects, COG is a community member of OPG's Canadian Centre for Nuclear Sustainability (CCNS).

CCNS was launched in October 2020 by OPG and is based in Pickering in close proximity to the nuclear plant. The organization is focused on collaboration, research and innovation in nuclear decommissioning and waste

management, among other areas. The centre aims to drive sustainability through development of best practice decommissioning and waste management and by leveraging these activities for regional economic development and innovation. Several suppliers and other organizations are co-located at the centre.

COG and CCNS are investigating opportunities that will take advantage of the collaboration mechanisms both organizations offer.

While decommissioning comes at the end of the nuclear life cycle, demonstrated innovation and effectiveness in its management is essential to nuclear's future. COG-member efforts, independently and through COG, are helping to make that happen.

COG decommissioning projects at a glance

In the last year, COG's decommissioning joint projects progressed plans and activities specific to their participants. The lessons learned and associated OPEX will benefit the entire industry.

Highlights from COG's projects in this area include:

Calandria segmentation

COG's Calandria Segmentation Study joint project, which launched in 2018, has been focused on developing decommissioning and segmentation strategies for reactors at OPG's Pickering Nuclear, Hydro-Québec's Gentilly-2 and, ultimately, KHNP's Wolsong Plant.

The initial phases of the project aimed to develop a calandria segmentation plan for Pickering Unit 1, including cost estimates, worker dose assessment and a detailed plan for disassembling and safely removing reactors, several years after shutdown.

The project deliverables, to date, have included a detailed report with the recommended segmentation strategies as well as different decommissioning timing scenarios (11, 20 and 30 years after shutdown). In 2019, KHNP and Hydro-Québec joined the project for the recently completed Phase 4 which focused on segmentation strategies for the CANDU-6 reactors located at both organizations' plants.

Two primary calandria segmentation or removal concepts have emerged through the study including an approach where calandria and reactor components are removed with light water and a hybrid removal approach involving component removal and borrowing methods from CANDU refurbishments and retubing.

The study also proposes waste management plans that outline how and where calandria and reactor components can be safely stored, once removed.

This year, KHNP is expected to use the study results to support Wolsong Unit 1 decommissioning schedule work.

Fuel encapsulation

Another decommissioning-related joint project is fuel encapsulation which was completed at the end of last year. The project involved the design and procurement of first-of-its-kind defective fuel bundle encapsulation equipment.

COG was asked by program participant, Hydro-Québec, to manage all aspects of the new tool's development and work directly with supplier participant, ATS Automation, on its testing and creation.

The tool has already been used to safely remove defective fuel bundles at Gentilly-2, work Hydro-Québec began in August 2020. It helped remove approximately 36 defective fuel bundles at the plant which was shut down in 2012. The tool was developed and designed with inputs from the Nuclear Waste Management Organization and OPG.

COG provided project management services, technical oversight and contract administration to support this joint project.

COG is currently supporting KHNP, Korea in the development of a decommissioning schedule for Unit 1 at its Wolsong plant (pictured). ***Image: KHNP***

COG and EPRI exchange knowledge, research and lessons learned for the benefit of each organization's members and the wider nuclear industry. ***Image: EPRI***

A CANDU portal to a world of nuclear knowledge

Through COG, CANDU operators gain economies of scale and strengthen their innovation leverage in their Electric Power Research Institute (EPRI) membership

For CANDU Owners Group (COG) and U.S.-based Electric Power Research Institute (EPRI), collaboration is a two-way street.

Between the two organizations, knowledge, research and lessons learned are reciprocally shared for the benefit of COG members and the wider nuclear industry.

"Through COG, our participating CANDU members can access the nuclear research conducted across the entire EPRI membership," says John Sowagi, COG's Director of Information Exchange. "The added value is we filter and collate information in a way most relevant to CANDU station operations. By doing that work once for everyone, our participating members saving money and resource."

At the same time, EPRI can request access to select COG research, released with the approval of our members.

"There is a real benefit to this model because participating COG members are gaining access to research that's already been done and the cost savings and efficiencies lead to compounding improvement across the nuclear industry," says Sowagi.

COG manages the EPRI membership through a cost-sharing agreement between participating COG members (COG's Canadian members and SNN, Romania).

The COG team identifies information and provides analysis, from EPRI data, most relevant to its members. Conversely, COG serves as a conduit to help build EPRI's global knowledge bank by providing collated CANDU information.

COG members also gain a direct link to expert global perspective from EPRI participation in many COG activities including peer groups, joint projects and working committees.

COG and EPRI share some commonalities. They are both not-for-profit, member-driven businesses that manage millions of dollars in research and development work and joint projects, annually. As well, both use collaboration to address technical and operational challenges and deliver value to their respective memberships through their collaborative activities.

"There is a real benefit to this model because participating COG members are gaining access to research that's already been done and the cost savings and efficiencies lead to compounding improvement across the nuclear industry."

Building a bigger toolbox

By leveraging COG's own collaboration model and joining it onto EPRI's, the participating members gain a lower cost entry to additional innovation opportunities.

Liette Lemieux, COG's Director of Research and Development says one example is the Nuclear Plant Modernization Toolbox released by EPRI in December 2020. The web-based toolbox contains examples, synopses and R&D reports of new applications of emerging technologies from nuclear plants around the world.

Lemieux, who represents COG on the EPRI Plant Modernization Committee, believes the toolbox is a valuable decision-making resource for COG members and one they helped develop.

"The toolbox reflects the value of the COG-EPRI relationship because COG members get access to a comprehensive listing of examples of where and how new technologies have been deployed at nuclear plants," says Lemieux. "And some of those same members participated in the Modernization Technology Assessments (MTAs), contained within the toolbox."

MTAs, which characterize potential plant modernization technologies or process improvements, are critical to the usability of the new EPRI resource.

Leveraging global experience

There are numerous examples of COG members incorporating EPRI research and innovation to improve plant performance, safety and equipment reliability.

The lessons learned from EPRI's Steam Generator Management Program have benefited COG members in strengthening a range of maintenance and mitigation activities from foreign object assessments to in-service inspections.

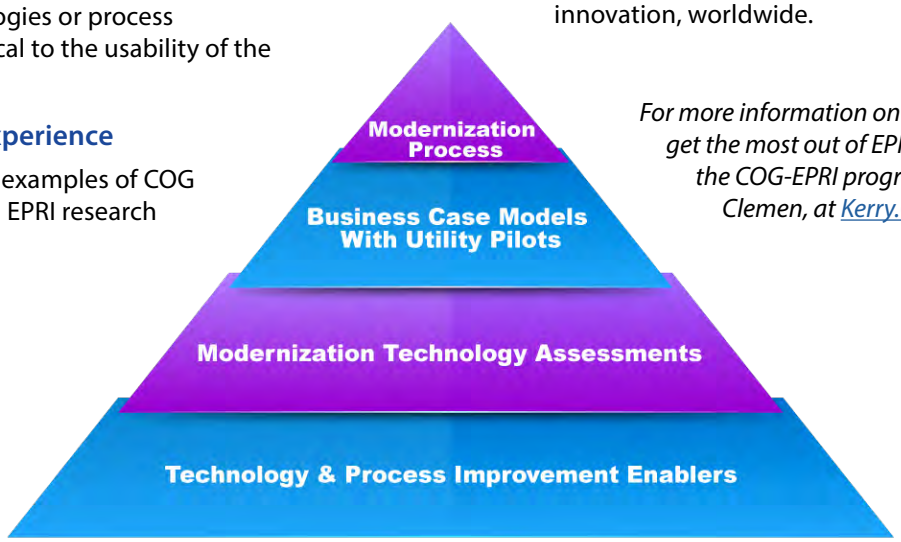
In 2019, OPG Darlington hosted EPRI's SMART Chemistry Pressurized On-line Monitoring skid to analyze reactor coolant, main feedwater and the steam generator blowdown systems.

The project earned OPG an EPRI Technology Transfer Award but more importantly, the system was implemented by OPG, and other global nuclear utilities, because it supported operational efficiency improvements and provided cost savings as compared to other monitoring approaches.

Meanwhile, EPRI members have benefited from access to the COG Strategic Research and Development Program's work on the use of robotics for decommissioning activities.

COG and EPRI recently signed a five-year agreement to continue collaborating for the benefit of each of their members and to advance nuclear research and innovation, worldwide.

For more information on how COG members can get the most out of EPRI membership, contact the COG-EPRI program manager, Kerry Clemen, at Kerry.Clemen@CANDU.org.



EPRI's Nuclear Plant Modernization Toolbox reflects the value of the COG-EPRI relationship because COG members get access to a comprehensive listing of examples of where and how new technologies have been deployed at nuclear plants. ***Image: EPRI***

ONTARIO POWER GENERATION

OPG works with COG supplier participant Curtiss-Wright on seismic testing of equipment, which takes place at the supplier's Newmarket, Ontario facility. OPG's 2020 EPRI Technology Transfer Award recognized its work on site-specific seismic hazards. ***Image: Curtiss-Wright***

EPRI Award three-peat for OPG

The CANDU Owners Group member brings home prestigious Technology Transfer Award for third straight year

Ontario Power Generation's (OPG) innovative use of seismic safety margin research has resulted in millions of dollars in cost savings, improved plant safety and gained recognition from Electric Power Research Institute (EPRI).

The work of OPG's Nasser Aly, Sevana Bedrossian, Katherine Gromek and Lambert Li won the CANDU utility a 2020 EPRI Technology Transfer Award (TTA), during Nuclear Power Council Advisory Week, held virtually earlier this year. Since 2015, OPG has won five EPRI TTAs which recognize applications of research contributing to improved plant safety and efficiency.

The OPG team applied EPRI research in the areas of seismic fragility, margin guidance and probabilistic risk assessment (SPRA) to revise and update internal guidelines and practices at Darlington Nuclear, relating to earthquake response and preparedness.

In 2020, the Darlington seismic hazard updates were reported to the Canadian Nuclear Safety Commission (CNSC) and helped secure regulatory acceptance. The application of the research also delivered millions of dollars in cost efficiencies to OPG by showing the seismic safety readiness of existing plant infrastructure.

EPRI's Seismic Probabilistic Risk Assessment Implementation Guide was a key resource used to inform OPG's seismic hazard updates. The guide provides utilities with methods to perform SPRAs for a variety of applications. The major elements of SPRA include: seismic hazard analysis; fragility evaluation and plant systems and sequence analysis and seismic risk quantification.

OPG was one of the first utilities in North America to implement and update its site-specific seismic hazards using the new EPRI methodology. The new approach could potentially be used or benchmarked by other CANDU plant operators to demonstrate meeting safety goals under the updated seismic hazard.




From left: OPG's Nasser Aly, Sevana Bedrossian, Katherine Gromek and Lambert Li, 2020 EPRI Technology Transfer Award winners.

Previous EPRI winners

For the sixth year in the last seven, a COG member has won at the prestigious EPRI Technology Transfer Awards. Below is a list of previous award winners:

2019

OPG's Shashank Gandhi for Probabilistic Safety Analysis Project

Application: Allowed OPG to demonstrate stronger alignment with regulatory safety requirements and improved plant operational efficiency

OPG's Peigang Cao, Emily Cornthwaite, Anil Garg, Ranganathan Santhanam and Pamela Woods for SMART Chemistry Pressurized Water Reactor Online Monitoring Demonstration

Application: Allows for almost continuous chemistry data monitoring resulting in more accurate data readings over manual approaches

2018

OPG and Bruce Power for Standardized Task Evaluations (OPG's Alex Crichton, Paul Villeneuve and Al Shiever; Bruce Power's Steve Cotton, Jodie McNabb, Rick Hagen and Byron House)

Application: Utilities use the evaluations program to ensure worker proficiency and job performance prior to arrival on-site

2016

NB Power's Jennifer Lennox for Use of Heat Exchanger Guidance to Develop In-house Program

Application: Guidance for heat exchanger program development and preventive maintenance plans

2015

OPG's Ghulam Khawaja and Bryan Villemaire for Innovative Applications of Modular Accident Analysis Program (MAAP) Code

Application: Upgrade of emergency operation procedures, severe accident management guidelines and plant designs to enhance nuclear safety

2014

CNL's Mike Wright for Materials Degradation Matrix

Application: Fundamental understanding of the degradation phenomena/mechanisms in CANDU PHWRs

The premiers of Ontario, New Brunswick, Saskatchewan and Alberta show their respective copies of the signed memorandum of understanding (MOU) between the provinces to collaborate on SMR development, from the virtual ceremony held, April 14. One of several SMR milestones in the first half of 2021. ***Image: Government of Ontario***

SMR development reaches new milestones

Building on the momentum of several small modular reactor (SMR) announcements late last year and early in 2021, CANDU Owners Group (COG), its members, participants and the nuclear industry continue to take steps toward SMR deployment before the end of the decade

As countries, globally, look to find ways to meet aggressive decarbonization targets, small modular reactors (SMRs), for both electricity and other energy applications, have become a focal point. SMRs are one way to leverage nuclear's strength to meet carbon reduction targets and build clean infrastructure.

Some Canadian utilities and other nuclear industry companies seized on the opportunity early and are now making headway on their deployment goals by the late 2020s and early 2030s.

In late 2020 and early 2021, proof of technology advancement has been evident in several next-step SMR announcements from multiple levels of government as well as CANDU Owners Group (COG) members, supplier and SMR vendor participants.

Last fall, Global First Power (GFP) announced it had signed a Project Host Agreement with Canadian Nuclear Laboratories (CNL) in support of GFP's proposed Micro Modular Reactor (MMR) Project at Chalk River Laboratories, a Canadian first. Then, on May 19 (2021), GFP announced it is progressing into site preparation licensing, moving it closer to construction.

GFP, formed in June 2020, is a joint-venture between Ultra Safe Nuclear Corporation and Ontario Power Generation (OPG).

OPG has also been looking at on-grid SMR development. In late 2020, OPG announced it would work with three SMR vendors to further develop the technologies for possible deployment. Soon after, OPG announced planning activities for future nuclear power generation at its Darlington site, to host an SMR, before the end of the decade.

The three COG SMR vendor participants are GE Hitachi Nuclear Energy, Terrestrial Energy and X-energy. All three vendors have been actively working with OPG, advancing their designs in the regulatory process and working with communities and stakeholders.

In other micro reactor development, Bruce Power and Westinghouse announced an agreement to pursue applications of Westinghouse's eVinci micro reactor program within Canada.

These industry milestones build on a foundation laid in 2018, when Canadian government and industry players unveiled Canada's SMR Roadmap, a vision and related blueprint for development and deployment of SMRs.

The follow-up to the Roadmap, Canada's Small Modular Reactor (SMR) Action Plan, was released in December 2020.

COG's role in the SMR Action Plan

COG, and many of its members and industry partners, have chapters in the Action Plan outlining their roles and commitments to achieve Canada's vision for the use of SMRs to meet the country's greenhouse gas emission reductions, including hitting net-zero emissions by 2050.

In collaboration with the Canadian Nuclear Association (CNA), COG is part of the Canadian Nuclear Industry SMR Secretariat to track progress against the Action Plan. As well, COG hosts SMR leadership and technology forums and a 10-member SMR vendor participant program focused on industry collaboration and harmonization.

In February, COG's Carlos Lorencez, Director, Nuclear Safety and Environmental Affairs, moderated a virtual panel on Canada's SMR Action Plan at the Nuclear Engineering International Small and Advanced Reactor Conference with representatives from Natural Resources Canada (NRCan), CNA, the CNSC and OPG. The panel discussed how Canada and its nuclear industry will use SMR technologies as a response to climate change and for economic benefit.

Next Steps on SMRs

At the provincial level, April 14, Alberta joined New Brunswick, Ontario and Saskatchewan in a memorandum of understanding (MOU) to collaborate on SMR development timed with the release of a joint SMR feasibility study, validating the value of SMRs to meet sustainability and clean energy priorities.

As well, in addition to the GFP licensing progression, there have been several funding and licensing milestones as well as partnership announcements this spring.

These include a $56 million investment by the federal government into New Brunswick's SMR activities to collaboration agreements between CANDU owners like OPG and SMR vendors like Moltex (see SMR milestone section for more examples).

Canada's SMR journey is far from complete but the strides made over the last three years show great promise for a clean and bright energy future.

For more about Canada's SMR journey and milestones, read these two stories published in *Nuclear Engineering International*:

Small and mighty — Canada's play for a clean energy future

Canada's well down the road to SMR deployment

SMR milestones keep coming

SMR-related announcements from COG members and SMR vendor participants have been numerous in the first half of this year. Some of them are highlighted.

Image: GFP

Global First Power enters formal phase of CNSC licensing

Global First Power (GFP) announced, May 19, its Micro Modular Reactor (MMR) Project had moved to the next phase of Canadian Nuclear Safety Commission (CNSC) licensing. The project has now moved to the formal phase of the licensing process, which will involve a detailed technical review. The announcement moves GFP closer to owning, constructing and operating Canada's first small modular reactor (SMR) at Chalk River Laboratories, with first power slated for 2026.

Image: CNL

CNL successfully fabricates new SMR fuel

In April, Canadian Nuclear Laboratories (CNL) announced it had successfully fabricated Fully Ceramic Microencapsulated (FCMTM) fuel pellets, an advanced and proprietary reactor fuel designed by Ultra Safe Nuclear Corporation (USNC) for their Micro Modular Reactor (MMR). This marked the first time a Tristructural-Isotropic (TRISO) was manufactured in Canada.

Image: Terrestrial Energy

Terrestrial Energy-Aecon announce SMR-focused engineering and construction services agreement

COG SMR vendor participant, Terrestrial Energy, and supplier participant, Aecon, signed an engineering and construction services agreement to support construction planning for Terrestrial's proprietary Integral Molten Salt Reactor (IMSR), Generation IV advanced nuclear power plant.

Image: OPG

OPG joins forces with Moltex to advance recycling of CANDU fuel for next generation nuclear power

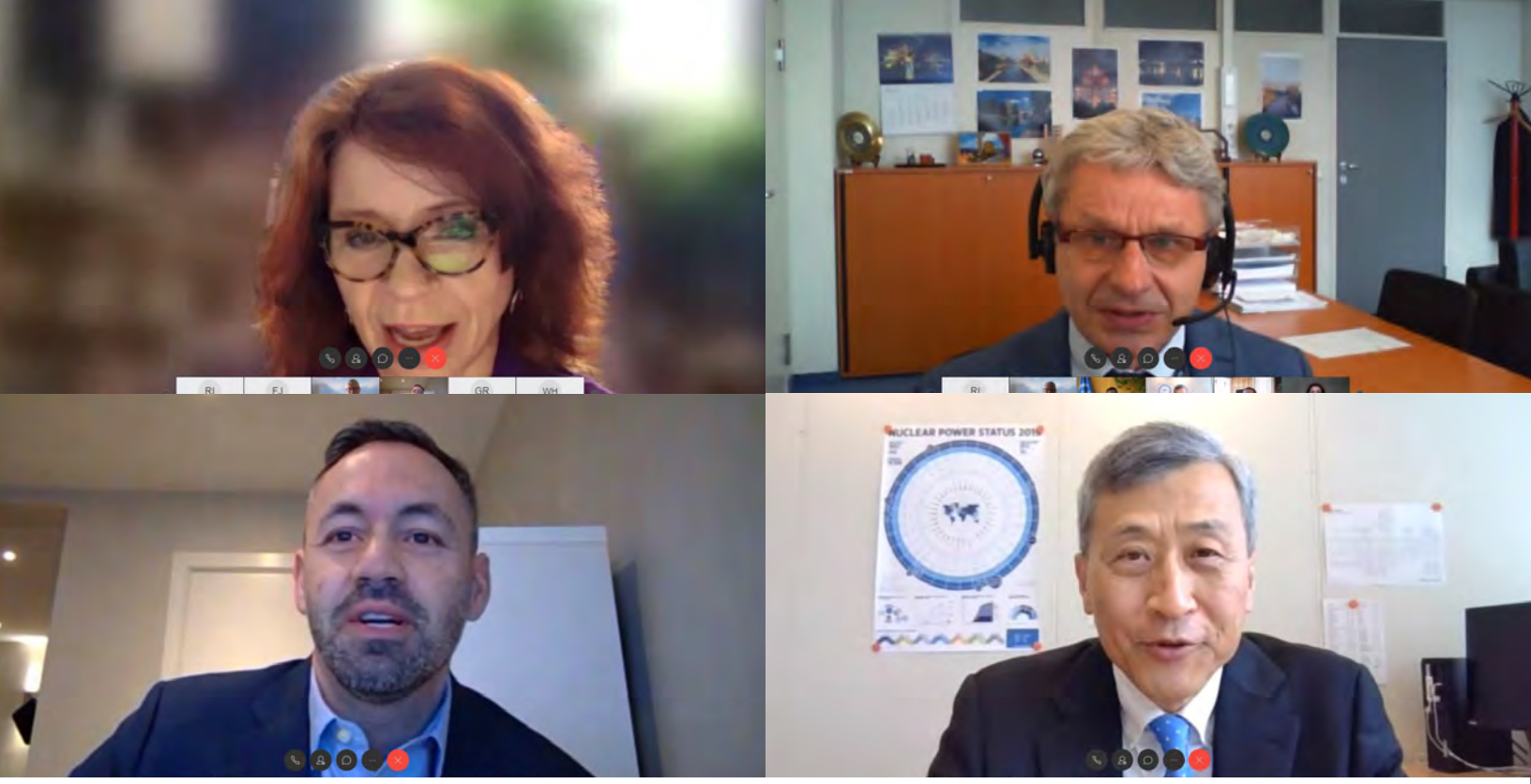
On March 30, OPG's Centre for Canadian Nuclear Sustainability (CCNS) announced an investment of $1 million in Moltex to explore innovation in recycling used nuclear fuel.

Image: ARC Canada

ARC Canada receives $20 million in funding from Government of New Brunswick

In February, ARC Canada, a COG SMR vendor participant, received $20 million in funding from the Government of New Brunswick. The funds are intended to support the deployment of its ARC-100 advanced SMR by the late 2020s.

Innovation through collaboration



Clockwise left: COG's Stephanie Smith joined by IAEA's Greg Rzentkowski, NRCan's Marco Presutti and IAEA's Dohee Hahn were representatives at the virtual signing ceremony, March 24, to recognize the expanded Practical Arrangement between COG and the IAEA.

COG-IAEA expand areas of collaboration

CANDU Owners Group (COG) and International Atomic Energy Agency (IAEA) have amended a Practical Arrangement they signed in 2019 to include decommissioning, waste management and nuclear safety among the areas in which they work together

COG and the IAEA are building on a long-standing relationship of sharing knowledge to address areas of growing interest and importance to the nuclear industry.

The two organizations have expanded their existing Practical Arrangement (PA) to focus on decommissioning, radioactive waste management, reactor safety and engineering, among other areas.

The amended agreement was signed at a virtual signing ceremony, March 24. COG President and CEO Stephanie Smith, IAEA's Director of Nuclear Installation Safety Greg Rzentkowski and Director of the IAEA's Nuclear Power Division Dohee Hahn represented the two organizations. The PA highlights COG's formalized relationship with these IAEA divisions.

Natural Resources Canada (NRCan) Director General, Electricity Resources Branch Marco Presutti represented the federal government at the event.

"Decommissioning and waste management are areas of increasing focus for the worldwide nuclear community, including COG members and participants. They are especially important for the CANDU industry as some long-serving reactors, like Pickering and Wolsong, come to the end of operation," said Smith at the signing ceremony.

"Knowledge management is truly a strength for both our organizations. Our collaboration in these, and other areas, benefits the members of our respective organizations and benefits the entire nuclear industry," Smith added.

In their remarks, Hahn and Rzentkowski reinforced the importance of collaboration in the areas of decommissioning and nuclear safety to ensure continued public acceptance and sustainability of nuclear technologies. They also expressed appreciation to COG for a mutually beneficial partnership that will be strengthened by this agreement.

"It has to be realized that over 60 per cent of the approximately 450 operational reactors are over 30 years of age," said Rzentkowski. "Taking measures to optimize their life cycle, including decommissioning and radioactive waste management, will become a growing issue in the coming years."

Added Hahn, "I am grateful for this opportunity to strengthen our [COG and IAEA's] longstanding relationship."

NRCan's Presutti commended both organizations for expanding their arrangement in areas, such as radioactive waste management, where Canada is focused on being a world leader.

The existing COG-IAEA PA, signed at the 63rd IAEA General Conference in September 2019, has enabled greater cooperation between both organizations through a number of international nuclear forums and technical working groups in the areas of knowledge management, aging and asset management, training and pandemic response.

From the outset of the COVID-19 pandemic to now, COG and IAEA members have exchanged OPEX through the IAEA's International Forum on Good Practices and Lessons Learned (Plant Operation and Engineering Support).

COG is working on several joint projects in the decommissioning area including calandria segmentation, fuel encapsulation of defective fuel and a decommissioning schedule. As well, projects specific to decommissioning planning and activities are anticipated to develop through COG's Decommissioning Peer Group.

The radioactive waste management area at COG includes a leadership forum and a waste management peer group. The Radioactive Waste Leadership Forum (RWLF) has the mandate to identify strategies and solutions for management of the waste streams from low and intermediate level to high level waste. In 2020, the RWLF completed development of an integrated waste strategy (IWS). The IWS is a live document that will be updated over the coming years to align with Canada's waste management strategy.

As well, COG, the University Network of Excellence in Nuclear Engineering (UNENE) and Ontario Tech University have been collaborating with IAEA to host the first Nuclear Energy Management (NEM) School in Canada. The NEM focuses on supporting young professionals in the nuclear sector to strengthen their managerial and technical competencies. It was delayed by the pandemic and is tentatively re-scheduled for later this year, pending changes to COVID-19-related restrictions.

The existing COG-IAEA PA has a term of five years and lasts until 2024. COG and IAEA's history of collaboration dates back to COG's founding in 1984.

COG's Director Corporate Services and CFO John Moore served as event host while attendees included members of COG management. The IAEA delegation included several other nuclear division representatives.

Click here to read the full joint announcement.

Working together for a stronger nuclear industry

Both COG and IAEA exchange information, OPEX and good practices through several forums and workshops. Areas of collaboration between the two organizations include (but are not limited to):

- COVID-19 pandemic response;
- Knowledge management;
- Safety, engineering and performance;
- Aging and asset management;
- Plant technical and economic performance;
- Nuclear training and professional development;
- Coaching and mentoring;
- Decommissioning and waste management; and
- Refurbishment.

As more CANDU reactors, like Pickering Nuclear, above, approach end of operation, COG and its members are increasingly looking to develop innovative approaches to decommissioning and waste. COG's enhanced agreement with the IAEA will further collaborative efforts in these and other areas. ***Image: OPG***

IAEA Supply Chain Management Strategy webinar panelists included (from top) COG's John Moore, Peter Čambál of Slovenské Elektrárne (Slovakia) and Maria Greskova of ROSATOM State Atomic Energy Corporation (Russia). ***Image: Lu Han/IAEA***

Nuclear procurement is a team effort

As part of an International Atomic Energy Agency (IAEA) webinar, Jan. 28, CANDU Owners Group's (COG) John Moore discussed how COG's approach to supplier procurement lowers risk for members and increases their value for investment

Like a well-performing CANDU plant, strong performance in nuclear procurement requires effective planning and a cohesive team.

Those were among the themes highlighted by COG's John Moore, Director of Corporate Services and Chief Financial Officer (CFO), who served as a panelist on the IAEA's recent Supply Chain Management Strategy webinar.

"COG has a wide supply base and strong working relationships with a number of R&D labs, like Canadian Nuclear Laboratories, and suppliers like Kinectrics and SNC-Lavalin," said Moore on the procurement panel.

"These strong relationships help ensure we maximize value for our members when we work with suppliers on joint research or projects."

The event was part of a webinar series focused on global nuclear supplier challenges and opportunities. Moore was joined on the panel by industry procurement experts, Peter Čambál, of Slovenské Elektrárne (Slovakia) and Maria Greskova, of ROSATOM State Atomic Energy Corporation (Russia).

Each panelist discussed their respective organization's approaches to procurement and supply chain management. Common practices included project needs identification, requirements development, supplier research and value analysis.

Moore highlighted how an effective procurement strategy links corporate goals and policies to specific items or services being purchased. He added that a clear procurement strategy informs and enhances all purchasing activities.

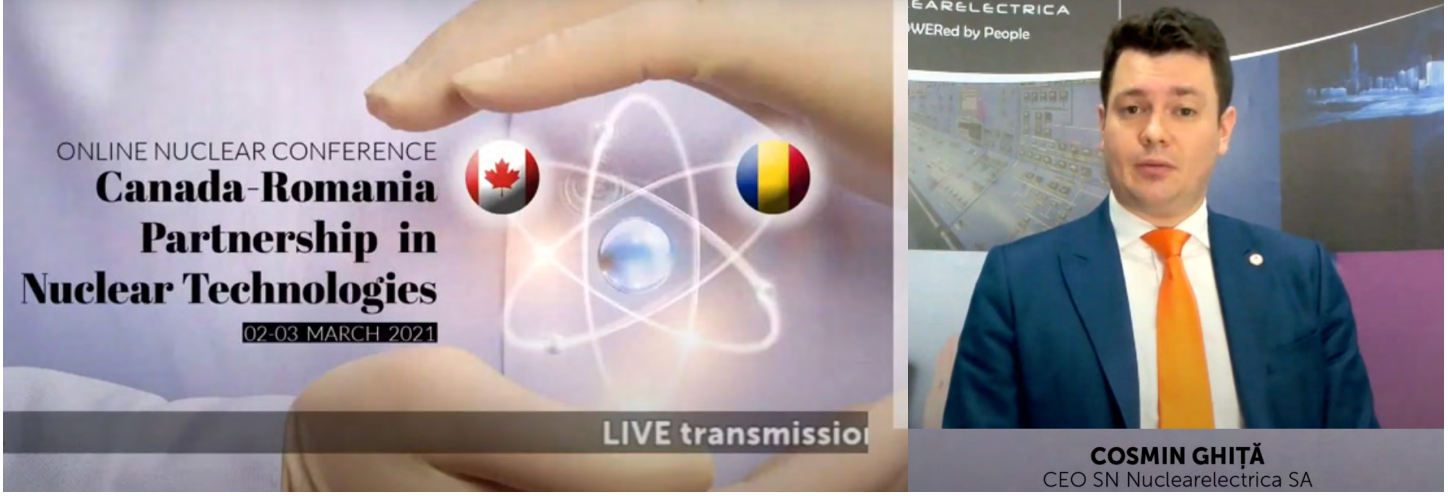
COG's procurement strategy reduces costs for members through bulk purchasing, competitive bidding, sharing of project risks/costs, procurement planning and collaboration between the procurement organization and suppliers to ensure project requirements are communicated, understood and met.

For example, COG members benefit from bulk procurement opportunities and projects through COG's Supply Chain, Obsolescence and Procurement Program, which helps COG utilities obtain spare parts in time to avoid plant shutdowns or outage extensions. COG is also engaged in on-going work to standardize and strengthen procurement governance and vendor management.

In 2016, Moore, then with the IAEA, helped co-develop a Nuclear Contracting Toolkit to support member states to plan and implement procurement and contracting processes for their nuclear projects.

Annually, COG procures about $70 million in products and services on behalf of its members. In 2020, COG expanded its procurement team, revised policies and continued its practices of working closely with vendors to ensure maximum value for member dollars.

Click here to watch the series of IAEA Supply Chain Management webinars to date.



Above, SNN, Romania CEO Cosmin Ghita participates at the "Canada-Romania Partnership in Nuclear Technologies" virtual trade mission, March 2 and 3. The event featured nuclear organizations, academic institutions and government representatives from both countries. ***Image: OCNI***

Canada-Romania trade mission illustrates long-standing relationship between the two nuclear nations

COG President Stephanie Smith highlighted the "long and beneficial," relationship between CANDU Owners Group and its member, Societatea Nationala Nuclearelectrica, during a virtual mission that brought industry, government and academia together

CANDU Owners Group (COG) and member Societatea Nationala Nuclearelectrica (SNN, Romania) have a history of collaboration dating back more than 30 years.

COG President and CEO Stephanie Smith reflected on this and the future of COG-SNN collaboration as part of the virtual "Canada-Romania Partnership in Nuclear Technologies" trade mission event, March 2 and 3.

In fact, many of the presenters during the two-day virtual mission reflected on the integration between the Canadian and Romanian industries, in large part due to the shared use of CANDU technology.

The event was organized by Organization of Canadian Nuclear Industries (OCNI), ROMATOM (the Romanian Atomic Forum), Energynomics, SNN and the Embassy of Canada to Romania. It included leaders from industry organizations and academic institutions in both countries, including the University Network of Excellence in Nuclear Engineering (UNENE).

Driving the virtual trade mission, in part, were SNN, Romania's refurbishment and new-build plans. In 2020, those plans were accelerated with the announcement of a U.S.-backed finance deal to support the two projects.

The plans include local Romanian industry, as well as COG supplier participants, AECOM, SNC-Lavalin and other Canadian and French partners. At the time, it was announced, AECOM, would lead the US $8-billion project. COG is also supporting the projects through its Refurbishment Forum, related peer groups as well as information exchange and OPEX sharing.

During her presentation, Smith discussed how SNN, Romania had joined COG during construction of its two-unit Cernavoda CANDU plant in 1991. SNN is also COG's only international member with voting status on the COG board due to the depth of its involvement in COG's R&D, joint project and base programs. Smith also highlighted SNN's leadership in shaping a "fleet mentality," through COG's CANDU-6 Fleet Forum.

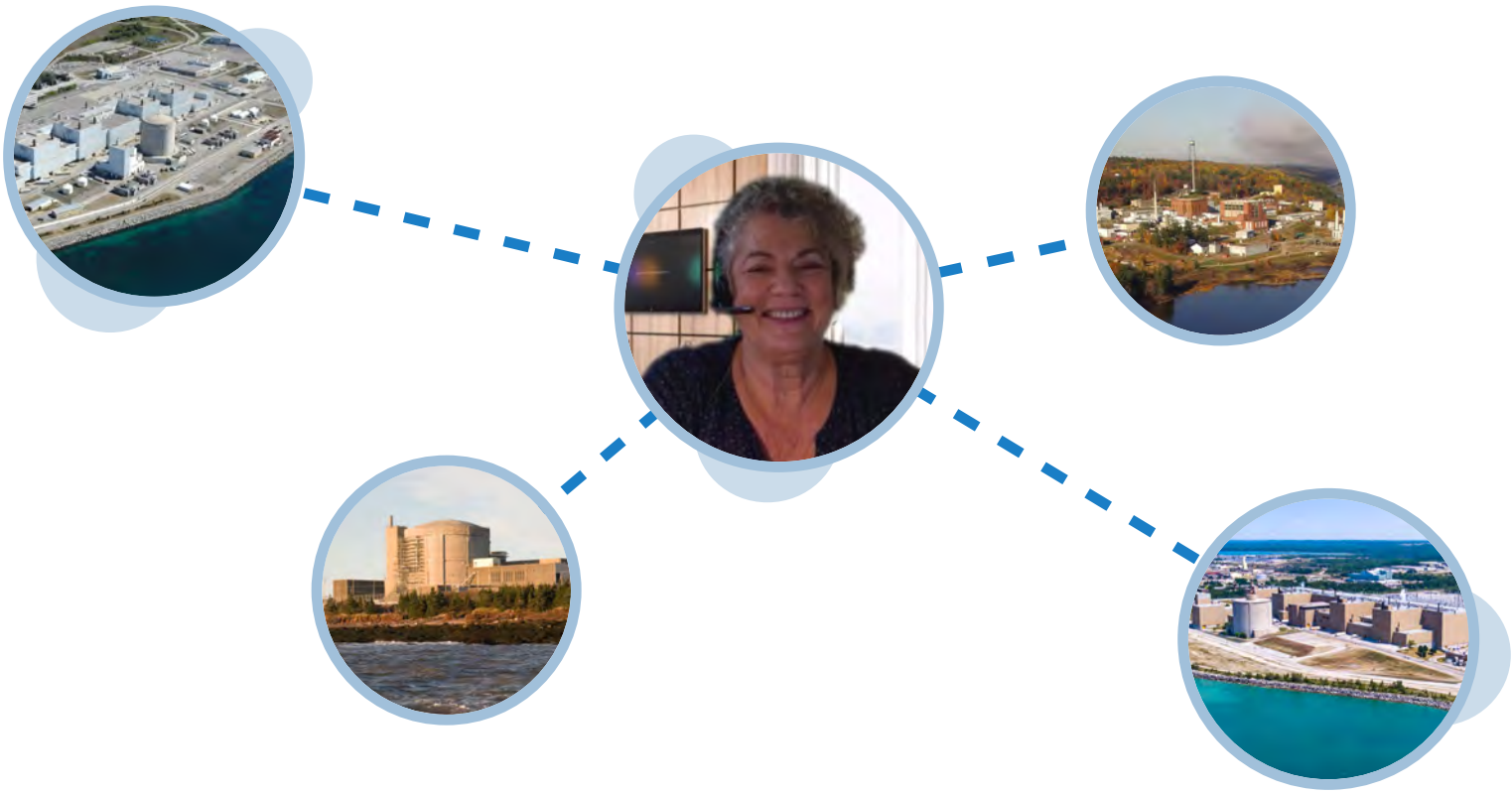
Smith spoke to how COG and SNN, Romania's long-standing collaborative relationship has set the foundation for future work together to strengthen outcomes in Cernavoda's refurbishment and CANDU-6 new-build plans, as well as, continued operational excellence improvements.

This, coupled with promising developments globally in small modular reactor (SMR) development, which both countries have been actively engaged in, made a virtual trade mission beneficial for the nuclear industry of both countries.

Click here to read the full event announcement from OCNI.

Click here and here to watch videos from both days of the virtual trade mission event.

Click here to see Stephanie Smith's presentation.



Nuclear training goes virtual

Designed to be flexible and interactive, COG's virtual training programs offer nuclear professionals a safe collaborative learning experience during the pandemic and could offer new delivery options beyond it

CANDU Owners Group's (COG) Learning and Development (L&D) team spent much of last year perfecting the use of virtual tools to keep members and participants connected, collaborating and learning, despite the COVID-19 pandemic.

Tools like WebEx and Teams have shown great potential for use during and beyond the pandemic.

With functions and features like instant polling, breakout rooms and virtual whiteboards that make learning on these platforms interactive and engaging, there is reason to believe even when we can safely meet together in person, once again, many meetings and training programs will remain virtual.

As well, since virtual learning can happen no matter where a participant is located, the flexibility it offers to distance learners means it is sure to stick around for the long-term.

From spring 2020 onward, COG's L&D team, led by Program Manager Mark Skuce, along with Laurie Fraser, Jilliane de la Cruz and Kelsey Rodger, has helped deliver virtual training offerings in areas ranging from the International Nuclear and Radiological Event Scale (INES), supplier human performance (HU) and safety culture to regulatory affairs (RA). Demand and feedback from COG members and participants has been strong.

Some of these virtual training courses are highlighted below.

Regulatory affairs training

The virtual RA training course, which features online lectures and self-guided exercises, was adapted from COG's in-class RA training program, launched in 2008.

COG's RA training helps ensure member employees are familiar with the latest regulations, regulatory documents and their implications for plant safety and operations. The in-class RA training had been designed for on-site RA staff, along with health physicists and radiation protection staff and was previously delivered as a one-day session. The virtual RA training runs for four days. This is because the L&D team recognized the different requirements for virtual and in-class learners.

"We continue to look at ways to expand our virtual training to ensure safety of our participants and support their professional development."

"We try to deliver a program that has the required RA information but is also flexible and engaging for participants who are mostly working from home," says Skuce. "We transformed how we share the course information with them. For example, we limit online sessions to 90 minutes and offer some on-demand learning resources. We use group break-out sessions and interactive polls to keep participants involved and focused."

Participants in the RA pilot training session included employees from Ontario Power Generation, Bruce Power, Canadian Nuclear Laboratories and New Brunswick Power. Additional virtual sessions were held through fall and winter 2020, covering RA regulations among other issues.

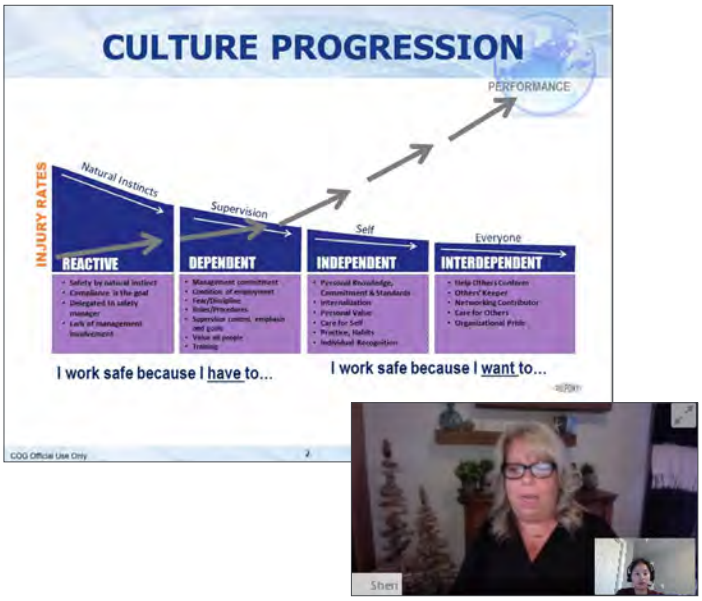
Supplier participant first line manager training

COG's Supplier Participant First Line Supervisor (SP FLS) Training program has also gone virtual. The leadership training, which traditionally runs as a three-and-a-half day course, focuses on building supply chain capacity, specifically, among supplier first-line managers.

The course covers topics from safety culture to human performance, coaching and motivation. A two-day virtual version of SP FLS, which highlighted the bigger course themes, was piloted in early September 2020 for employees at COG supplier participant, Kinectrics. Course participants were working on the Bruce Power MCR.

The virtual training was a refresher for the Kinectrics team on key leadership concepts they had learned at a COG-led in-person session held prior to the pandemic. Former COG Board Chair Paul Spekkens delivered a component on safety culture and human performance and Bruce Power's Sheri White delivered the sections on observation, coaching and difficult conversations.

"As the pandemic continues, COG's strength in virtual training will benefit members and participants," says Skuce.



The Kinectrics virtual training session held in early September 2020 focused on building supply chain capacity.

"In terms of our technology, infrastructure and expertise, and based on the positive feedback we've received from our pilots, we continue to look at ways to expand our virtual training to ensure safety of our participants and support their professional development."

This year, COG's L&D team continues to have a busy schedule of virtual training planned in the areas of nuclear safety, supplier HU and regulatory issues.

A lineup of COG's virtual training sessions can be found on COGonline.org or by clicking here.

COG's Learning and Development team led by Program Manager Mark Skuce, along with Kelsey Rodger, Jilliane de la Cruz and Anjana Mistry, now COG's Administrative Assistant to the Executive Offices (clockwise from top left), as well as Laurie Fraser (facing page), helped COG pivot to virtual training.

In the face of a global crisis, COG goes virtual

When the COVID-19 pandemic first struck in spring last year, in an instant, businesses around the world were forced to pivot to remote technologies.

COG was quick to transition to its already established virtual tools as a safe alternative to face-to-face meetings and training. COG's Learning and Development (L&D) team looked at ways to convert its leadership and professional development programs, normally held in-person, into interactive virtual courses designed for nuclear professionals working from home or anywhere.

A number of its training programs were converted to interactive virtual offerings after successful pilots and instructive feedback from members and participants.

CANDU industry plans for carbon-free future

CANDU Owners Group members and partners have made news over the last year, setting in motion ambitious plans to reach net-zero carbon emissions and advancing major projects to achieve sustainability for the nuclear industry

The nuclear industry has its eyes set firmly on a clean-energy future.

The evidence of this can be found in the announcements, over the last year, from CANDU Owners Group (COG) members, participants and industry partners as they plan and move forward initiatives to strengthen industry sustainability and support Canada's vision of net-zero carbon emissions by 2050.

From the setting of carbon emissions targets and significant milestones in major refurbishment work to investments in innovation and a changing leadership landscape, the news across the nuclear industry reflects the period of transformation and change the sector is currently undergoing.

Image: OPG

OPG and Bruce Power set net-zero targets

In the last year, Ontario Power Generation (OPG) and Bruce Power have set ambitious carbon emission reduction targets for the coming years. There are several areas being targeted for contributing to lower emissions by both COG members. These include innovations to their own generating equipment supporting decarbonization efforts, electrification initiatives across the economy, continued clean power generation from refurbished reactors and development of new clean technologies such as small modular reactors (SMRs) and other clean energy sources from nuclear such as hydrogen and fusion.

Image: NB Power

New Brunswick Power invests in new Centre for Artificial Intelligence

COG member New Brunswick Power (NB Power) partnered with Université de Moncton (UM) and will invest nearly $900,000 toward the launch of the new NB Power Centre for Artificial Intelligence. The new hub, hosted by UM, will be focused on research in artificial intelligence, sensors and robotics to strengthen efficiency and reliability at NB Power.

Image: Bruce Power

Nuclear Innovation Institute releases report exploring hydrogen opportunities

On Feb. 1, Nuclear Innovation Institute (NII) released a report titled *Seizing Ontario's opportunity to spark a national hydrogen economy*, which urges policymakers to encourage growth and investment and support companies, infrastructure and talent around hydrogen energy.

The report, prepared by the NII's Bruce Power Centre for Next Generation Nuclear found that Ontario has a distinct advantage in developing hydrogen power because the province's clean electricity grid – 60 per cent of which comes from nuclear power – can produce an affordable, dependable supply of hydrogen.

The report follows the release of Canada's hydrogen strategy in December 2020, which sets the goal for the country to be a global leader in clean hydrogen production.

Image: AECL

AECL president says Canada needs diversity of energy options to meet climate change goals

In an opinion piece for The Hill Times, June 7, Fred Dermarkar, Atomic Energy of Canada Limited (AECL) President and CEO wrote that nuclear and renewables must work together for Canada to meet its emission targets. In the piece, Dermarkar says that the fight against climate change necessitates looking at all available energy options. The former COG president was appointed by the federal government to take the helm of AECL, Feb. 7. Under his leadership, AECL has joined the Clean Energy Ministerial's **Equal by 30** initiative, a global commitment by public and private organizations to work towards equal pay, leadership and opportunities for women by 2030.

Image: Bruce Power

Bruce Power celebrates one-year milestone on MCR

In February, Bruce Power celebrated its first year of the execution phase of its Major Component Replacement (MCR) project with a virtual event and the release of its Ontario Energy Report for 2020. The virtual event recognized the contributions of Bruce Power employees, contractors, suppliers and more than 1,000 tradespeople in keeping the MCR project on track.

Bruce Power is making impressive progress with the Unit 6 project, including the successful removal of 50,000 feet of feeder tube from the vault and the event-free removal of the lower feeders – a first in CANDU refurbishments.

Image: Government of Canada

Canada positions itself for clean energy future

COG members, participants and partners are actively supporting several plans released over the last year by the Canadian Government which aim to make the country a global leader in clean energy technologies and help Canada reach net-zero carbon emissions by 2050.

The government plans cover areas ranging from an overarching approach to climate change and hydrogen development to the design and deployment of small modular reactors (SMRs) as a contributor to decarbonization of Canada's economy. As well, in fall 2020, the Natural Resources Canada (NRCan) announced a public consultation process to inform the modernization of Canada's radioactive waste policy to promote long-term management solutions, aligning with international standards and best practices. A clear path on nuclear waste management will be crucial to adoption of nuclear as an essential part of Canada's clean energy future.

Inventing a better world

Nuclear science and technology comes to life through COG suppliers' state-of-the-art facilities and expertise

For COG members, success depends on having both hands firmly on operational excellence today, with an eye always looking ahead to ensure nuclear earns its spot as part of a clean energy future. The road there consists of the right mix of continuous improvement and innovation.

Through the CANDU Owners Group research forums and other mechanisms, teams from COG member organizations identify needs and opportunities for COG's research and projects. COG researchers and suppliers deliver on that vision with new technologies and processes that drive improvements in day-to-day operations and the innovative changes that further advance the benefits derived from nuclear generation.

COG works with science and technology institutions like Canadian Nuclear Laboratories, Kinectrics and Stern Labs in Canada, as well as other research institutes and national labs in COG-member countries, internationally. COG facilitates about $70 million of R&D and joint projects annually across more than 300 research areas and 30-50 joint projects. This also includes work with 14 universities and other institutions comprising the University Network of Excellence in Nuclear Engineering (UNENE).

Here is a look at some of COG's leading research partners.

Image: CNL

Canadian Nuclear Laboratories

Canadian Nuclear Laboratories (CNL) science and technology development activities are focussed in the areas of energy, health, safety & security and the environment, including reactor sustainability, advanced fuels, small modular reactors, and hydrogen technology.

CNL is Canada's largest science and technology complex and widely considered the "birthplace" of CANDU reactor technology.

Read more at cnl.ca.

Kinectrics

Kinectrics' nuclear laboratories bring together multi-disciplinary engineering and analysis teams to develop solutions for challenges faced by their diverse nuclear industry clients. Kinectrics services support nuclear utilities through each phase of plant life, ensuring assets and equipment perform safely, reliably and efficiently throughout their entire life cycle. As well, Kinectrics, in partnership with industry and academia, recently launched, Helius, a new collaborative innovation centre focused on the development, testing, qualification and long-term support of clean energy technologies.

Kinectrics services include laboratory and testing facilities, as well as a diverse fleet of field inspection equipment and a team of 850 engineers and technical experts in Canada. Kinectrics' nuclear labs have capability for work in many areas specific to all aspects of all life cycle periods of CANDU and other nuclear technologies.

Click here for a 360 degree look at Kinectrics' nuclear laboratory facilities and areas of speciality.

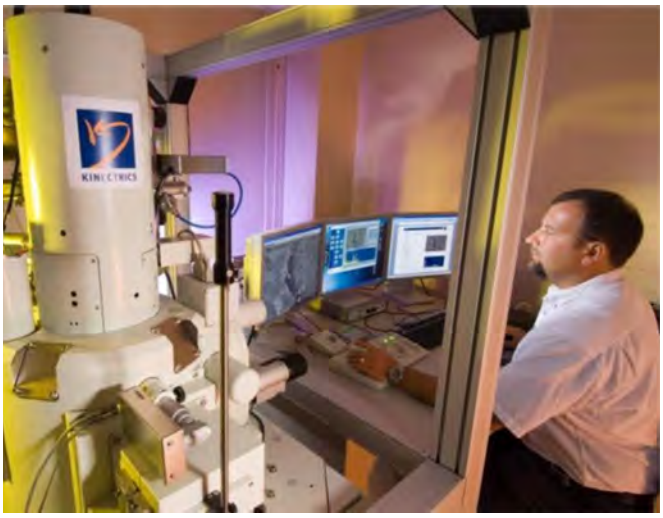


Image: Kinectrics

Image: Stern Laboratories

Stern Laboratories

Founded in 1988, Stern Laboratories is a 25,000-square foot Canadian-owned lab in Hamilton, Ontario. It specializes in the simulation of CANDU, boiling water reactor (BWR) and pressurized water reactor (PWR) heat transport systems, safety systems, reactor fuel and fuel channel components, conducting experiments while analyzing and reporting results.

Among the key areas of COG work, critical heat flux (CHF) experiments are performed in full-scale, horizontal CANDU fuel channels at reactor operating conditions. This is achieved using directly heated fuel simulations demonstrating 28, 37, and 43 element CANDU geometries.

Click here to read more about Stern.

Image: Fedoruk Centre

UNENE network of universities contributes to CANDU sustainability and advancement

The universities within the University Network of Excellence in Nuclear Engineering (UNENE) each have faculties contributing to excellence in nuclear science, technology and engineering. They are helping to retain CANDU capacity to ensure long-term sustainability of the fleet, while contributing to future technology development in other areas including small modular reactors. UNENE connects the universities with industry and government to facilitate funding and advancement of research, education and outreach to meet today's operating challenges and to create tomorrow's clean energy opportunities.

Visit UNENE.ca to learn more.

Bruce Power's Unit 6 (right) Major Component Replacement (MCR) and Ontario Power Generation's (OPG) Darlington Refurbishment projects (left; suppliers at work) have both benefited from significant supplier contributions, highlighting the value offered by the CANDU Owners Group (COG) Supplier Participant Program (SPP) in building a stronger industry. ***Images: Bruce Power and OPG***

COG supplier program keeps pace with changing role for supply chain

Growth and expanded focus areas in COG's industry-leading Supplier Participant Program reflects an industry transformation that is creating new opportunities for Canada's nuclear suppliers here and globally

Over the last several years, CANDU Owners Group's (COG) Supplier Participant Program (SPP) has grown, during a time of industry evolution that has elevated the role of nuclear suppliers as key partners, integral to operating and project success and even, in some cases, as operators, themselves.

Since 2015, when COG made it a priority to develop the program, membership has increased to nearly 30 Canadian and international companies and the scope of the program has significantly evolved, as well. Earlier this month, three new supplier organizations joined the program: Calian, Isaac Operations and L3Harris (see company profiles on the next page).

The SPP meets bi-monthly and now includes a diverse group of participants providing a range of services. These include engineering, construction, tooling, equipment, cybersecurity, waste management, decommissioning, R&D support, radiation protection and several other areas relevant to safe, economic and successful CANDU operation.

"The significant growth in the program is a testament to the value offered to COG's utility members and the supplier community through promotion of safety culture, OPEX sharing and our 'one team' approach," says COG SP Program Manager Macit Cobanoglu.

The SPP's "one team" approach refers to utilities and suppliers working as a single integrated team. Cobanoglu says utilities are recognizing it as one of the key success factors helping to advance their major projects.

In recent years, nuclear suppliers have played an integrated role in COG member major projects, from Ontario Power Generation's (OPG) Darlington Refurbishment to Bruce Power's Major Component Replacement (MCR) and have become utility partners in new business development.

Cobanoglu says the SPP's major initiatives, which include Human Performance (HU) metrics adoption as well as first line supervisor (FLS) and supplier culture of excellence (SCOE) training programs aim to strengthen collaboration between COG member utilities and suppliers, address common challenges and develop quality control standards.

"The program ensures that a strong supplier network exists, leading to a culture of openness and transparency with member utilities, while clearing the path to successful execution of work by suppliers," says Cobanoglu.

For more information on the COG Supplier Participant program, visit the program page or contact Program Manager Macit Cobanoglu (Macit.Cobanoglu@CANDU.org)

And that makes…29!

COG's newest supplier participants, Calian, Isaac Operations and L3Harris have brought the total number of participating supplier companies to 29, while adding to the perspectives, best practices and OPEX shared within the program. Below are profiles of three companies:

Calian

Ottawa-based Calian's vision is to deliver innovative solutions that help the world communicate, learn, lead healthy lives and stay safe. Calian's team of specialized experts are dedicated to meeting client needs, continuous improvement and delivering exceptional quality. The company focuses on a four-segment structure: Advanced Technologies, Health, Learning and IT & Cyber Security to represent its diverse set of solutions and areas of work. Calian has a 35-year track record of solid financial management and project execution in these areas.

Calian Nuclear is an ISO 9001 certified division of Calian. Its team of experts have helped ensure the safety and security of Canada's nuclear infrastructure with participation in hundreds of projects serving the nuclear industry and all levels of government, both in Canada and internationally.

Click here to learn more Calian.

Isaac Operations

Toronto-based Isaac Operations specializes in hands-on, front-line operational and financial performance improvement. Its team of experienced engineers works closely with companies to improve their operations and supply chain. The organization works across several sectors from manufacturing and health care to food and beverage and marine, employing a scientific approach to solve operational challenges with technical expertise.

Click here to learn more about Isaac Operations.

L3Harris

L3 MAPPS is a subsidiary of L3Harris, a global aerospace and defense technology innovator with approximately $18 billion in annual revenue and 48,000 employees and customers in more than 100 countries.

A leading global supplier of control and simulation solutions for the marine, power generation and space sectors, based in Montreal, L3 MAPPS entered the power plant simulation business four decades ago. It developed a simulator for the Pickering 'A' CANDU plant and through cooperation with Atomic Energy of Canada Ltd., L3 MAPPS has been supplying CANDU plant digital control computer systems since 1970. Today, L3 MAPPS is the world's foremost supplier of high-end full-scale simulators for nuclear power plants as well as simulation solutions for coal, oil and gas fired plants.

Click here to learn more about L3Harris.

Prior to launching its Supplier Culture of Excellence training, COG delivered a First Line Supervisor training program (pictured) for suppliers covering aspects of safety culture, human performance and leadership fundamentals.

Strengthening human performance within the nuclear supply chain

Joint COG-SNC-Lavalin "Supplier Culture of Excellence" virtual training course helps supply chain improve human performance and safety

A key principle of nuclear human performance (HU) is that even the best people make mistakes and all mistakes are preventable.

The CANDU Owners Group (COG)-SNC Lavalin Supplier Culture of Excellence (SCOE) training course was launched in January 2021. It aims to help supplier organizations gain a foundational understanding of HU while creating a positive work environment in which performance and safety improve and where human error is prevented or mitigated.

The training is open to the whole supplier community, which COG member organizations rely upon to execute major projects and support station operations. This collaborative relationship makes a strong commitment to supplier safety and quality culture, critical.

The virtual course is comprised of four two-hour modules and is based on SNC-Lavalin's Nuclear Division half-day training in safety culture and HU, previously delivered by the COG supplier participant to its own employees.

The SCOE training begins by identifying what excellence in nuclear safety and performance looks like which is followed by key concepts and practices in HU. The final two modules cover HU performance tools, OPEX examples, leadership fundamentals and organizational improvement strategies.

The premise for this work began in 2019 when the COG Chief Nuclear Operators' Forum (CNOF), sent a letter to the Canadian supply chain, indicating nuclear suppliers should increase focus on safety and performance within their own organizations.

"We have a unique opportunity to secure nuclear as a cornerstone of the electricity mix in Canada. But this can only be realized if we achieve the highest level of work safety and quality," the CNOF letter stated.

Prior to that, COG's Supplier Participant Program (SPP) Human Performance Metrics Task Team (HUMTT), began developing a guideline for monitoring supplier HU. The guideline encourages and promotes behaviours within supplier organizations that strengthen safety and quality.

As well, it provides suppliers with resources to measure HU within their organizations and compare performance between vendors. The HU guideline received a strong endorsement at the CNOF and a pilot workshop for roll out to the supplier community was held in November 2019.

The new SCOE training was developed in response to that pilot's results which reinforced the need for HU and safety culture training among suppliers. The SCOE course will serve as a pre-requisite for a future one-day HU workshop focused on supplier performance measurement.

In 2019, COG also launched another training program directed at suppliers. The First Line Supervisor (FLS) course integrates elements of HU with a focus on strengthening supplier first-line managers' skills, in areas such as leadership practices, performance improvement and building safety culture competencies.

Together, COG's supplier training courses support continuous improvement and the pursuit of safety and performance excellence.

For more information on the SCOE training course and to register for the next round of sessions taking place in May, contact: Macit Cobanoglu, COG Supplier Participant Program Manager (Macit.Cobanoglu@CANDU.org).

Innovation: It’s the people

The building blocks of collaboration

COG workshops, peer teams and meetings

CANDU Owners Group (COG) hosts more than 150 forums, peer groups, technical committee meetings and workshops per year covering a range of topics. These gatherings strengthen connections, support member collaboration and help move the CANDU industry forward

Information exchange is a critical piece of infrastructure in an industry where knowledge management is essential to success.

Throughout the global COVID-19 pandemic, COG's collaboration infrastructure has proven resilient, with a continued busy schedule of forum, peer group meetings and workshops carried out on virtual platforms to ensure the continuity of critical knowledge transfer and OPEX sharing.

Recent gatherings have focused on topical industry issues such as: radioactive waste of future SMRs in Canada; CANDU asset preservation through improved chemistry performance; incorporating Indigenous knowledge into environmental assessments and emergency response preparedness fundamentals, among others.

COG members and participants use the lessons learned and good practices gained from participation in these meetings to improve plant safety, operations and performance. Each meeting or workshop focuses on specific subject areas.

In some cases, the meetings focus on transfer of knowledge, with relevant research, reports and recent experiences shared to build knowledge on the latest trends and industry updates. In others, it is about creating new knowledge by working together on research, projects and strengthening human performance through new processes and behaviours.

Collectively, the work of the forums and peer groups create the foundations for continuous improvement and innovation to strengthen CANDU operations, as well as development in new technologies of common interest.

"COG's forums and peer groups are comprised of senior executives and station managers from across our membership," says John Sowagi, COG Information Exchange Director.

"The forums and peer groups are interconnected and constantly communicating with one another, funneling information back and forth and strengthening alignment within these organizations and amongst CANDU utilities. This ensures CANDU plants and the broader industry are all pulling in the same direction."

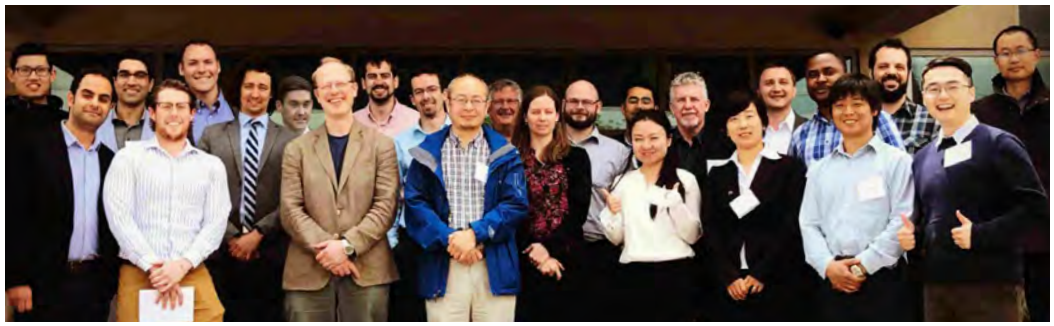
Nuclear organizations tend to be physically isolated by nature, with plants spread across vast geographies. COVID-19 has exacerbated this. Through virtual technologies, COG has served to maintain the connection across its membership.

And, by connecting senior leadership forums with the peer groups through these meetings, it helps connect organizational leaders with on-site personnel to ensure alignment between strategic decision-making and in-plant execution.

Similarly, an on-going peer group effectiveness initiative (see accompanying feature), is ensuring COG peer groups reflect the priorities of industry and each group is progressing toward aligned goals and objectives.

Click here to view a full listing of COG forums, peer groups and committees.

For the full list of COG events, click here to visit the event calendar on COGonline.org.



COG's forums, peer teams and working groups contribute to the creation of new technologies and processes in R&D and joint projects, supporting the transfer of knowledge to other stations and new generations.

The Maintenance Managers Peer Group (pictured) has participated in the COG peer group effectiveness initiative designed to strengthen outcomes through performance metrics.

A "measured approach" for COG peer group value

COG peer groups look to strengthen outcomes through performance metrics

They say what gets measured gets done. A CANDU Owners Group's (COG) peer group effectiveness initiative set out to prove the point through a pilot project that is now being more broadly implanted throughout COG's peer group program.

In 2019, a pilot project was initiated at the request of COG's Chief Nuclear Officers' Forum (CNO Forum) to increase the effectiveness of COG peer groups and strengthen alignment between peer group work and initiatives with the industry's priority areas.

Led by COG's Information Exchange (IE) team, and following an extensive consultation process, the pilot focused on measuring the performance of three peer groups for a period of six months. Performance metrics focused on OPEX and best practices-shared or dispositioned as well as products and services developed and shared by the peer groups.

The CNO Forum supported the use of these performance metrics and the pilots were launched within the Fuel Handling, Equipment Reliability and Asset Management Peer Groups. These peer groups were selected because their work directly impacts CANDU plants. For example, within the Fuel Handing Peer Group, the pilot led to the development of a common fuel handling index that tracks performance measurement in nine specific areas.

The Fuel Handling Peer Group also initiated regular monthly OPEX and best practice-focused meetings. Peer group members indicated the pilot had supported operational and process improvements across their organizations, specifically in the areas of equipment reliability and a reduction in forced outages.

Based on the success of the original pilot, in 2020 and 2021, other COG peer groups have implemented the new effectiveness initiative. These peer groups include human performance, training, pressure boundary, maintenance managers and cybersecurity, among others.

Different performance metrics were developed for peer groups focused on business processes, regulatory affairs and safety issues. Through this initiative, those groups will be measured based on their OPEX sharing but also goal setting and planning activities as well as achievement on those goals.

COG's newest arrivals strengthen value for members

In recent months, CANDU Owners Group has added bench strength to its talented workforce, who together serve as a diverse and expert asset to COG's members and the industry

Every day, the people working at the CANDU Owners Group (COG) use their collective expertise and experience to leverage excellence through collaboration to the benefit of COG's members and the nuclear industry across Canada and internationally.

That begins with the diverse and talented pool of people who work at COG and the hundreds of participants in peer groups and forums from our member, participant and partner community.

Through the expertise and efforts of about 70 employees and contractors, COG is responsible for leading research, development and joint projects worth more than $70 million per year.

Ultimately, the achievements of these collective efforts results in innovation and continuous improvement for the millions of people who rely on our members for safe, reliable and affordable electricity.

As part of its commitment to excellence in leading collaboration, COG continues to strengthen the team that makes these results possible.

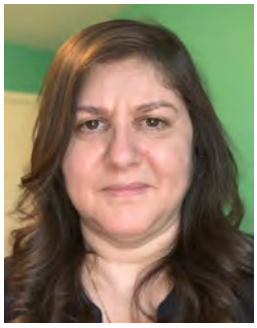
A communicator joins COG's management team

On March 22, Sarah Charuk joined COG as Senior Manager, Communications, reporting to COG President & CEO Stephanie Smith. In this role, Charuk will work as part of the leadership team to effectively position COG and its mandate; support communications to COG employees, members and stakeholder communities and continue to advance the COG communications program, with a focus on driving awareness of the important contributions of COG members in the nuclear industry.

Charuk brings over 15 years of senior communications leadership experience, including her role as Director of Communications for Northland Power, a global sustainable power producer. She also previously worked with GS1 Canada, a global standards organization, Element Fleet Management and the Ontario government.

Charuk holds a master's degree in communications management from McMaster University and a bachelor's degree in political studies from Queen's University.

This is a new role within COG as it brings its strategic communication function in house.



Strategic Research and Development

In January, Virgini Donaldson joined COG as program manager for the Strategic Research and Development (SRD) program.

With approximately 70 on-going projects, COG's SRD program focuses on meeting long-term goals such as industry sustainability and improved plant life expectancy, over the next 25 years and beyond.

Donaldson brings 30 years of experience across multiple sectors to COG. Ten of those years were spent in the nuclear industry with leadership roles in the areas of applications engineering, quality, design as well as project and risk management.

Prior to joining COG, Donaldson worked with two nuclear valve manufacturing companies (CCI and Curtiss-Wright, a COG supplier participant) in the design, manufacture and supply of both commercial and nuclear valves to CANDU and non-CANDU plants worldwide.

CANDU joint audit service

Hari Nayar joined COG as the new program manager for the CANDU Industry Assessment Committee (CANIAC) program in November 2020.

Nayar assumed CANIAC oversight and supports the growth of the program which enables its members to share quality assurance audits of suppliers to CANDU nuclear plants. Membership to CANIAC is open to all suppliers who satisfy the requirements of the CSA N299, N286 or N286.7 series of standards. Nayar supervises a team of auditors specializing in these nuclear supplier audits.

Previously, Nayar worked at Ontario Power Generation (OPG) for 14 years in various roles including as section manager in the supplier audit, quality engineering and performance area as well as supply inspection services. He recently returned to Canada from the United Arab Emirates, where for six years, he worked for a subsidiary of Emirates Nuclear Energy Corporation (ENEC).

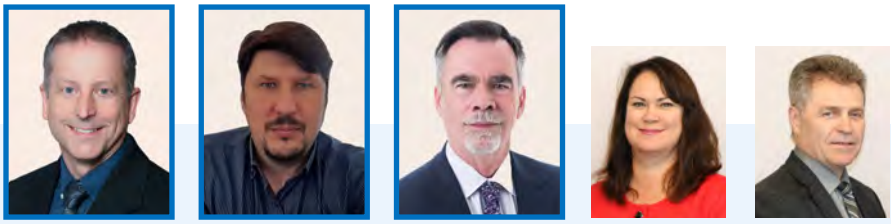
CANIAC has seen extensive growth over the past year. COG's Nidhi Gaudani, led the effort to build the program from its inception.

OPEX and Newsgroups

Andre Dixon joined the COG team as a software solutions engineer, Nov. 24, 2020, focusing on improvements to COGonline.org's OPEX and Newsgroups applications. These tools, respectively, contain more than 35-years of operating experience (totalling more than 45,000 entries) and 50+ topical newsgroups in which subscribers get the latest information on specific areas of CANDU and industry activity.

Dixon's work will ultimately make these tools easier for COG members to search, retrieve and share information.

Dixon holds a bachelor of science from University College of the Caribbean (Jamaica) and brings expertise in many IT areas including programming languages, web-based frameworks and databases.



COG welcomes three new board members from NB Power, SNN-Romania and CNL. OPG and Bruce power are also represented on the board.

Good things come in threes

COG welcomes its third new board member of 2021, New Brunswick Power's Jason Nouwens

New Brunswick Power's Point Lepreau Director, External Affairs Jason Nouwens joins the COG board of directors bringing nearly 25 years of varied nuclear industry experience to the role.

Nouwens, takes over for former COG board director, Michael Hare, who recently retired from NB Power. Nouwens is the third new director at COG in 2021. CNL's Jeffrey Griffin and SNN, Romania's Dumitru Benchea also joined the COG board, this year, replacing outgoing directors Neil Mantifel and Sorin Ghelbereu, respectively.

Nouwens first joined Point Lepreau in 1997, as a member of the systems engineering team, where he served in supervisory and management roles for more than a decade.

In 2014, Nouwens transitioned to the regulatory affairs (RA) team and, in 2016, he was appointed Director, Regulatory Affairs and Performance Improvement, a role Nouwens held until 2021.

At CNL, Griffin is the Vice President, Science and Technology while SNN's Benchea was recently appointed Engineering Director at Cernavoda.

Other COG board members include Ontario Power Generation's Vice President Nuclear Decommissioning Strategy Carla Carmichael and Bruce Power's Senior Vice President of Engineering and Chief Nuclear Engineer Gary Newman (chair).

Click here to read more about the COG Board of Directors.

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CANDU Owners Group (COG)
655 Bay Street, 17th Floor
Toronto, ON M5G 2K4 Canada
Phone: 1-416-595-1888
Fax: 1-416-595-1022
Email: cog@candu.org

CANDU Owners Group Inc.

"Excellence Through Collaboration"