



INNOVATION

FOR THE FUTURE OF NUCLEAR ENERGY

A GLOBAL FORUM

JUNE 10 -12 2019
GYEONGJU, SOUTH KOREA

SUMMARY AND INSIGHTS

EPRI | ELECTRIC POWER
RESEARCH INSTITUTE

 **IAEA**
International Atomic Energy Agency


KHNP

 **NEA**
NUCLEAR ENERGY AGENCY

**NATIONAL NUCLEAR
LABORATORY**



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LETTER FROM STEERING COMMITTEE

The nuclear industry is a vital part of the global energy mix, in particular to address climate change, because it's a zero-carbon energy source. Changes in the electricity industry however, have left nuclear energy challenged in recent years. It is time to overcome those challenges, and to do that we must embrace innovation.

WHY WAS THE FORUM IMPORTANT?

There are more than 450 operating power reactors, which together produce just over 10% of the world's electricity. Nuclear power is the second-largest source of low-carbon electricity today, according to an International Energy Agency May 2019 report.

The industry has identified an urgent need to overcome barriers to sustaining the current nuclear fleet and advance its contribution to a resilient and stable electric power grid and help address climate change goals. Organizers recognized that this effort could not be led by one person or organization alone, and that momentum was needed to rally stakeholders from all aspects of the industry together to start connecting the dots and to build a vision together for nuclear's future.

WHY WAS IT UNIQUE?

- The Global Forum brought representatives in from outside the industry to give perspective on what is possible in similarly challenging environments.
- Utility and regulatory decision-makers were brought into the conversation together, when traditionally separate conversations occur. The Global Forum showcased the necessity for further collaboration among these groups.
- The Global Forum is the place decision makers go to get things done. The Global Forum hosted engaging, deep dive small group discussions among all participants, including panelists, even those outside the industry.

Global Forum attendees made an unprecedented, collaborative commitment to enable change, drive positive disruption, and make a difference in the nuclear industry. Attendees prioritized the most critical innovation technologies or processes, identified barriers, timeframes, and needed organizational engagement for deployment. Collaboration networks will soon be engaging in action planning for those prioritized innovations.

The Global Forum Steering Committee looks forward to making progress on these innovations and will keep all delegates informed as we approach the Fall 2020 Global Forum in London.



EPRI Vice President and CNO Neil Wilmshurst gave the keynote address.

- It concluded with a call to action and follow-up planning to make a difference on identified actions.
- Early career nuclear professionals played an active role throughout the Global Forum.

Neil Wilmshurst,
Vice President
& CNO, EPRI

Heather Feldman,
Director of Plant
Support, Nuclear
Sector, EPRI

Ed Bradley, Team Leader,
Nuclear Power Plant
Operation & Engineering
Support, IAEA

Young-Seung Kim,
Vice President, Technology
Policy & Strategy
Department, KHNP

Rob Whittleston,
Vice President,
Insights, UK NNL

Sama Bilbao y León,
Head, Division of
Nuclear Technology
Development &
Economics, OECD-NEA

WHAT WAS THE GLOBAL FORUM?

The Global Forum was a gathering of industry leaders to focus on accelerating deployment of innovations for the nuclear operating fleet and secure the sustainability of nuclear power.

INNOVATORS AND DELEGATES FROM:



Nuclear Power Utility Leaders



Innovators and Entrepreneurs



Researchers and Academia



Government Leadership



Nuclear Regulators



Technology Providers

TIMELINE:

JUNE

10

DAY 1

Keynote & Panel Discussions

JUNE

11

DAY 2

Small Groups
& Regulatory

GUIDING PRINCIPLES

Collaboration

Delegates will work together for a common purpose for the global nuclear industry.

Disruption

Delegates from within the nuclear industry feel empowered to be change agents and proactive, rather than reactive. Innovators outside the global nuclear industry feel empowered to be transformative disruptors.

REPRESENTING 16 COUNTRIES:



Austria



Canada



China



Egypt



France



Germany



India



Japan



Russia



Saudi Arabia



South Africa



South Korea



Switzerland



United Arab Emirates



United Kingdom



United States

JUNE

12

DAY 3

Call to Action

Group Discussions
for Roundtable

Enabling Change

Delegates feel empowered at all times to actively participate in all aspects of the global forum.

Making a Difference

Delegates want to make a difference with every input and contribution made to the global forum.

AGENDA AND INVITED INNOVATORS

DAY 1: Keynote & Panel Discussions

Opening Remarks: Jae Hoon Chung, President and CEO, Korea Hydro & Nuclear Power Co., LTD (KHNP)

Welcome Address: Young Joon Joo, Deputy Minister for Energy & Resource, Ministry of Trade, Industry and Energy (Government of Korea)

Keynote from the Global Forum Steering Committee:

Neil Wilmshurst, Vice-President and Chief Nuclear Officer, Electric Power Research Institute (EPRI)

PANEL: Deployment of Transformative Innovation – Sharing across Sectors

- Chairperson: Arshad Mansoor, Senior Vice President R&D, Electric Power Research Institute (EPRI)
- Takafumi Anegawa, President of Research Institute, Tokyo Electric Power Company Holdings, Inc. (TEPCO)
- Sharon Cheetham, Executive Director and Co-Founder, RenaSci
- Garrett Reisman, Senior Advisor, SpaceX, Professor of Astronautical Engineering, University of Southern California
- Anshu Roy, Founder and CEO, Rhombus Power
- Yongsik Shin, Senior Vice President, SK Telecom

PANEL: Transforming Nuclear for Our Future

- Chairperson: Fred Dermarkar, CEO, CANDU Owners Group (COG)
- Shin Whan Kim, Executive Vice President, NSSS Division, KEPCO Engineering and Construction
- Abderrahim Al Mazouzi, Senior Researcher, Électricité de France (EDF), Industry Executive Committee Representative NUGENIA
- Jason Wight, Director of Engineering, Pickering Nuclear Generating Station, Ontario Power Generation (OPG)
- Masayuki Yamamoto, Deputy Chief Nuclear Officer, General Manager, Nuclear Asset Management Department, TEPCO

PANEL: Innovation in the Nuclear Sector

- Chairperson: Fiona Rayment, Executive Director, Nuclear Innovation and Research Office (UK)
- Yunho Kim, Vice President, Head of Central Research Institute (CRI), Korea Hydro & Nuclear Power (KHNP)
- William D. Magwood IV, Director General, Nuclear Energy Agency (NEA)
- Jeffrey Merrifield, Partner, Pillsbury Winthrop Shaw Pittman LLP
- Patrick Morilhat, Programme Director R&D, Nuclear Performance, Électricité de France (EDF)
- Neil Wilmshurst, Vice President and Chief Nuclear Officer, Electric Power Research Institute (EPRI)

DAY 2: Small Group Discussions & Regulator Roundtable

Small Group Topic 1: How can technology transform nuclear?

- Chairperson: Kirsty Hewitson, Vice President Innovation, National Nuclear Laboratory (NNL)
- Early Career Chairperson: Stacey Shepherd, Innovation Coordinator, Électricité de France (EDF) Energy
- Table facilitators/presenters:
 - John Bintu, Strategic Advisor, Nuclear Innovation and Research Office (UK)
 - Tae-hui Kim, Senior Manager, Korea Hydro & Nuclear Power Co., LTD (KHNP)
 - Henry Preston, Scientist, Fuel Performance, National Nuclear Laboratory (NNL)

- Allan Simpson, Scientist, Nuclear & Reactor Physics, National Nuclear Laboratory (NNL)
- Wil Smith, Government and External Relations Associate, Electric Power Research Institute (EPRI)

Small Group Topic 2: How can frameworks that help boost innovation be designed?

- Chairperson: Christina Van Drunen, Director of Science & Technology Strategy and Collaboration, Canadian Nuclear Laboratories (CNL)
- Early Career Chairperson: Jeffery Preece, Program Manager, Water Management Technology, Generation, Electric Power Research Institute (EPRI)
- Table facilitators:
 - Chris Comfort, Innovation and Technology Manager, Southern Company
 - Abderrahim Al Mazouzi, Senior Researcher, Électricité de France (EDF), Industry Executive Committee Representative NUGENIA
 - Cher-Young Park, Senior Manager, Korea Hydro & Nuclear Power Co., LTD (KHNP)

Small Group Topic 3: How must culture, leadership and collaboration evolve to stimulate and deliver effective innovation?

- Chairperson: Joan Knight, Innovation Director, Exelon
- Early Career Chairperson: Marianne Nari Fisher, Associate Project Officer, International Atomic Energy Agency (IAEA)
- Table facilitators:
 - Luca Capriotti, Nuclear Fuel Engineer, Idaho National Lab (President, International Youth Nuclear Congress)
 - Hyo-jong Park, Senior Manager, Korea Hydro & Nuclear Power Co., LTD (KHNP)
 - Jonathon Bew, Graduate Consultant (Nuclear), Hydrock

Regulator Perspectives Roundtable

- Chairperson: William D. Magwood IV, Director General, Nuclear Energy Agency (NEA)
- Early Career Chairperson: Malisol Ohirko, Analyst NTE Division, Nuclear Energy Agency (NEA)
- Participants:
 - Thierry Charles, Deputy Director General, Institut de Radioprotection et de Sûreté Nucléaire (IRSN)
 - Michael Finnerty, Deputy Chief Inspector and Director New Reactors Programme, UK Office for Nuclear Regulation (ONR)
 - Ramzi Jammal, Executive Vice-President and Chief Regulatory Operations Officer Regulatory Operations Branch, Canadian Nuclear Safety Commission (CNSC)
 - Jinho Lee, Vice President, Korea Institute of Nuclear Safety (KINS)
 - Fiona Rayment, Executive Director, Nuclear Innovation and Research Office (UK), Chair of NEA NI2050 Advisory Panel
 - David Wright, Commissioner, U.S. Nuclear Regulatory Commission (NRC)

DAY 3: Call to Action

Small Group Discussion Insights and Actions to Deploy Innovations

- Chairperson: Jeffrey Merrifield, Partner, Pillsbury Winthrop Shaw Pittman LLP
- Early Career Chairperson: Mary Presley, Principal Technical Leader, Electric Power Research Institute (EPRI)
 - Insights were collected from the three small group chairs and early career chairs. Delegates then prioritized innovations from each of the small group discussions and answered a set of questions to begin to pursue a plan of action.

KEY TAKEAWAYS FROM THE GLOBAL FORUM

Innovation starts at the top with leadership setting a “moonshot” vision and leading with actions to enable innovation. This sets the tone for the entire organization to create an environment for success.

Nurturing Innovation

- The future of nuclear energy is built by today’s early career professionals. The nuclear energy industry attracts and retains this talent with a work environment that encourages new ideas and energizes the workforce.
- Representatives with a wide variety of backgrounds and experience from outside of nuclear energy are welcome as that creates diversity of thought and makes innovation happen.
- Freedom to fail when the consequences are low is a mindset that needs to permeate nuclear energy organizations to promote innovation.

Voice of the Early Career Nuclear Professionals

- We think the path to decarbonization should include a strong and reliable nuclear power plant fleet, and innovation is key to its sustainability.
- Innovation attracts us, and as the next generation of innovators, our inclusion at all levels of the conversation will foster that culture of innovation.
- We noticed that leadership has an appetite for change. We have a creative energy to pursue innovation, and with a strong vision set from leadership, we want to help keep the momentum going.

Communicating Inside and Out

- Leadership at regulatory organizations are supportive of innovation. All elements of the industry need to come together to embrace and tackle challenges as a nuclear community.
- Nuclear energy has been one of the most prevalent providers of low carbon energy for decades. The role of nuclear is only becoming more important and everyone in the industry has a responsibility to ensure it fulfils this role.
- We are all in this together. An innovative sector is a successful sector.

ACTIONS

Delegates at the Global Forum prioritized the most critical innovation technologies or processes. Collaboration Networks to pursue actions to accelerate deployment of those will be available soon. Meanwhile, co-organizers have gathered several success stories of actions already taken.

MACHINE LEARNING



To accelerate use of big data, data analytics, and artificial intelligence for optimization of operations and maintenance.

SUCCESS STORY

U.S. utility uses Work Order Data Visualization Tool to save on materials and labor

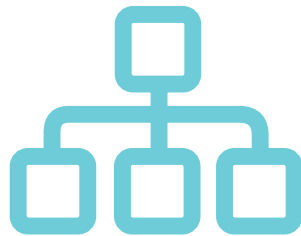
PROBLEM: Exelon wanted to accurately quantify equipment maintenance costs at their sites, but had no way to easily visualize the list of preventive and corrective maintenance tasks that had been performed for a given component or system.

ACTION: Exelon used the EPRI Work Order (WO) Data Visualization Tool, released in March 2017, first at its Quad Cities facility (and then other sites) to gain specific insights and drive decision-making based on more than 30 detailed system reviews. As part of its maintenance strategy optimization effort, the team used the tool to review approximately 2,700 preventative maintenance tasks for equipment in these systems.

RESULT: The Quad Cities team cut costs by removal of non-critical, non-safety related HVAC system-related tasks (saving \$30,000 annually) and extending Motor Control Center inspection intervals (saving \$75,000 annually). The team optimized maintenance strategies across several components in order to maintain appropriate levels of equipment reliability while, ultimately, cutting total maintenance costs.

If you're interested in learning more about this success story, contact EPRI Engineering Principal Project Manager Jeff Greene at jgreene@epri.com.

FRAMEWORK TO SHARE COMPARABLE, RELIABLE DATA



To increase data sharing on research and development, operations and maintenance.

SUCCESS STORY

COG Supplier Participant program develops sharing process for CANDU supply chain

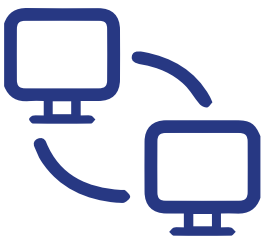
PROBLEM: With increased participation of contractors and vendors embedded in leadership roles for CANDU refurbishment projects and operations, CANDU Owners Group (COG) members identified a need to strengthen safety and quality culture within the supply chain.

ACTION: In 2015, COG began revitalization and further development of its Supplier Participant (SP) program using the same approach to knowledge management, including knowledge creation, retention and transfer -- through operational experience sharing, performance targets and leadership/supervisor training -- used by COG member utilities.

RESULT: With 27 active members (compared to eight in 2015), the program has grown significantly in participants and scope, and is demonstrably more mature in its approach to knowledge transfer. The SP program established processes for regular sharing of supplier operational experience and key industry learnings; implemented a First Line Supervisors Training Program; created Human Performance metrics program launching in October 2019; and developed a shared-cost quality assurance audit program of sub-suppliers. It also developed bi-monthly forums as a bridge for direct interaction between the supplier community and their utility customers.

If you're interested in learning more, contact CANDU Owners Group Director of Information Exchange John Sowagi at john.sowagi@candu.org.

DIGITAL TWINNING



To use a virtual environment and sensors (Digital Twin) for the discovery of cost savings and nuclear plant performance opportunities for application in the physical world.

SUCCESS STORY

EDF “reactor build” digital twin model reduces outage durations

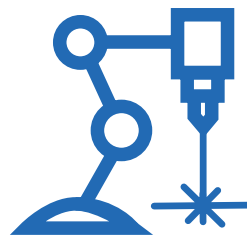
PROBLEM: A key driver to improve the performance and competitiveness of a nuclear fleet is to optimize maintenance preparation and reduce the duration of plant outages.

ACTION: EDF launched a significant digitalization programme, and launched a “reactor build digital twins” programme to enable key performance improvement. The team scanned one of its reactor buildings, combined and edited all the scans together, and placed 3D-pictures and existing related CAD objects into the model to arrive at EDF’s first digital twin.

RESULT: The digitalized reactor, or Digital Twin, enables maintenance teams to: develop pre-job briefings and better plan for outage periods; more effectively measure distances between components while the reactor is operating; find components – the twin identifies back components in the model with a tagging system – and save time during outage. This first digital twin is currently being adapted, improved and re-used to twin EDF’s entire reactor fleet, which seeks to positively impact the outage preparation on a large scale.

If you’re interested in learning more, contact EDF Programme Director R&D, Nuclear Performance Patrick Morilhat at Patrick.morilhat@edf.fr.

ADVANCED MANUFACTURING



To deploy advanced manufacturing methods including 3D printing to address supply change challenges.

SUCCESS STORY

Electron beam welding of pressure vessel sections saves production time and costs

PROBLEM: The key to the economic viability of future reactors lies in using advanced manufacturing techniques to significantly reduce production costs and lead times. Producing a pressure vessel using current processes can take as long as 3-4 years.

ACTION: In an ongoing R&D programme supported by the US Department of Energy, NuScale Power, EPRI and the UK’s Nuclear Advanced Manufacturing Research Centre (Nuclear AMRC) are developing a range of techniques to reduce pressure vessel production time to less than 12 months in total. One key technology being developed at the Nuclear AMRC is electron beam welding of thick-walled vessel sections, including sections produced from metal powder by hot isostatic pressing.

RESULT: Trials at the Nuclear AMRC have successfully demonstrated that girth welds of large vessel sections can be completed in less than 60 minutes.

If you’re interested in learning more, contact Nuclear AMRC Metallurgist James Connell at james.connell@namrc.co.uk.

PANEL HIGHLIGHTS



Deployment of Transformative Innovation – Sharing across Sectors

Leaders in aerospace, pharma, electric vehicles, start-ups and telecom painted a vision of what it takes to overcome barriers and innovate within their industries.

Innovation starts at the top

Leadership must set a compelling vision – the moon shot – and establish a culture of moving swiftly with diverse teams. A compelling vision attracts, retains and inspires talent of all ages to be a part of something bigger that connects us to humanity.

Innovation must be a culture

A swift culture where teams are small in size and free from the constraints of undue process have the ability to iterate in a reasonable time frame, and still be accountable to leadership. This culture has the freedom to fail and can push the envelope and accelerate new learnings. It is a culture of diversity and inclusion where everyone is unconstrained in their thinking, including young professionals and outsiders. The team goes, plans, acts, experiments and tests with checks and balances from mentors that are open to and complement their innovative thinking.

Innovation takes communication

Successful acceleration and implementation of innovation requires communication among all stakeholders. Effective and frequent communications among the circle of innovators from developer to deployers to regulators enhances understanding, enables early questions, and minimizes set-backs.

Innovation is risk mitigation

These ideas were dispelled: risk should be eliminated; and innovation increases risk. Accidents are infrequent in high risk industries such as space and nuclear. When accidents occur, the level of risk is no different than it was before the accident. However processes put in

place after an accident tend to squeeze out innovation. Innovation is the very thing needed to mitigate the risk – the amount of mitigation must be right-sized for the risk.



Innovation results from disruption and competition

NASA felt it from SpaceX. SpaceX made technical advances at reduced costs that changed U.S. space policy. In 2010, the U.S. administration reoriented the space program to focus solely on deep space. After meeting with SpaceX, the administration gave NASA direction to purchase low Earth orbit services from the more advanced private sector to reduce costs.

The traditional automotive industry felt it from electric vehicles. Today electric vehicle components are disrupting and challenging manufacturers to look at building new parts and develop associated training for the next generation of factory workers.

Is the nuclear industry feeling it from other carbon free energy sources? Competition in the energy market has already led operators to develop innovative means to make nuclear power generation more feasible and sustainable, including common design models that standardize processes and increase operational efficiencies.

PANEL HIGHLIGHTS



Regulatory Round Table Perspectives

Leaders shed light on many of the common concerns among the operators and technology developers in terms of how regulation and regulators can enable innovation, demystifying the stigma of being a barrier.

Finding a common ground to increase innovation

- Regulators are working together to find a common ground for establishing regulatory frameworks for new and innovative nuclear technologies.
- Regulators are interested in reaching a common understanding on how to approach issues such as security and emergency preparedness for the new designs.
- Building on common goals is key towards a harmonized regulatory framework.

Regulation as an enabler of innovation

- Regulators need to become involved in the development of new technologies from the beginning.
- Early involvement of regulatory bodies will lead to time and cost optimization.
- Regulators cannot isolate themselves, they need to have regular and open communication with operators, vendors and developers and amongst regulatory authorities.
- Regulators are open to dialogue, but the industry has to reach to them.

Communication and collaboration will lead to innovation

- Regulators need to be better informed and involved in the development of new technologies, this will enable them to anticipate the regulations that will then be needed to license the new technologies.
- Developers have to reach out to the regulators.
- Regulators can be allies in the creation of new technologies.
- An equilibrium between safety, openness and innovation has to be reached, and for this, regulators need to be involved.
- Solutions can be built when regulators and developers work together.



The regulator leaders have found common ground on which to work together. Now, it is time for the developers to include them in the process of innovation from its inception. They are looking forward to this, are open for discussion and are expecting to and willing to become enablers of new technologies.

PANEL HIGHLIGHTS



Transforming Nuclear for Our Future

Leaders focused on identifying barriers to nuclear industry innovation and developed initial ideas about how to overcome them.

Three pillars of innovation

1. Technological innovation: the application of innovations in technology to enhance nuclear operations
2. Process innovation: the application of refined or new processes to achieve improvements in efficiency, reliability and effectiveness in management, leadership and culture
3. Business framework innovation: the application of new frameworks to leverage opportunities that could not be otherwise achieved, including partnerships, redefining roles for industry associations, and so on.

Five areas for innovation opportunity

1. Digitalization or modernization, including everything from control of systems and components to the use of Artificial Intelligence to enhance worker performance, performance monitoring and inspection methods.
2. Challenges in component obsolescence.
3. Incorporating nuclear in the public discourse and government policy discussions about decarbonization.
4. Evolving regulatory requirements for existing reactors.
5. Radioactive waste disposal.

Barriers to innovation

- Skepticism for change.

- Fear of reducing safety when innovating.
- Economics– the traditional process for business case approvals does not always lend itself to making the case for funding innovations
- Allocating time to innovate.
- Lack of high-quality data to deploy.
- Frameworks and processes for enabling efficient and effective regulatory reviews of new technologies.

Implementing innovation



Identification: Engage the workforce – including young generation – to look for opportunities to innovate include new ideas coming from new minds. Prioritize the innovation opportunities. Be aware of what others are doing to minimize duplication and maximize synergy.

Development: Connect the most appropriate technology to the problem. Engage resources beyond station staff and traditional suppliers. Secure financing and managing project risk.

Deployment: Address legal challenges (IP, ethics, data privacy), security challenges (resilience to cyber attacks), and regulatory challenges (use of non-traditional technologies and methods).

A culture of innovation

For innovation to flourish, organizations should adopt a culture that nurtures and promotes innovation within an organization, and that encourages collaboration on those innovations between organizations.

PANEL HIGHLIGHTS



Innovation in the Nuclear Sector

Leaders from across the global nuclear sector came together to discuss the innovations that are already being applied in the industry and what the main key issues are that must be overcome.

Collaboration is king for successful innovation

Driving change through innovation in Nuclear needs collaboration across all areas - industry, academia, research organisations, government, finance and regulators. Importantly collaboration on innovation must be both within and outside of the sector.

A new relationship between innovators and regulators is essential

For innovations to be effectively implemented, there needs to be a new relationship between regulators and innovators that will enable deployment of standardised, cost effective, and timely solutions.

A better sharing of knowledge and best practice will enable innovation

We have so much knowledge across the sector but we are not sharing effectively. We need to harness our collective knowledge to enable our innovations to flourish.

Diversity of thought will drive innovation

We need to think differently; turn the challenges into opportunities and engage with a more diverse group of thought leaders to address our collective innovation challenges. A good question can spark an innovation and we must positively enable this. Early careers people bring innovation and energy - so are we engaging with them enough?

Innovations are about taking managed risks

For innovation to be successful, risk taking in a managed way should

be rewarded and become the norm for the industry. After all, if we always do what we always did we will always get what we always got. Within the right environment freedom to fail will drive success.

Innovation in how we communicate will enable success

We need to communicate better with the broader society working with schools, further / higher education and engagement with other carbon free energy providers on the role that Nuclear energy can play in achieving a clean, sustainable, and affordable energy mix.



Innovation will drive down construction and operating costs

Through optimising designs, using new technology in materials, manufacturing and digital systems, learning from other sectors, technology partnerships construction costs will be reduced. Through application of big data and artificial intelligence early diagnostics will drive down operational costs.

SMALL GROUP DISCUSSION HIGHLIGHTS

Technology

Leaders from across the global nuclear sector came together in diverse teams to workshop the application of disruptive technology with a focus on the opportunity presented by digital innovation including value and the barriers to its implementation.

Innovation means different things to different people

At a basic level, it is doing something new or different for value. Organisations embracing innovation can enjoy vast and diverse benefits. Twenty-five different forms of value were identified throughout the three sessions by participants. Reducing costs while improving safety and efficiency can be a key output, however a less obvious value derivation can be, for example, improving skill retention and inspiring the next generation of nuclear talent.

Working together will enable success

The nuclear industry has been slow to embrace disruptive technology. A regulatory environment and industry culture both perceived to be conservative decreases the attractiveness of investment in innovation. All stakeholders must work together to champion innovation and reduce these perceived barriers to the adoption of new technology. An innovative sector is a sustainable sector.

Machine learning and big data is a mature technology in other sectors

Automation of processes, predictive maintenance and guiding regulatory inspections are just some of the possible applications that

would improve operator efficiency, safety, reliability and deliver cost savings.

Digital twins have wide ranging applications and are already deployed in some aspects of nuclear

Digital twins can be deployed from full plant to sub-component scale to support design and provide cost and safety benefits. Digital twins also offer considerable training and educational opportunities.

Due to their accessibility they can be used to improve public understanding and acceptance of nuclear technology.

Advanced manufacturing techniques are essential to keeping nuclear competitive

Many advanced manufacturing methods have been developed and deployed in other highly regulated sectors – so why not nuclear? The opportunity is vast; electron beam welding can significantly reduce the need for costly inspections; hot isostatic pressing of waste offers

substantial size reduction and security benefits; and full-scale component modulization and standardization would significantly reduce construction time (and therefore cost) and improve reliability.

Immerse in the future of nuclear

Immersive technologies including virtual and augmented reality offer real benefits across the industry including improved knowledge transfer through applications in maintenance, training and design validation. This is another mature technology frequently deployed in other highly regulated sectors, and a real opportunity for nuclear to up its game.



SMALL GROUP DISCUSSION HIGHLIGHTS

Frameworks

Development of revolutionary technologies is not the only way to achieve innovation. Sometimes, taking a step back and reassessing the way we have been looking at our assumptions and our processes may allow us to pivot and start seeing things differently. Rethinking the way we have always done things, may result in a substantially more advantageous outlook. Several framework shifts were identified and prioritized by the small group discussions. Here are details on three.

Worldwide transition from the linear no-threshold model

This would allow the nuclear sector to revisit the underlying assumption for all safety and radiation protection models, thus right-sizing the regulatory frameworks, emergency response zones and measures, etc. This would allow the simplification of nuclear systems and processes, thus resulting in lower construction, maintenance and operation costs.



Framework to share comparable, reliable data, in the areas of R&D, operations, maintenance

The nuclear sector has collected, and continues to collect an enormous amount of data, both in the R&D space and in the O&M space. Unfortunately these data don't have consistent formats, are stored in incompatible media, are not openly available and often have proprietary or company-sensitive information. A global

framework capable of collecting, systematically organising and "anonymously" sharing without prejudice is desired. This framework would allow the community to collectively use and make the most of advanced technologies such as learning algorithms, AI and other data driven innovations.

Clean Energy Centers integrating nuclear and renewables

It is important to demystify nuclear energy. We must add nuclear to the global conversations on clean energy goals.

Other frameworks identified

- Global supply chain coupled with financial framework to reduce costs and improve efficiencies
- Coordinated, multi-lateral risk-informed regulatory approval process
- Coordinated, global nuclear technology public engagement campaign, including early-years education and new technologies
- Global innovation sharing portal
- Framework to share the risk of innovations at national and international levels
- Consider opportunities to coordinate/enhance dialogue between INPO/WANO and safety authorities
- Budgetary funding process for nuclear regulatory organizations (US/Canada)



SMALL GROUP DISCUSSION HIGHLIGHTS

Culture and Leadership

Innovative digital transformations and emerging technologies highlighted in the other Global Forum small group discussions require different leadership and more employee engagement within the context of culture, leadership and collaboration to be successful.

Eight reoccurring innovative practices emerged

To improve the culture of innovation across the nuclear industry:

1. Organizations must foster a culture of accepting and learning from failure.
2. Leadership should be encouraged to grant sufficient time, budget and resources for workers to innovate.
3. Senior leadership levels should develop a high-level commitment and strategy for innovation.
4. "Innovation leaders" should be designated within organizations, and should report to institutional leadership or utilize dedicated teams to pursue innovative projects.



5. Innovation activities should not be subjected to the same hierarchical structure as operations.
6. Leaders should be educated on techniques and tools for leading innovation.
7. Diversity should be improved and enhanced beyond the traditional sense, including diversity of thought, experience and education.

8. Information sharing platforms should be more effectively used to accomplish shared objectives between institutions and international organizations.

"Fear of failure" has restricted true innovation in the sector

This is leading to risk aversion instead of managing appropriate risk. If industry truly seeks to remain competitive, innovation will

require fostering a culture driven by a purpose and value from the start, with adequate resources and support for more flexible practices.



CREATING A CULTURE OF INNOVATION

Throughout all the panels and small group discussions, innovators and delegates made clear that action should also be taken within all organizations in the nuclear industry to nurture a culture of innovation. Below is the action statement and a success story of cultural change.

A culture of innovation



To foster diversity of thought, acceptance of and learning from failure, and drive purpose, value, and operational performance improvement.



SUCCESS STORY

Xcel workforce realignment improves operational performance, increases efficiencies

PROBLEM: Nuclear plants were originally designed for the core business of operations and maintenance (O&M). Over time plant staff sizes have roughly doubled with more workers filling support roles, which resulted in elevated operating budgets.

ACTION: In collaboration with the U.S. Nuclear Energy Institute (NEI), Xcel Energy nuclear plant staffs were realigned under two primary functions – operate and maintain. Support functions have been centralized to eliminate redundancy and lessen site impact.

RESULT: This transformation established clarity in roles overseeing risk management, which now report to operations, and for roles overseeing equipment reliability, which now report to maintenance. This clarity is empowering the workforce to assume more ownership, improving performance and increasing efficiencies. Xcel saw preliminary O&M reductions of 25% and is continuing to make more improvements.

If you're interested in learning more contact Xcel Energy General Manager of Nuclear Fleet Operations and XE1 Nuclear Strategic Initiatives Team Lead Don Bosnic at don.bosnic@xenuclear.com.

HOW TO GET INVOLVED

Join the Global Forum for Nuclear Innovation (GFNI) Collaboration Network

Vision: Collaborators regularly engage in the Global Forum Collaboration Network to meet and work together to accelerate innovation deployment at nuclear power plants.

Objectives: A coordinated global effort (leveraging the unique, collaborative culture of the industry) to identify innovation opportunities, share successes and lessons learned, understand benefits, and remove barriers to implementation is increasingly regarded as necessary. This international network has been established to increase collaboration and experience sharing in the field of innovation to support the current fleet of nuclear power plants and to highlight related work from international and other relevant organizations. The network will focus on and promote cross-cutting projects that aim to enable or even accelerate innovation implementation within the nuclear industry.

The innovation areas include technologies, processes, frameworks, culture, leadership and regulation.

How to Join: Please contact GFNI.Contact-Point@iaea.org.

Plan to attend Global Forum 2020

Global Forum 2020, to be held in the United Kingdom on 4 to 7 October 2020, will continue to drive the momentum from the June 2019 event. It will reflect on successes to date, gather updates on 2019 action items, and explore future challenges.

The 2020 Forum will:

- Help to strengthen existing and identify new partnerships.
- Further identify and pursue opportunities to provide support and foster innovative solutions to ensure that nuclear continues to make its essential contribution to low carbon energy that our planet needs.
- Provide a platform for the next generation of nuclear leaders to share their vision for the future.
- Reflect on successes to date and consider the challenges of the future.
- Include a topical, technical meeting on innovation.

JOIN US



4-7 OCTOBER 2020 LONDON, UNITED KINGDOM



At the close of the 2019 Global Forum, hosted by KHNP, Senior Vice President and Chief Technology Officer Han Sang Wook (right) hands UK National Nuclear Laboratory (NNL) Vice President of Insights Rob Whittleston (left) the ceremonial baton. NNL will co-host the 2020 Global Forum with EDF Energy in London.



