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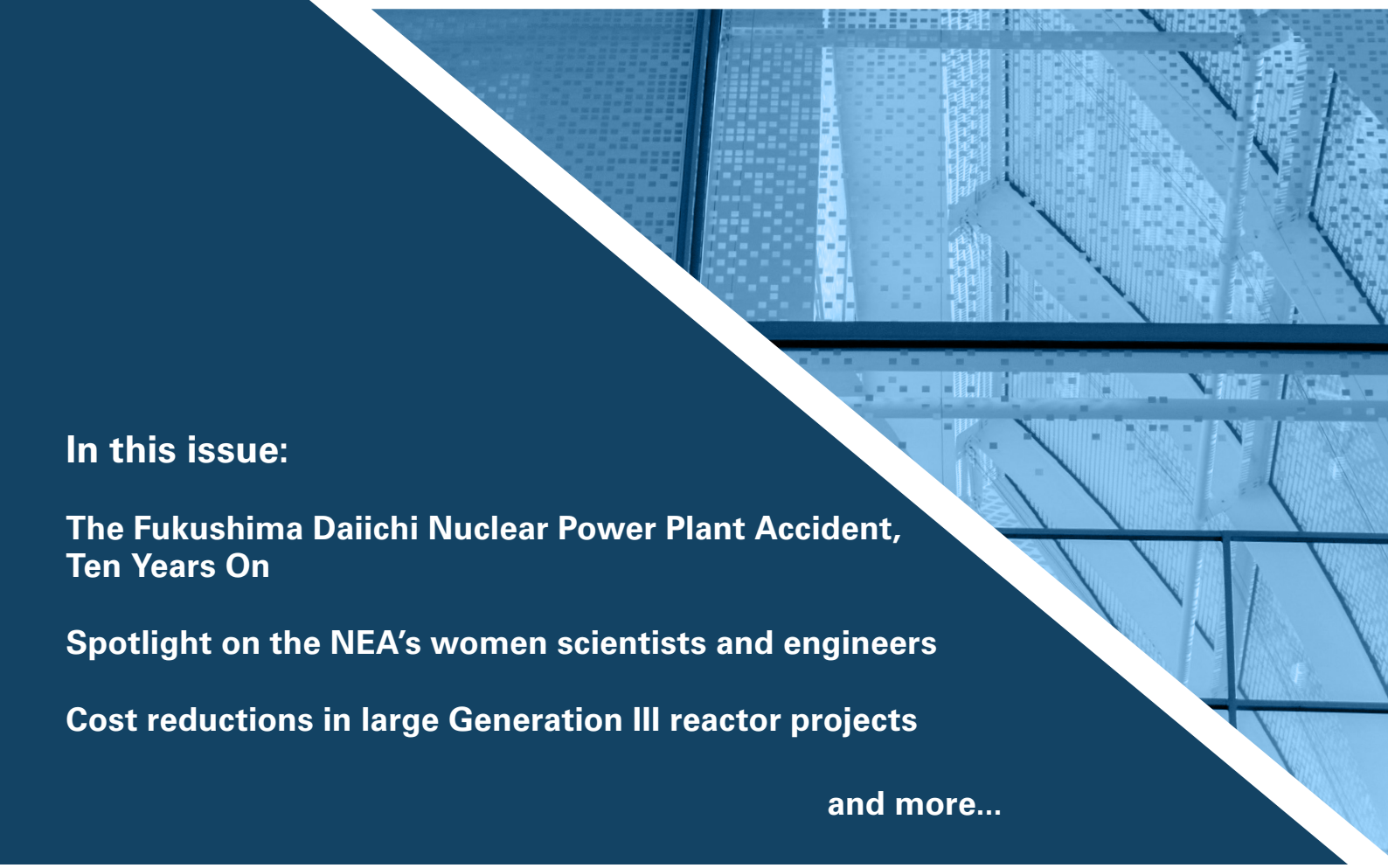

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An equal path

When I joined the NEA in 2014 as Director-General, I spent much of my first day meeting one-on-one with all my direct reports. I reported later to friends and old colleagues that it was an interesting and singular experience. These were very experienced men with tremendous expertise and knowledge who hailed from all over the world – France, Germany, Mexico, Japan, the United States and other countries. The many cultural and personality differences were starkly apparent and the contrasts were both energising and occasionally amusing.

One other factor about these men struck me as I reflected on that first day: they were, in fact, *all* men.

The NEA seemed a bit behind the times. While the Agency had previously seen a series of three female Deputy Director-Generals and one female head of the Office of Legal Affairs, it had never, in its nearly 60 years of operation, had a female head of a programmatic division.

This, of course, changed quickly. The first woman to head an NEA programme division joined the NEA less than a year later and more followed. Eventually, the NEA reached a point two years ago when all heads of its programmatic divisions were female. I find that most people were unaware of this and feel that was appropriate; it wasn't a policy or an achieved goal to be touted – it was just the result of good recruiting. Not one was hired because she was female; they were all the best-suited candidates who applied.

While the NEA's division heads are not now all women, they are still significantly in the majority. Further, among the technical and legal professionals in the NEA's programme divisions, 41% are female. There remains room for improvement in the Agency's gender balance, but very good progress has been made in recent years.

In the global nuclear sector, women are substantially underrepresented in technical and managerial positions – about 12 to 15% is a general estimate we've seen in many countries (with a few much higher and a few much lower). In reality, the data about the role of women in nuclear is very incomplete, making a clear understanding of the issues that keep these numbers so low elusive.

The Steering Committee on Nuclear Energy, which oversees the operation of the NEA, decided to address these issues at its October 2020 meeting. It authorised a group of representatives from NEA member countries to undertake a rapid effort to: collect and analyse data to understand the challenges to gender balance in the nuclear sector; examine the need for an international policy instrument to support countries working to enhance the contribution of women; and develop targeted communications to improve gender balance in the nuclear energy field.

This is an exciting and important initiative. Nuclear science and technology can help provide a brighter, cleaner, more prosperous future for people all over the world, but to do so, it will need the participation and support of all those who could benefit – not just a mostly male fraction. We need the best and brightest minds, the best and most compelling public ambassadors, and the best and most perceptive leaders. Many of these will be women and we need them now and in the long-term future.

This effort has just begun. It remains to be seen whether the NEA will be able to recommend clear, substantive policies to its members that will make a real difference. But I firmly believe that it is our obligation to try. Anyone seeing the eyes of young girls attending NEA International Mentoring Workshops light up when a successful, highly-accomplished female scientist or engineer tells them "follow your dreams; you can be whatever you choose to be" will agree.

William D. Magwood, IV,
NEA Director-General

The Fukushima Daiichi Nuclear Power Plant Accident, Ten Years On*

by N. Muroya

Mr Nobuhiro Muroya (nobuhiro.muroya@oecd-nea.org) is NEA Deputy Director-General.

A street planted with cherry trees in the Yonomori district of Tomioka Town, a little over 7 kilometres from the Fukushima Daiichi Nuclear Power Plant, taken in April 2019. Although access to this area was restricted for a long time after the accident, residents have more recently been allowed to visit during the cherry blossom season to enjoy the trees in full-bloom. In March 2020 the government lifted evacuation orders for about seven hectares in the area. The aim is for residents to be able to make a full return in the spring of 2023.

By courtesy of the Town of Tomioka, Japan

On 11 March 2011, a large earthquake struck off the coast of the eastern part of Japan, and a massive tsunami swept areas of the eastern coast. The world then witnessed the worst ever nuclear accident to have occurred in an NEA member country.

In the ten years since the accident at the Fukushima Daiichi Nuclear Power Plant the Japanese authorities have undertaken very challenging work to address the on-site and off-site consequences, as well as rebuilding the social and economic fabric of the areas impacted by the earthquake, the resulting tsunami and the nuclear accident. The global community has come together with Japan to both offer assistance and draw lessons to further improve nuclear safety worldwide. This endeavour has been greatly facilitated by the openness of the Japanese government and industry leaders as well as the co-operation of international organisations, governments and companies. In March 2021 the NEA published its third major study of the aftermath of the accident. The latest report surveys the research initiatives and the expanding knowledge and action made possible by such openness and co-operation. It also provides a forward-looking analysis of ongoing international co-operation.

Addressing the considerable challenge of decommissioning the complex nuclear clean-up site, the Japanese government's flexible Mid-and-Long-Term Roadmap reflects both the priority for safety and the implementation system. The 2019 (fifth) revision focusses on managing the contaminated water and the treated water stored on site and other radioactive waste, as well as on removal of both stored fuel and fuel debris. Environmental remediation is performed

* *Fukushima Daiichi Nuclear Power Plant Accident, Ten Years On: Progress, Lessons and Challenges,* on which this article is based, is available for download from the NEA website.

The festival parade "Soma Nomaoi" in Minamisoma City (about 24 kilometres north of the Fukushima Daiichi Nuclear Power Plant), Fukushima Prefecture, taken in July 2019. Every summer, approximately 400 inhabitants of the region wear samurai combat costumes and swords for three days and conduct festivals in an ancient format to practice the tradition of samurai and traditional horse training techniques. The impact of the Fukushima Daiichi Nuclear Power Plant accident and associated evacuation order as well as of the earthquake and tsunami were significant in Minamisoma City and the surrounding areas. Neither the 2011 tsunami nor the current pandemic has interrupted the tradition. In recent years many residents who returned after the evacuation order was lifted have participated in Soma Nomaoi.

By courtesy of the City of Minamisoma, Japan

to allow wherever possible the safe return of the population to affected off-site areas; the decontamination in the Special Decontamination Area was performed as planned by the end of March 2017, and the work in the Intensive Contamination Survey Area was completed in March 2018.

Institutional shortcomings uncovered in the aftermath of the accident prompted the government of Japan to completely redesign its approach to nuclear regulation and oversight. It established the Nuclear Regulation Authority (NRA) in 2012 and gave it organisational, cultural, financial and political independence. The NRA quickly established new regulatory requirements to assure the safe operation and improved resilience of Japanese facilities in the face of conceivable events. The NRA continues to learn and is currently adopting a new risk-informed oversight process whose implementation includes essential discussions and interactions with operators. Japan has also adapted or supplemented legislation as needed in order to enhance safety, emergency preparedness and the nuclear liability framework enabling compensation.

At the international level too, much has been learnt. NEA projects supported by participating member countries and the government of Japan, as well as other NEA joint efforts, have delivered cross-cutting safety research. A common understanding of the accident has led to improved tools to support decommissioning and a better quantification and understanding of plant safety margins. Potential improvements have been identified in several areas such as fuel designs that are more tolerant of accidents and electrical power systems that are more robust. Comprehensive safety reviews were done across NEA member countries to assess readiness for severe accident conditions, and have identified plant and process improvements to mitigate the potential impact of external hazards. As highlighted in the 2016 NEA report *Five Years after the Fukushima Daiichi Accident: Nuclear Safety Improvements and Lessons Learnt*, many such measures have been implemented.

To address near-term challenges in handling very low-level post-accident radioactive waste, the NEA examined how to develop a complex waste characterisation and categorisation process. NEA activities have also focussed on post-accident recovery management, including balancing decisions in radiological protection, as an important pillar of ensuring public health and well-being. Human aspects of nuclear safety, such as regulatory safety culture and broader stakeholder involvement in decision making, have been a significant focus of NEA activities. The 2021 report details the range of such initiatives and the lessons learnt. The activities of other international organisations are acknowledged and referenced as well.

Significant issues remain to be faced as Japan continues the difficult, long-term effort to clean up the Fukushima Daiichi site and revitalise the surrounding communities impacted by the earthquake and resulting tsunami and nuclear accident. Technical challenges concern, inter alia: fuel debris removal; decontamination methods; environmental remediation; and related waste issues. Regulatory and legal challenges include: regulation under uncertainty; reinforcing institutional nuclear safety systems; legal preparedness; holistic optimisation decisions; and effective regulatory engagement with a broad range of stakeholders including licensees and the public. The ongoing task of rebuilding and revitalising communities and local economies should benefit from a guidance framework outlining a consensual process to facilitate recovery and enable the communities to develop greater societal resilience. Reflection and action will be needed on preserving intergenerational knowledge and experience, and also on clarifying ethical values and challenges.

Nevertheless, Japan has achieved significant progress in vigorously addressing the accident through actions and reforms at both the technical and institutional levels. With co-operation from the NEA and other international organisations, the technical understanding of the accident event has progressed significantly, thereby aiding all countries to improve safety and preparedness. Environmental, social, political and economic aspects, including safety culture, must be a continued focus if nuclear power is to play its part in addressing the world's need for clean, safe, reliable energy.

The NEA will continue its strong support for the long process ahead to address the aftermath of the Fukushima Daiichi accident and continue developing knowledge that can be gleaned from the experience.

Reference

NEA (2021), *Fukushima Daiichi Nuclear Power Plant Accident, Ten Years On: Progress, Lessons and Challenges*, OECD Publishing, Paris.

NEA (2016), *Five Years after the Fukushima Daiichi Accident: Nuclear Safety Improvements and Lessons Learnt*, OECD Publishing, Paris.

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Spotlight on the NEA's women scientists and engineers

by G. Demiray and E. Gamarra

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What role do women in the nuclear field? We asked the women scientists & leaders of the NEA: https://www.youtube.com/watch?v=kyYpkaSWovo

Ground-breaking discoveries by remarkable women scientists, such as Marie Skłodowska-Curie and Lise Meitner, have advanced fundamental knowledge in the nuclear field and laid the foundation for the modern technologies in development today. However, despite substantial progress in recent years, women are significantly under-represented in technical and leadership positions in the nuclear sector. This lack of gender diversity may have substantial impacts on the future of nuclear energy in NEA member countries. The Agency therefore encourages its members to explore ways of recruiting and retaining women in science and technology, as well as new approaches to improve gender balance in the nuclear sector.

During Women's History Month, women scientists and leaders at the NEA reflected on their studies, careers and the role of women in science, technology, engineering and mathematics (STEM).

Martina Adorni,

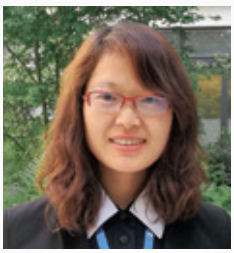
Nuclear Safety Specialist

Martina Adorni has a PhD in nuclear and industrial safety from the University of Pisa. She has always been fascinated by science, but what really inspired her to explore her interest in STEM was an amateur astronomy society in her hometown. "I started to attend their courses of astronomy, because I found their information in a small part of the local newspaper," she said. "Once I started to attend those meetings, I became more eager to study science." Based on her personal experience, Martina highlighted the importance of encouraging girls to explore STEM at an early age. "The issue is about giving equal opportunities to women. We will never be able to reach equal representation if we do not start doing this earlier, like at the high school level, or even earlier," she said. "In this respect, I think that the NEA's mentoring workshop can be very inspiring for countries that aspire to achieve gender balance in STEM."

Daniela Foligno,
Junior Scientist, NEA Data Bank

Daniela Foligno has a background in energy engineering and a PhD in nuclear particle physics from Aix-Marseille University. Her motivation to join the STEM field emerged from a desire to understand the fundamentals of how things work and the physics of everyday life, which transformed into a career where she feels like she is making a difference. "During my studies, it felt difficult to always be part of minority," she noted. "If there are 250 people in your class and only 10% of them are women, at some point you start asking yourself some questions like: What am I doing here? Am I intelligent enough to compete with these brilliant men?" Foligno encouraged female students and young professionals to pursue their interest in STEM despite these thoughts. She added that she is inspired by her women colleagues and managers at the NEA. "When I first arrived at the NEA, I was really surprised to see so many women working in the nuclear field, especially in leadership positions," she said. "Most of our heads of division are women and I feel very motivated by that."

Jinfeng Li,
Radioactive Waste Management Specialist



Jinfeng Li has a PhD in environmental science from Peking University and is the first Chinese expert to join the NEA's main Secretariat. She made up her mind about becoming an environmental engineer when she was just twelve years old. "When I was little, I knew that there are many other people around the world who suffered from water pollution, air pollution and soil pollution," she said. "I wanted to solve the environmental problems in China, and all over the world. I believe nuclear power is a good solution for these issues, so I joined the nuclear industry." For Li, women scientists and leaders can play a key role in this process. "Female leaders show their potential and abilities to manage all these resources and produce high quality products," she said. "I think female scientists can also play an important role, because I feel women have more empathy and can understand other people's needs and fears more easily."

Julie-Fiona Martin,
Nuclear Scientist

Julie-Fiona Martin has a PhD in nuclear physics from Paris-Sud University. After realising the significant impact of energy production and consumption in society, she decided to pursue a career in nuclear science. "I really wanted to play an active role in our society and I loved math and sciences," she said. According to Martin, the nuclear sector has not yet reached full gender balance, but is making good progress. "I think we embrace the issue and, for this, I'm very proud to be part of the NEA: we talk about it and work on it," she said. "You can see in our daily operation that we pay attention to many, many details, we're improving things, both in the way we work and also for the member countries."

Elena Poplavskaia,
Nuclear Scientist, NEA Data Bank

Elena Poplavskaia graduated from the National Research Nuclear University MEPhI (Moscow Engineering Physics Institute). By choosing to pursue further studies in the nuclear sector, she followed in the footsteps of her parents, who were scientific researchers. "There were 25 classmates in the group so we, the three girls in the class, were the minority," she said. "But at the same time we were involved in many discussions, and had very respectful relationship with the professors. They encouraged us to participate in many tasks and projects, and it was a very good and interesting environment." Elena also highlighted the importance of role models and mentors in encouraging girls to study STEM. "I think the NEA follows the best practice, because this is one of the important tasks globally, how to improve the situation regarding women's involvement in science and technology."

Belkys Sosa,
Nuclear Safety Specialist

Belkys Sosa graduated from the University of Maryland with a Bachelor of Science in nuclear engineering. "I was fortunate to know at a very young age what I wanted to do. I love math and science courses and was good at it," she said. "Therefore, it was natural for me to gravitate to engineering as I got older." It was not easy to be the only woman in some of her nuclear engineering classes or the only female engineer in some of the companies she worked at early in her career. "But I'm a big believer that excellence at work speaks for itself and that we should all be recognised for our accomplishments regardless of gender," she said. "My advice for girls today is to not be embarrassed or afraid to ask questions in class and if they love math or science to enroll in STEM classes as early as possible. In general, they should pursue the love of knowledge in any subject they like."

NEA work on gender

As part of its mission, the NEA is committed to supporting its member countries in achieving a robust, qualified workforce and developing the next generation of nuclear professionals and leaders. The under-representation of women in the nuclear sector has a direct impact on member countries' capabilities to maintain a highly skilled nuclear labour pool. Accordingly, attracting and retaining more women into careers in physical science and technology, as well as enhancing the conditions and prospects for women at each stage of their education and career development is an important goal that the NEA is assisting its member countries in pursuing.

To help remedy the gender gap and ensure a robust and diverse science, technology, engineering, and mathematics (STEM) pipeline for the future of the nuclear sector, the NEA is collaborating with member countries to target the next generation. Since 2017 the NEA has organised International Mentoring Workshops to encourage more young women to study STEM subjects.

Another way to ensure a necessary, skilled workforce for the future is to engage young scientists in attractive and innovative research projects. The NEA is pursuing this approach through its NEA Nuclear Education, Skills and Technology (NEST) Initiative.

The Agency is also working with its member countries to explore new and creative approaches to gender balance in the nuclear science and technology arena. In January 2020, the NEA Director-General had an open conversation on issues related to leadership in today's nuclear energy sector with Rumina Velshi, President and Chief Executive Officer of the CNSC. Highlights from the wide-ranging conversation were captured in the publication *Insights from Leaders in Nuclear Energy: Innovative Leadership* and included Ms Velshi's long-standing involvement in nuclear energy regulation, activities promoting careers in STEM, and how to achieve better gender balance in the workforce.

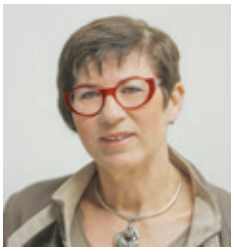
Two NEA webinars held in May 2020 further underscored why gender diversity is important for the nuclear sector. The first featured Dr Rita Baranwal, United States Assistant Secretary for Nuclear Energy in a discussion with the NEA Director-General on leadership and gender balance. The second featured a panel of experienced nuclear leaders alongside a panel of early-career professionals. Speakers shared their personal experiences in nuclear science and technology, before exploring how governments, research bodies and the private sector might help improve the representation of women across the nuclear sector.

In October 2020, the NEA Steering Committee noted the observations and outcomes of the NEA Exploratory Meeting on Improving Gender Balance in Nuclear Energy held in December 2019 and authorised follow-up actions to improve gender balance in nuclear energy under the auspices of the NEA. A working group chaired by Steering Committee Vice Chair Fiona Rayment will obtain the data needed to develop and propose specific policies in this area that may be recommended to all member countries.

For more information visit *www.oecd-nea.org/gender.*

Véronique Rouyer,

Head of the NEA Division of Nuclear Safety Technology and Regulation



Véronique Rouyer is responsible for overseeing NEA activities in the fields of nuclear safety research and the regulation of nuclear facilities. She manages a team of specialists conducting studies, analyses, research and other activities with the participation of senior experts from NEA member countries with a view to enhancing global nuclear safety.

Ms Rouyer first became interested in nuclear science when she visited a nuclear power plant with her family during her early teenage years. "The trigger point for my motivation to join the nuclear sector was when I visited a reactor for the first time," she said. "I remember that I was dazzled!"

With this inspiration, Ms Rouyer pursued studies in chemical engineering and then obtained a postgraduate degree in nuclear engineering from the French National Institute for Nuclear Science and Technology. Before joining the NEA, she enjoyed a 15-year career with France's Institute for Radiological Protection and Nuclear Safety (IRSN), most recently as the Director of Nuclear Safety Research. Previously, she also worked with the France's Alternative Energies and Atomic Energy Commission (CEA) in a variety of leadership roles in nuclear criticality experiments and fuel cycle research.

Throughout her career, Ms Rouyer has encouraged young women scientists and researchers to be resilient in the face of obstacles. "When I was a manager in charge of a large team, I did my best to push the women on my team to be brave and to use their network for support. This showed them they could do and create amazing things," she noted.

Ms Rouyer also highlighted that women in science can and should have the same positions as men. "I consider that there is no difference in principle between a man and a woman if they are motivated and do their best," she said. "Women can play all the roles, and should play all the roles. And we have a lot of examples to prove that a man and woman can have the same role and the same position."

For Ms Rouyer, such female role models who have been able to pursue successful careers in science and engineering are key to bridging the gender divide in STEM. It is important for technical organisations like the NEA to encourage young women to consider future opportunities centred around STEM disciplines. NEA International Mentoring Workshops have proven to be very beneficial in this regard. "During these workshops, students can interact informally with high-level mentors, and mentors can share their own real-life experiences," she explained. "This kind of exchange can help the students get motivated to discover careers in science and technology. It can also help demystify the nuclear field."

Rebecca Tadesse,

Head of the NEA Division of Radioactive Waste Management and Decommissioning

Rebecca Tadesse is responsible for overseeing NEA activities in the field of radioactive waste management. She also has a large role in the co-ordination of NEA activities related to the decommissioning and clean-up of the Fukushima Daiichi site.

Before joining the NEA, Ms Tadesse was with the United States Nuclear Regulatory Commission (NRC) as the Chief of the Radiation Protection Branch in the Office of Nuclear Regulatory Research. Previously she also served as Senior Policy Advisor for Commissioners and Senior Operational Assistant in the Executive Director's Office. Prior to working for the NRC, she worked in the private sector in nuclear energy and the US Food and Drug Administration.

You hold a Master's degree in environmental science/policy from Johns Hopkins University and a Bachelor's degree in radiation physics from Purdue University. What made you interested in studying science and pursuing a career in STEM?

My family immigrated to the United States from Ethiopia when I was 11 years old. At the time I did not speak English too well and had to learn the language. As you would expect, math and science courses were not that much English driven, so I excelled in and was attracted to that area.

My parents always told me to be a physician or engineer, so I joined the premedical course when I started my Bachelor's degree. However, when I visited my sister in medical school and experienced her work, I knew it was not for me.

Finally, a classmate recommended I sign up for the physics department, and that's how I ended up majoring in nuclear physics. I was focusing more on medical physics because I thought that was close to the medical field. And I did an internship during my junior year at the Johns Hopkins Department of Radiation Oncology and Molecular Radiation Sciences. But working in oncology for children was a depressing experience for me and I realised I could not do it. Then, I decided to go into nuclear energy and started working with nuclear power plants.

When you entered the nuclear field, did you face any difficulties as a woman scientist? And if yes, how did you overcome them?

When working with nuclear power plants, the first thing I experienced was that the union staff, mostly men, would always try to point out my faults, saying "You're not qualified to be here." But throughout my career, I believed that if I do the best that I can, people would learn to respect me as a professional ready to work.

There are always little situations like this where someone wants to make you feel like you do not belong there. If you react to them, they win; so always make sure to be professional, stick to your position and move forward.

I think we need an improved balance in the nuclear sector. During the meetings, 75% of participants are men, and maybe 25% are women. I don't think there is any difference between the two genders in terms of technical knowledge and capacity, but I think women bring different views and fresh approaches to problem-solving. To achieve success in an organisation, we need diversity – not just gender diversity but also ethnic diversity and diversity in thought.

What is your personal impression of gender balance at the NEA?

The gender balance at the NEA is quite impressive. When you see the senior management composition, it's quite diverse with a lot of women that are highly skilled and experienced. Unfortunately, that has not been the case in the past 25 years that I spent in the nuclear industry. Women around here are very supportive and they really help me to grow.

I remember that when I first came to the NEA for my job interview, the interview took place in the main conference room, which is dedicated to Lise Meitner. In fact, all of NEA's meeting rooms are dedicated to accomplished women scientists. You look around, and then you see the picture of these incredible women who allowed us to be in the position we are right now. It's very encouraging and inspiring, and provides a tribute to women that contributed to the nuclear science field since its beginning.

Speaking of encouragement and inspiration, you also participated in the sixth NEA International Mentoring Workshop in Science and Engineering, which was held in Fukushima, Japan in 2019. What are your personal impressions from this event?

In the two years that I have been at the NEA, participating in the mentoring workshop series is the most satisfying thing I have done. It is crucial to get kids interested in science early on; early adolescence is when they are making decisions for themselves. Some of these girls are so smart, and some of the questions they were asking were so relevant.

One thing that I always believed is important to show to kids is that you have to have balance in life. Sometimes girls feel like they have to choose between family and career, and as a working mom, I want to showcase that you could have it all. It's not easy, and there are times you wonder why you are doing it, but women are capable of doing anything and everything that they set their minds to.

I genuinely believe that we need to maintain balance. As professionals and educators, we are responsible for reaching out to elementary-level kids and exposing them to science and math. When my friends ask me, "What is your tombstone going to say?" I tell them that I want my tombstone to say that I helped people, encouraged them. I was a good friend, a good mother and a wife. I had a good balance and that is what we as a society should seek out.

What other advice do you have for girls or young women interested in pursuing studies and careers in STEM?

There is nothing that you cannot do. You can do anything you want; it is just dedication, motivation and tenacity. You need to figure out what you love and pursue it. It might sound a cliché when I say that you can have it all – it is not easy, but it's worth it. Being in science, you see the difference that you make that benefits society.

Cost reductions in large Generation III reactor projects*

by A. Vaya Soler and M. Berthélemy

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The EPR Nuclear Power Plant of Olkiluoto, Finland.

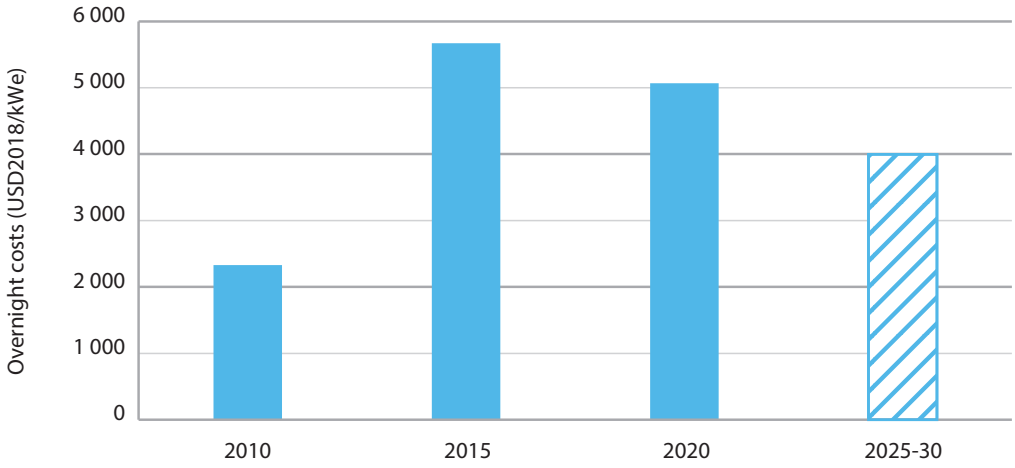
Plans for new nuclear power plants in OECD countries are at a critical juncture with the completion of several first-of-a-kind (FOAK) projects. These projects were initiated after a long hiatus for nuclear construction that significantly eroded the nuclear supply chain and the industry's capabilities. This is reinforced by a de-industrialisation trend in some OECD countries. In addition, initial budget estimates were heavily influenced by the lack of design maturity and execution planning at the time of the construction start, as well as the increasingly uncertain political context. The sums invested in these FOAK projects have served to finance not only the construction of the reactors themselves, but also to rebuild these capabilities. Understanding the prospects and drivers of nuclear construction costs reduction is therefore key to addressing the risk perception of near-term nuclear new build projects.

Recent trends in nuclear new build

The trend in projected overnight construction costs is presented in Figure 1 below for OECD countries and shows a significant increase in costs between 2010 and 2015. The same applies to the construction delays. The announced schedules for these projects were typically of 5-6 years. Those already in operation were built in around 10 years. Some of them are still under development and could be tentatively delivered more than 15 years after their construction start.

* *Projected Costs of Generating Electricity 2020 and Unlocking Reductions in the Construction Costs of Nuclear: A Practical Guide for Stakeholders* on which this article is based, are available for download from the NEA website.

Figure 1: Trend in the projected cost of new nuclear power plants in OECD countries



Source: IEA/NEA (2005, 2010, 2015, 2020).

Table 1: Construction costs of recent FOAK Generation III/III+ projects

Type	Country	Unit	Construction start	Initial announced construction time	Ex-post construction time	Power (MWe)	Initial announced budget (USD/kWe)	Actual construction cost (USD/kWe)
AP 1000	China	Sanmen 1, 2	2009	5	9	2 x 1 000	2 044	3 154
	United States	Vogtle 3, 4	2013	4	8/9*	2 x 1 117	4 300	8 600
APR 1400	Korea	Shin Kori 3, 4	2008	5	8/10	2 x 1 340	1 828	2 410
EPR	Finland	Olkiluoto 3	2005	5	16*	1 x 1 630	2 020	>5 723
	France	Flamanville 3	2007	5	15*	1 x 1 600	1 886	8 620
	China	Taishan 1, 2	2009	4.5	9	2 x 1 660	1 960	3 222
VVER 1200	Russia	Novovoronezh II-1 & 2	2008	4	8/10	2 x 1 114	2 244	**

* Estimate. ** No data available.

Notes: MWe = megawatt electrical capacity. kWe = kilowatt electrical capacity. *Source:* NEA (2020).

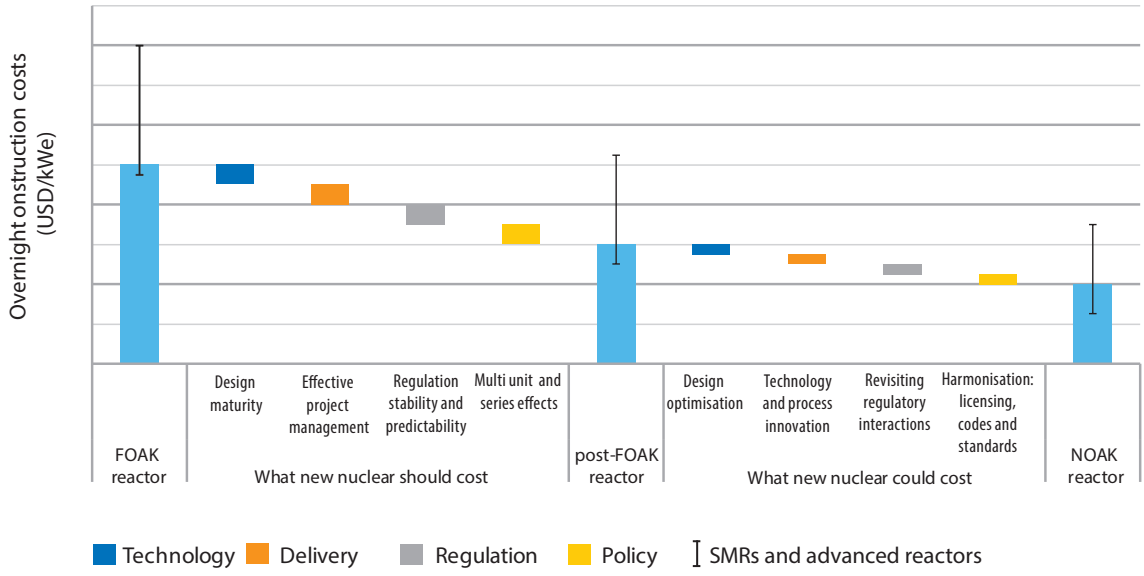
Some of these recent projects are presented in Table 1, illustrating a similar trend in projected overnight construction costs for OECD countries. Differences between initial announced budgets and ex-post construction costs reflect the cost escalations that have affected these projects, but the gap should be analysed cautiously as the initial announced budgets are the result of very specific conditions.

As a result, stakeholder and public confidence in the capability of the nuclear industry to deliver new build projects has been eroded. This situation has also raised the level of perceived investment risk, intimidating investors and further reducing the chances of attracting financing for future projects.

However, if the nuclear industry in western OECD countries takes advantage of the accumulated experience and the lessons learnt from recent projects, nuclear plant construction can enter a more rapid learning phase allowing it to deliver the next projects at lower cost and with significantly fewer uncertainties.

In several countries, nuclear power is delivered today essentially on time and on budget. In China and Korea, a significant number of projects have been executed in less than six years over the last decade. These differences could be explained by alternative design features (in terms of constructability, for example). However, even for a same design, there are notable differences depending on the country in which the reactor is being built. This gap cannot be explained solely by site-specific conditions inducing slight design modifications. Thus, the challenges experienced in western OECD countries in delivering new nuclear power plant projects are not inherent to the technology itself but rather depend on the conditions in which these projects are developed and executed, and on the interactions between the different stakeholders.

Figure 2: Nuclear cost and risk reduction drivers



Note: kWe = kilowatt electrical capacity.

Source: NEA (2020).

Key drivers for reducing the construction costs of nuclear new build

The NEA study *Unlocking Reductions in the Construction Costs of Nuclear: A Practical Guide for Stakeholders* (NEA, 2020) identifies eight drivers to unlock positive learning as well as continuous improvement in large Generation III reactor projects. These drivers are summarised in Figure 2.

Lessons learnt from historical and recent nuclear new build projects

Historical and recent evidence suggest that the lessons learnt are well understood and can be easily implemented in future projects. Several non-OECD countries delivering competitive nuclear projects today are already taking advantage of them. As a result, the next nuclear project should be delivered at lower costs after entering a phase of more rapid learning. Key lessons learnt include:

- Design maturity: The detailed design has to be completed and ready for construction. This implies early involvement with the supply chain during the design process in order to integrate the necessary requirements to improve constructability.
- Project management: The design also requires a robust implementation strategy with a clear definition of responsibilities and identification of competences at all levels and stages of the project. A strong and experienced project management team is essential to ensure its proper execution and to deal effectively with all interfaces and unexpected risks.
- Regulation: Predictability and stability of the regulatory regime is a precondition for the implementation of these measures.
- Multi-unit and series effect: Once a sufficient level of design maturity has been achieved, there is a strong opportunity in freezing the design configuration and systematically replicate it as many times as possible building up supply chain capabilities.

In the near term (early 2020s), considering these lessons learnt, the most effective way to reduce construction costs is to develop a nuclear programme that takes advantage of serial construction with multi-unit projects on the same site, and/or construction of the same reactor design on several sites.

Cost reduction opportunities in the short term (up to 2030)

In the short term (up to 2030), with the previous drivers and conditions already in place, the cost of nuclear projects could be further reduced.

In technology and process innovation, a range of cost reduction opportunities could be exploited through the interplay between the reactor design and the associated delivery processes. These drivers are not necessarily sequential and can be mobilised even during early planning stages in order to accelerate learning.

There is evidence that countries in more advanced stages of learning are already benefiting from these opportunities and working on a continuous improvement basis similar to other industries. In addition, in order to maximise the potential of cost reduction, the right balance between improvement and replication needs to be found in order to incorporate lessons learnt. Timely decision making has also to be acknowledged with the objective to ensure the right pace of new construction and diminish the risk of over engineering.

At the reactor design level, the experience gathered in the first constructions can be used to reach higher levels of simplification, standardisation and modularisation as well as to integrate the latest technical advances. Organisational efficiencies can also be unlocked through a new set of innovative processes.

Additional opportunities in the longer run (beyond 2030)

Longer-term (beyond 2030) cost reductions are also possible. There are indications that countries in more advanced learning stages are moving in this direction.

Further cost reductions can be achieved by means of higher levels of harmonisation in codes and standards, and licensing regimes. Other highly regulated activities such as the aviation sector have already undertaken significant efforts in this field with positive results. Without neglecting the strong political dimension and the need to protect the sovereignty of national regulators, international collaboration for regulatory harmonisation has demonstrated that it is possible to reach common positions in some areas (MDEP, 2010).[7]

Thanks to the experience gained with recent FOAK projects, new nuclear power plant projects can enter a phase of rapid learning in western OECD countries with near-term overnight costs reductions of 20% to 30% compared to today's levels. Moreover, leveraging several factors that arise at the technical, organisation and regulatory level could unlock additional cost reductions in new projects and increase the predictability of their delivery. More active government intervention in risk allocation and mitigation strategies for new projects will also have significant impact on financing. As result, financing costs, which can represent 80% of the total investment costs, could notably fall further, improving the economic performance of nuclear energy.

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Update on NEA Joint Projects

Nuclear safety, nuclear science, radioactive waste management, radiological protection

NEA joint projects and information exchange programmes enable interested countries, on a cost-sharing basis, to pursue research or the sharing of data with respect to particular areas or issues in the nuclear energy field. The projects are carried out under the auspices, and with the support, of the NEA.

At present, 17 joint projects are being conducted or completed in relation to nuclear safety, 2 in the area of nuclear science (advanced fuels, and characterisation of fuel debris and fission products), 2 in support of radioactive waste management and 2 in the field of radiological protection. These projects complement the NEA programme of work and contribute to achieving excellence in each area of research.

Analysis of Information from Reactor Buildings and Containment Vessels of the Fukushima Daiichi NPS (ARC-F) Project

Contact: Yuji.KUMAGAI@oecd-nea.org

Current mandate: January 2019 to December 2021

Budget: EUR 495 K

Participants: Canada, China, Finland, France, Germany, Japan, Korea, Russia, Spain, Sweden, Switzerland and the United States.

- consolidate a deeper understanding of severe accident progression and the status inside the reactor buildings and containment vessels of the Fukushima Daiichi nuclear power plant, mainly by analysing data and information from the plant.
- establish a framework for sharing the information between Japanese organisations and international experts in reactor safety.

Advanced Thermal-hydraulic Test Loop for Accident Simulation (ATLAS) Project

Contact: ChangWook.HUH@oecd-nea.org

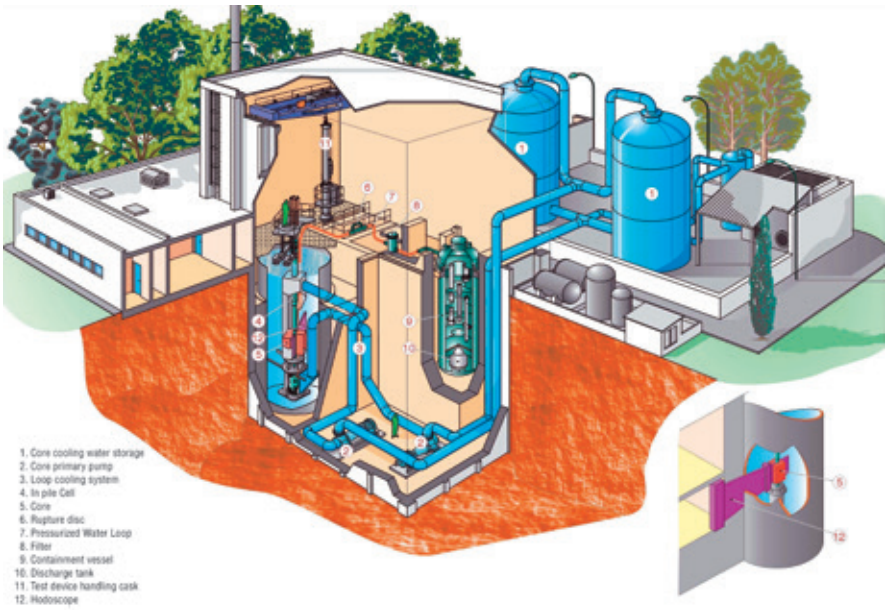
Current mandate (phase 3): January 2021-December 2024

Budget: EUR 4 million

Participants: Belgium, China, Czech Republic, France, Germany, Korea, Spain, Switzerland, United Arab Emirates and United States.

- establish an IET database for safety analysis code validation and for assessment of thermal hydraulic behaviours,
- address the scaling issues by performing the counterpart tests and enhance reliability of safety analysis methodology.

The ATLAS facility.
KAERI, Korea



Cabri reactor with water loop scheme.
IRSN, France

Cabri International Project (CIP)

Contact: Andrew.WHITE@oecd-nea.org

Current mandate: March 2018-March 2026

Budget: ≈ EUR 74 million

Participants: Czech Republic, Finland, France, Germany, Japan, Korea, Slovak Republic, Spain, Sweden, Switzerland, United Kingdom and United States.

- extend the database for high burn-up fuel performance in reactivity-induced accident (RIA) conditions;
- perform relevant tests under coolant conditions representative of pressurised water reactors (PWRs);
- extend the project database to include tests done in the Nuclear Safety Research Reactor (Japan) on boiling water reactor (BWR) and PWR fuel.

Component Operational Experience, Degradation and Ageing Programme (CODAP)

Contact: Diego.ESCRIGFORANO@oecd-nea.org

Current mandate (phase 4): January 2021-December 2023

Budget: EUR 292 K

Participants: Canada, Chinese Taipei, Czech Republic, Finland, France, Germany, Japan, Korea, Netherlands, Slovak Republic, Spain, Switzerland and United States.

- collect information on passive metallic component degradation and failure of the primary system, reactor pressure vessel internals, the main process and standby safety systems and support systems (i.e. ASME Code class 1, 2 and 3, or the equivalent), as well as non-safety-related (non-Code) components with significant operational impact;
- establish a knowledge base for general information on component and degradation mechanisms such as applicable regulations, codes and standards, bibliography and references, R&D programmes and proactive actions, information on key parameters, models, thresholds and kinetics, fitness for service criteria, and information on mitigation, monitoring, surveillance, diagnostics, repair and replacement;
- develop topical reports on degradation mechanisms in close co-ordination with the CSNI Working Group on Integrity and Ageing of Components and Structures (WGIAGE).

Co-operative Programme for the exchange of Scientific and Technical Information Concerning Nuclear Installation Decommissioning Projects (CPD)

Contact: wei-whua.loa@oecd-nea.org

Current mandate: January 2019-December 2023

Budget: ≈ EUR 84 K/year

Participants: Belgium, Canada, Chinese Taipei, Denmark, France, Germany, Italy, Japan, Korea, Lithuania, Russia, Slovak Republic, Spain, Sweden, Switzerland, United Kingdom, United States and the European Commission.

- exchange scientific and technical information among nuclear facility decommissioning projects, based on biannual meetings of the Technical Advisory Group, to ensure that the safest, most environmentally sound and economical options for decommissioning are employed.

Experiments on Source Term and Delayed Releases (ESTER) Project

Contact: Markus.BEILMANN@oecd-nea.org

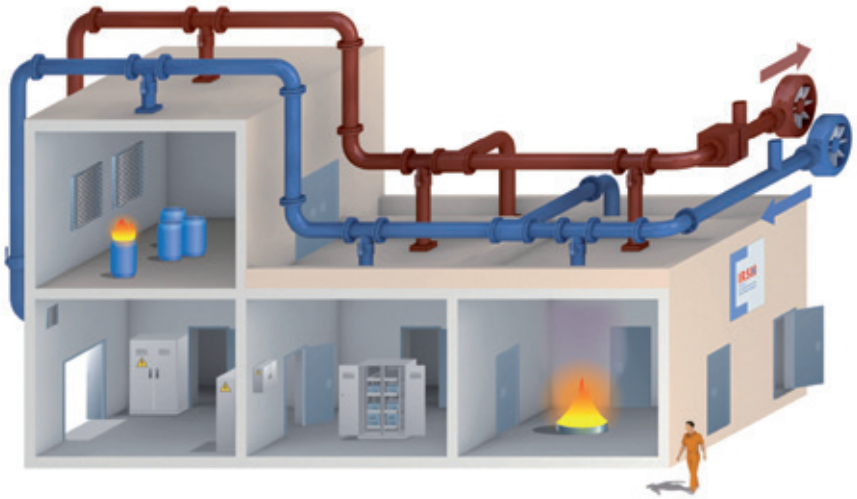
Current mandate: September 2020 to August 2024

Budget: EUR 3.144 million

Participants: Finland, France, Germany, Japan, Korea, Sweden and the United States.

- conduct and analyse experiments that address remobilisation of fission product deposits that might occur during a severe nuclear accident and contribute to delayed releases.
- obtain an improved understanding of processes involved in the formation of organic iodides in the containment.

The Prisme Project DIVA facility for fire propagation studies.
IRSN, France



Experimental Thermal Hydraulics for Analysis, Research and Innovations in NUclear Safety (ETHARINUS) Project

Contact: Didier.JACQUEMAIN@oecd-nea.org

Current mandate: October 2020-September 2024

Budget: EUR 4.9 million

Participants: Belgium, China, the Czech Republic, Finland, France, Germany, Hungary, Japan, Korea, Russia, Spain, Sweden, Switzerland and the United States.

The objective is to perform integral tests in the German Framatome PKL-facility, the Russian PSB-VVER JSC ENIC facility and the Finnish PWR PACTEL LUT University facility to:

- investigate thermal-hydraulic transients relevant for current PWR plants as well as for new PWR design concepts, including e.g. passive systems;
- provide data for verifying thermal-hydraulic computer codes used in safety analyses;
- provide data for further developing these codes for complex representative scenarios and flow-regimes.

Fire Incidents Records Exchange (FIRE) Project

Contact: Markus.BEILMANN@oecd-nea.org

Current mandate (phase 6): January 2020-December 2022

Budget: EUR 210 K

Participants: Belgium, Canada, Czech Republic, Finland, France, Germany, Japan, Korea, Netherlands, Spain, Sweden, Switzerland, United Kingdom and United States.

- define the format for, and collect fire event experience (through international exchange) in, a quality-assured and consistent database;
- collect and analyse fire events over the long term so as to better understand such events, their causes and their prevention;
- generate qualitative insights into the root causes of fire events that can then be used to derive approaches or mechanisms for their prevention or for the mitigation of their consequences;
- establish a mechanism for the efficient feedback of experience gained in connection with fire events, including the development of defences against their occurrence, such as indicators for risk-based inspections;
- record event attributes to enable quantification of fire frequencies and risk analysis.

Fire Propagation in Elementary, Multi-room Scenarios (PRISME) Project

Contact: Andrew.WHITE@oecd-nea.org

Current mandate (phase 3): January 2017-December 2021

Budget: EUR 4.26 million

Participants: Belgium, Finland, France, Germany, Japan, Korea, United Kingdom and United States.

- answer questions concerning smoke, fire and heat propagation inside a plant by means of experiments tailored for code validation purposes for fire modelling computer codes;
- undertake experiments related to smoke and hot gas propagation, through a horizontal opening between two superimposed compartments;
- provide information on heat transfer to cables and on cable damage;
- provide information on the effectiveness of fire extinguishing systems.

Halden Reactor Project

Fuel and Material Programme Extension

Contact: Didier.JACQUEMAIN@oecd-nea.org

Current mandate: January 2021-December 2023

Budget: EUR 3,7 million

Participants: Belgium, China, Czech Republic, Denmark, Finland, France, Germany, Hungary, Japan, Korea, Netherlands, Norway, Russia, Slovak Republic, Sweden, Switzerland, United Arab Emirates, United Kingdom, United States and the European Commission.

Generate key information for safety and licensing assessments by:

- producing topical reports on the following issues:
  - fuel safety and operational margins;
  - cladding performance and behaviour;
  - plant ageing and degradation.
- developing a reliable HRP database capitalising on knowledge and data collected over the years by the project

Human Technology Organisation (HTO) Project

Contact: Kamishan.MARTIN@oecd-nea.org

Current mandate: January 2021-December 2023

Budget: EUR 13,24 million

Participants: Canada, China, France, Germany, Japan, Korea, Netherlands, Norway, Sweden, United Arab Emirates and United States.

- advancing in the Human-Technology Organisation (HTO) field by working on aspects of human performance, reliability and organisation in various stages of the plant life, including during accident situations.

High Energy Arcing Fault Events (HEAF) Project

Contact: Markus.BEILMANN@oecd-nea.org

Previous mandate (phase 2): September 2018 to December 2021

Budget: EUR 2.38 million

Participants: Belgium, Canada, France, Germany, Japan, Korea, the Netherlands, Spain and the United States.

Perform experiments to obtain scientific fire data on high energy arcing fault phenomena known to occur in nuclear power plants by:

- conducting 21 full-size equipment HEAF experiments on electrical cabinets which are partially provided by the participating organisations;
- using international collaboration to expand the pool of available test data the development of a new US NUREG to investigate the effects of high energy arcing faults.

Hydrogen Mitigation Experiments for Reactor Safety (HYMERES) Project

Contact: Markus.BEILMANN@oecd-nea.org

Current mandate (phase 2): July 2017-June 2021

Budget: EUR 4.84 million

Participants: China, the Czech Republic, Finland, Germany, Japan, Korea, Russia, Spain, Sweden, Switzerland and the United States.

Improve the understanding of hydrogen risk phenomenology in containment in order to enhance modelling in support of safety assessments that will be performed for current and new nuclear power plants. With respect to previous projects related to hydrogen risk, HYMERES introduces three new elements:

- tests addressing the interaction of safety components;
- realistic flow conditions;
- reviews of system behaviour for selected cases.

International Common-cause Failure Data Exchange (ICDE) Project

Contact: Diego.ESCRIGFORANO@oecd-nea.org

Current mandate (phase 8): January 2019-December 2022

Budget: EUR 560 K

Participants: Canada, Czech Republic, Finland, France, Germany, Japan, the Netherlands, Sweden, Switzerland and the United States.

- collect and analyse common-cause failure (CCF) events over the long term to better understand such events, their causes, and their prevention
- generate qualitative insights into the root causes of CCF events which can then be used to derive approaches or mechanisms for their prevention or for mitigating their consequences
- establish a mechanism for the efficient feedback of experience gained in connection with CCF phenomena, including the development of defences against their occurrence, such as indicators for risk based inspections
- generate quantitative insights and record event attributes to facilitate quantification of CCF frequencies in member countries
- use the ICDE data to estimate CCF parameters.

The PANDA reactor pressure vessel.
Paul Scherrer Institute, Switzerland

Information System on Occupational Exposure (ISOE)

Contact: aleksandr.rakhuba@oecd-nea.org

Current mandate: January 2020-December 2023

Budget: EUR 411 500

Participants: Armenia, Belarus, Belgium, Brazil, Bulgaria, Canada, China, Czech Republic, Finland, France, Germany, Hungary, Italy, Japan, Korea, Lithuania, Mexico, Netherlands, Pakistan, Romania, Russia, Slovak Republic, Slovenia, South Africa, Spain, Sweden, Switzerland, Ukraine, United Arab Emirates, United Kingdom and the United States.

Improve the management of occupational exposure at nuclear power plants by exchanging broad and regularly updated information, data and experience on methods to optimise occupational radiological protection:

- collect, analyse and exchange occupational exposure data, occupational exposure management experience at nuclear power plants and "as low as reasonably achievable" (ALARA) practices;
- provide broad and regularly updated information on methods to improve the protection of workers and on occupational exposure in nuclear power plants;
- provide a mechanism for dissemination of information on these issues, including evaluation and analysis of the data assembled and experience exchanged, as a contribution to the optimisation of radiological protection.

Loss of Forced Coolant (LOFC) Project

Contact: Andrew.WHITE@oecd-nea.org

Current mandate: March 2011-March 2022

Budget: EUR 3 million

Participants: Czech Republic, France, Germany, Hungary, Japan, Korea and United States.

Perform integral tests in the high-temperature engineering test reactor (HTTR) in order to:

- provide experimental data to clarify the anticipated transient without scram (ATWS) in the case of an LOFC with occurrence of reactor re-criticality;
- provide experimental data to validate the key assumptions in computer codes predicting the behaviour of reactor kinetics, core physics and thermal-hydraulics related to protective measures for safety;
- provide experimental data to verify the capabilities of these codes regarding the simulation of phenomena coupled between reactor core physics and thermal-hydraulics.

Primary Coolant Loop Test Facility (PKL) Project

Contact: Didier.JACQUEMAIN@oecd-nea.org

Current mandate (phase 4): July 2016-September 2020

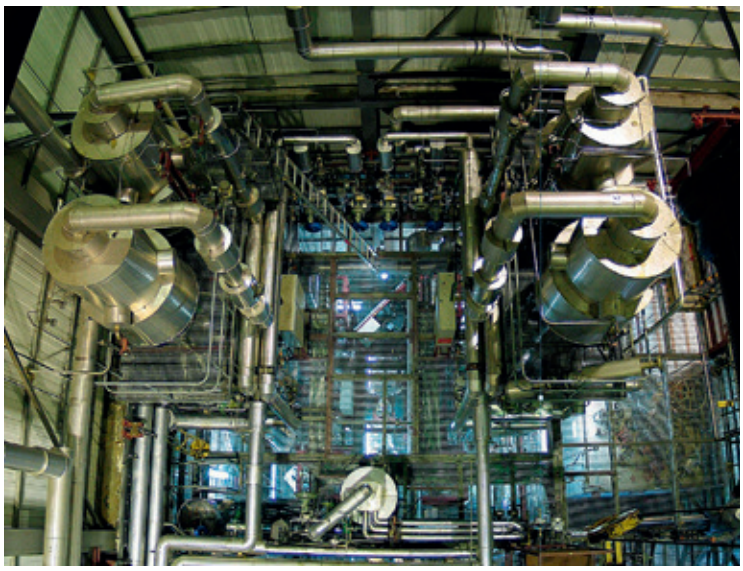
Budget: EUR 4.78 million

Participants: Belgium, China, the Czech Republic, Finland, France, Germany, Hungary, Japan, Korea, Russia, Spain, Sweden, Switzerland and the United States.

The objective was to perform integral tests in the PKL-facility to:

- investigate safety issues relevant for current PWR plants as well as for new PWR design concepts;
- focus on complex heat transfer mechanisms in the steam generators and boron precipitation processes under postulated accident situations;
- provide data for verifying computer codes used in safety analyses;
- provide data for further developing these codes for complex scenarios and flow-regimes.

Top view of the PKL facility, Germany.
ORANO (AREVA), France



Preparatory Study on Analysis of Fuel Debris (PreADES)

Contact: Yuji.KUMAGAI@oecd-nea.org

Current mandate: July 2017-December 2021

Budget: EUR 275 K

Participants: Canada, France, Japan, Korea, Sweden, Switzerland, the United States and the European Commission.

- collect information for improving knowledge and methodologies for fuel debris characterisation that will support future fuel debris sampling at the Fukushima Daiichi units 1-3;
- identify the needs for fuel debris analysis that will contribute to decommissioning of the Fukushima Daiichi plant and deepen the knowledge base of severe accidents;
- prepare a future international R&D framework on fuel debris analysis.

Reduction of Severe Accident Uncertainties (ROSAU)

Contact: Didier.JACQUEMAIN@oecd-nea.org

Current mandate: September 2019 to September 2024

Budget: ~ EUR 8.635 million

Participants: Belgium, Canada, the Czech Republic, France, Japan, Korea, Sweden and the United States.

- reduce knowledge gaps and uncertainties associated with severe accident progression by performing large-scale tests investigating spreading of melt in a cavity and the effect of metal content in melt on molten core-concrete interaction as well as in-core and ex-core debris coolability.
- refine and validate models and codes for each test category to form the technical basis for extrapolating the findings from the experiments to plant conditions.

Rod Bundle Heat Transfer (RBHT)

Contact: Didier.JACQUEMAIN@oecd-nea.org

Current mandate: October 2019 to October 2022

Budget: ~ EUR 1.44 million

Participants: Belgium, the Czech Republic, Finland, France, Germany, Italy, Japan, Korea, Spain, Sweden, Switzerland and the United States.

- simulate reflood scenarios in a prototypical PWR rod bundle section;
- investigate the effect of complex (e.g. oscillatory), inlet flows;
- obtain high-quality data on flow rates, temperature distributions, heat-fluxes and droplet size distributions;
- organise a benchmark exercise to further develop and assess system thermal-hydraulics and sub-channel codes.

Source Term Evaluation and Mitigation (STEM) Project

Contact: Markus.BEILMANN@oecd-nea.org

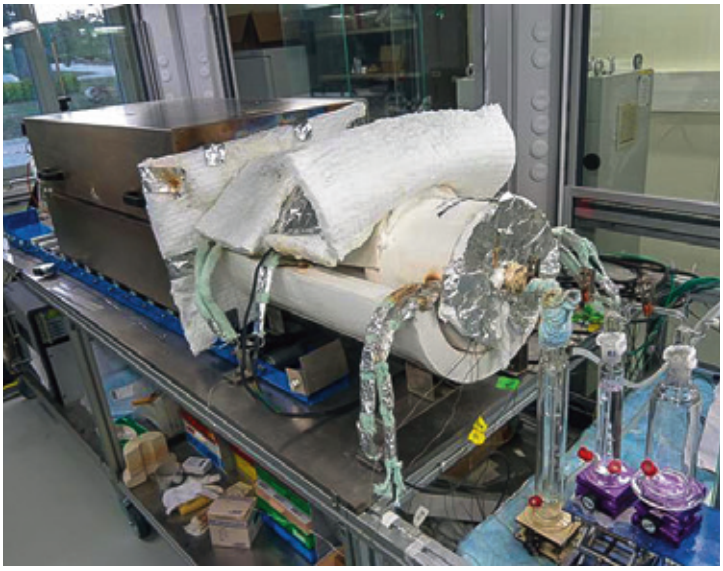
Current mandate (phase 2): January 2016-December 2019

Budget: EUR 2.48 million

Participants: Canada, Finland, France, Germany, Japan, Korea, Sweden, the United Kingdom and the United States.

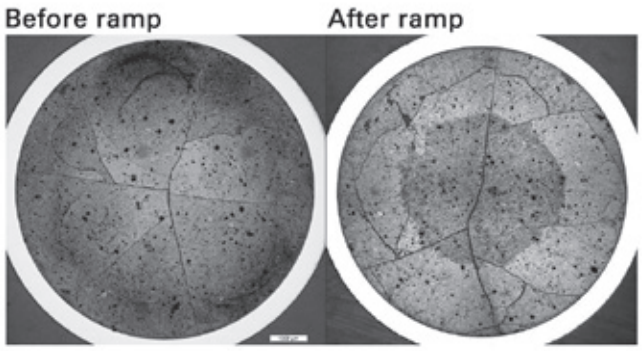
Improve the general evaluation of the source term, and in particular:

- perform experiments to study the stability of aerosol particles under radiation and the long-term gas/deposits equilibrium in a containment;
- conduct a literature survey on the effect of paint ageing;
- perform experiments to study ruthenium transport in pipes.



The STEM Project: The START test facility (right) and the alumina crucible (left) with RuO2 powder in the quartz tube.
IRSN, France

Studsvik Cladding Integrity Project (SCIP) ramp test.



After ramp: lot of small radial pellet cracks.

Studsvik Cladding Integrity Project (SCIP)

Contact: Markus.BEILMANN@oecd-nea.org

Current mandate (phase 4): July 2019-June 2024

Budget: ~EUR 14 million

Participants: China, Czech Republic, Finland, France, Germany, Hungary, Japan, Korea, Russia, Spain, Sweden, Switzerland, Ukraine, United Kingdom and the United States.

- generate high-quality experimental data to improve the understanding of the dominant failure mechanisms for water reactor fuels and devise means for reducing fuel failures;
- achieve results of general applicability (i.e. not restricted to a particular fuel design, fabrication specification or operating condition);
- achieve experimental efficiency through the judicious use of a combination of experimental and theoretical techniques and approaches.

Studsvik Material Integrity Life Extension Project (SMILE)

Contact: Markus.BEILMANN@oecd-nea.org

Current mandate: January 2021 - December 2025

Budget: ~EUR 17 million

Participants: China, Czech Republic, Germany, Japan, Sweden, Switzerland and the United States.

- The general objective of the SMILE Project is the investigation of materials harvested from nuclear power plants in order to obtain critical data and mechanistic understanding of materials ageing mechanisms to support plant ageing management, life extension programmes and operating licence renewals.

THAI Experiments on Mitigation measures and source term issues to support analysis and further Improvement of Severe accident management measures (THEMIS) Project

Contact: Didier.JACQUEMAIN@oecd-nea.org

Current mandate: November 2020 – April 2024

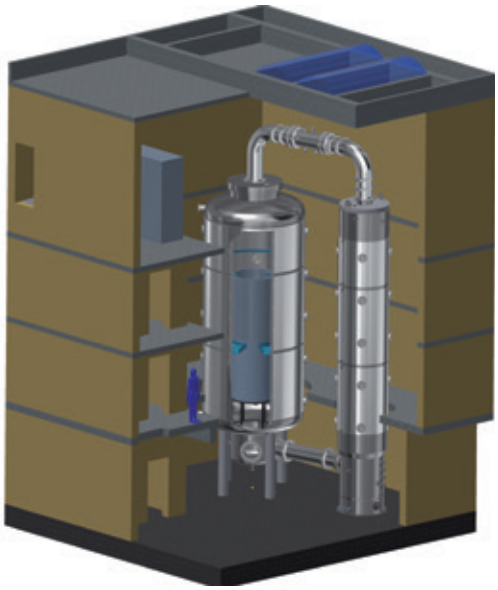
Budget: ≈ EUR 5.05 million

Participants: Belgium, Canada, China, Czech Republic, Finland, France, Germany, Japan, Korea, Russia, Slovak Republic, Spain, Sweden and United Kingdom.

The project aims to address remaining questions and examine experimental data relevant to nuclear reactor containments under severe accident conditions, the focus being on long term ex-vessel phases, concerning:

- specific water-cooled reactor aerosol and iodine issues, as well as hydrogen mitigation under accidental conditions;
- passive autocatalytic recombiner (PAR) operation;
- hydrogen combustion and flame propagation in two-compartment systems;
- the resuspension of fission products.

THAI+ test facility.
Becker Technologies, Germany



Thermochemical Database (TDB) Project

Contact: jesus.martinezgonzalez@oecd-nea.org

Current mandate: February 2019 to February 2023 (TDB-6)

(New Phase: TDB-6: 2019-2023)

Budget: EUR 1.0 million

Participants (TDB-6): Belgium, Canada, the Czech Republic, Finland, France, Germany, Japan, the Netherlands, Sweden, Switzerland, the United Kingdom and the United States.

Produce a database that:

- contains internally consistent thermodynamic data of solid and aqueous species for elements of interest in radioactive waste disposal systems;
- documents why and how the data were selected;
- gives recommendations based on original experimental data, rather than on compilations and estimates;
- documents the sources of experimental data used.

Thermodynamics of Advanced Fuels – International Database (TAF-ID) Project

Contact: davide.costa@oecd-nea.org

Project agreement (Phase 2): November 2018 to December 2022

Budget: ≈ EUR 477 K

Participants: Canada, France, Japan, Korea, the Netherlands, United Kingdom, United States and the European Commission.

Make available a comprehensive, internationally recognised thermodynamic database and associated phase diagrams on nuclear fuel materials for the existing and future generation of nuclear reactors. Specific technical objectives this project intends to achieve are:

- predict the solid, liquid and/or gas phases formed during fuel/cladding chemical interaction under normal and accident conditions;
- improve the control of experimental conditions during the fabrication of fuel materials at high temperature;
- predict the evolution of the chemical composition of fuel under irradiation versus temperature and burn-up.

Thermodynamic Characterisation of Fuel Debris and Fission Products Based on Scenario Analysis of Severe Accident Progression at Fukushima-Daiichi Nuclear Power Station (TCOFF)

Contact: davide.costa@oecd-nea.org

Project agreement: June 2017- July 2020

Budget: ≈ EUR 760 K

Participants: Czech Republic, France, Germany, Japan, Korea, Netherlands, Russia, Sweden Switzerland, the United States and the European Commission.

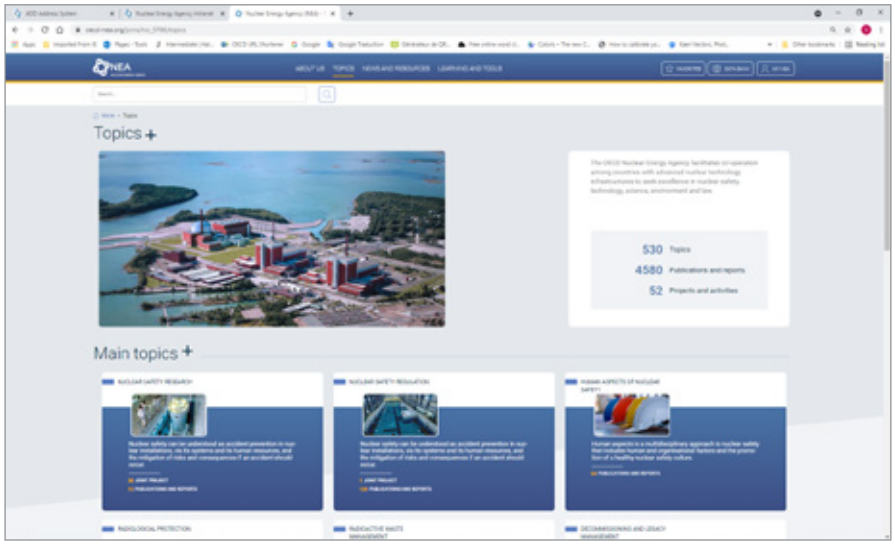
The TCOFF project focuses on melted core progression and fission-product behaviour to support characterisation of the current status of fuel debris in the framework of a broader range of activities and joint projects across the NEA; all of which provide various levels of support to the decommissioning process at the Fukushima Daiichi nuclear power plant. The project aims to:

- improve the quality and/or inventory of thermodynamic databases, which are used for severe accident analyses with a reference to the severe accident progression at different units of the Fukushima Daiichi NPS;
- conduct joint thermodynamic evaluations of the severe accident progression at in-vessel and ex-vessel phases at units 1, 2 and 3 of the Fukushima Daiichi nuclear power plant, aiming at characterising fuel melting; molten core relocation; fission product behaviour; the chemical and phase composition of fuel debris; and the thermodynamic evaluation of the formation of materials, which may potentially be detected at the Fukushima Daiichi nuclear power plant.

A fresh look for the NEA website

by Y. Ha, V. Handa and D. Zayani

Ms Yina Ha (yina.ha@oecd-nea.org) Ms Vrinda Handa (vrinda.handa@oecd-nea.org) and Ms Danielle Zayani all work in the NEA Division of Nuclear Technology Development and Economics.



Screenshot of New NEA website.

For any organisation its website is an excellent starting point to gain insight to its work. With the relaunch of its website in October 2020, the Nuclear Energy Agency has set out to serve both its stakeholders and a broader audience by improving access to official documents, reports and publications and providing timely information of upcoming NEA initiatives and events. Given the COVID-19 pandemic and the change in lifestyle worldwide, people have become increasingly reliant on internet services. As website users include policymakers, nuclear experts and international researchers, all of whom need to easily access up-to-date information, the new platform has to be more innovative and inclusive to meet evolving user needs.

The old website was organised according to the work of the various NEA standing technical committees, which could be confusing for people not familiar with the work of the NEA. The relaunched website now presents content by topic. All related projects, activities, and events are organised around a common subject and presented on the same page. This allows the NEA to present and archive all official documents systematically.

The new website also allows viewers to find and access NEA publications and reports quickly. During the migration to the new site all official documents and publications had additional meta data added and as a result are now searchable by subject, language, document type and even 'cote', the internal referencing number familiar to NEA committee and working group members.

The NEA website now contains an enhanced search functionality. This functionality is augmented by tags for knowledge management that cover the main topics, subtopics, workshops and recent NEA initiatives. Clicking on other tags allows users to easily navigate through different search results, without the need to actively search for specific topics. This reduces the amount of research time for site visitors.

Website redesign process

The website renewal project began with a series of workshops facilitated by a website development agency. The initial brainstorming focused on identifying the key user personas of the NEA website as well as the characteristics of each user profile. After establishing the needs of each of the user personas identified, the NEA team mapped the associated pathways and user journeys through the website. Mapping user journeys highlighted any weaknesses in the previous website and offered an opportunity to enhance the overall user experience on the new website. The project team used the outcomes of these exercises to determine the appropriate navigation structure and functionalities of the new website.

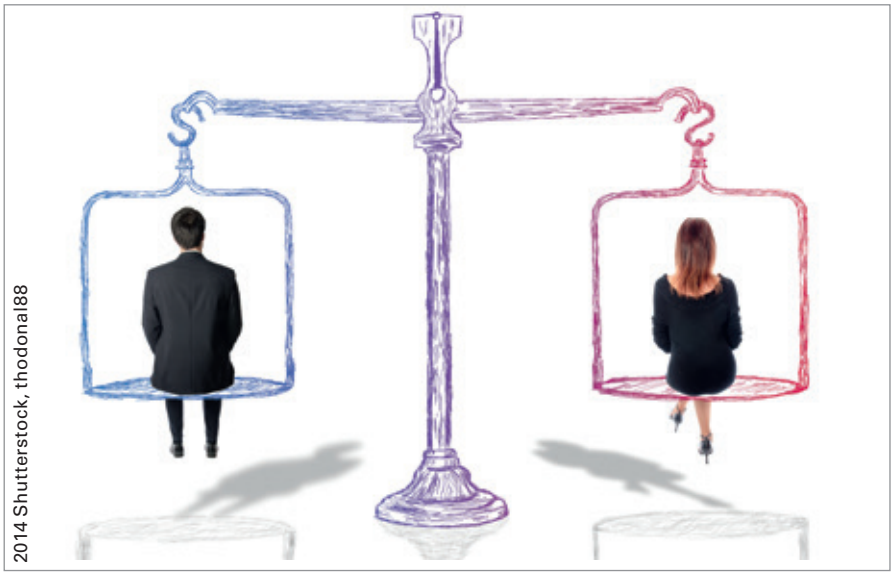
The final workshop sessions focused on sketching the layout of several wireframes with graphic design considerations. Each of the wireframe sketches were then developed and improved through subsequent webinars with the website development consultants. During the final stages of development, NEA staff members were involved in the user acceptance testing process to ensure that the templates met the functional design specifications and requirements identified during the workshops. An iterative process, centred around feedback and suggestions from both internal and external stakeholders, was used throughout.

Migrating existing content (web pages, images, publications and reports, official documents, event pages, etc.) from the old website onto the new CMS was a vast undertaking. All content had to be consistently categorised on the basis of topic, language, theme or document type. Crucial to this process was the work of several interns, who despite having no prior knowledge and experience of the nuclear energy sector made a major contribution to the success of the project. The timely delivery of the NEA's new website and completion of the migration process is an excellent example of collaboration between the organisation's many cross-functional divisions. This is in line with the essence of the organisation's ethos and its very purpose in the nuclear energy space.

Improving the gender balance in nuclear energy

by G. Demiray

Ms Gulfem Demiray (gulfem.demiray@oecd.org) is a Communications Manager in the NEA Central Secretariat.



2014 Shutterstock, thodonal88

The NEA convened a second high-level working meeting on improving the gender balance in nuclear energy on 11-12 February 2021. The meeting kicked off on the International Day of Women and Girls in Science and brought together experts from 13 NEA member countries, as well as representatives from the International Atomic Energy Agency (IAEA) and the European Commission.

During her keynote remarks, Canadian Nuclear Safety Commission (CNSC) President and Chief Executive Officer Rumina Velshi underlined the urgency of making significant and sustained progress to improve gender equality in the nuclear field. "It rests on us – as leaders, as decision makers – to do everything in our power to encourage women to pursue a path in the nuclear industry, and to ensure that overt and unconscious barriers to their success are removed once and for all," Velshi said.

Among NEA member countries, a number of initiatives have been launched to promote science, technology, engineering and mathematics (STEM) education, and several countries have initiated policies on gender balance. The participants at the meeting discussed these initiatives and exchanged information regarding the status of women in the nuclear sectors in their home countries. While many countries reported continued difficulty in attracting and retaining women in the nuclear sector, it was noted that many lack data to effectively inform policy approaches.

The participants also discussed what practical steps might be taken to address the challenges related to the participation of women in nuclear energy activities. They reflected on short-term efforts to increase the number of women in the nuclear sector, as well as on strategies that could be applied at the international level.

"Unlocking the full potential of women to participate in the global nuclear workforce supports economic growth and boosts prospects for a clean energy future around the world," said NEA Director-General William D. Magwood, IV. "NEA countries could benefit from working together on this common challenge in order to develop policy recommendations and guidelines for a diverse nuclear workforce that will strengthen economies and ensure a vibrant clean energy future."

Director-General Magwood also highlighted NEA initiatives on capacity and gender balance that focus on the younger generations who are interested in pursuing studies and careers in STEM fields, including the Nuclear Education, Skills and Technology (NEST) Framework, the Global Forum on Nuclear Education, Science, Technology and Policy, and the International Mentoring Workshops.

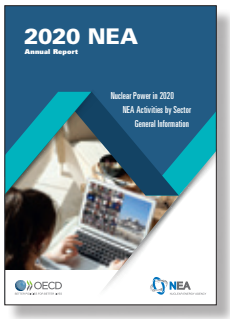
The meeting included a special session on the younger generation. Rebecca Ferris, Engineering Manager at EDF Energy, shared her personal experiences in nuclear science and technology. She addressed the perspective of the next generation of nuclear professionals and emphasised the importance of role models for junior professionals. "Improving our gender balance is a key part of enabling nuclear energy to contribute to our net zero aspirations," she said. "We must make full benefit of all our current talent and encourage more to join us."

The delegates agreed to review existing efforts to determine the data gaps and needs on the international level to inform further collaboration and engagement. There was strong interest in developing joint data collection instruments to identify the barriers and challenges confronting women in NEA member countries, in order to develop targeted policy recommendations.

Fiona Rayment, Chief Science and Technology Officer at the United Kingdom National Nuclear Laboratory, chaired the meeting and concluded on a note on the importance of diversity of thought. "Bringing diversity of thinking, problem-solving enables innovation and creates optimum solutions," Rayment said. "Gender balance will be a key component in enabling diversity of thought and it's fitting that we address this challenge now as we celebrate the International Day of Women and Girls in Science."

All NEA publications are available free of charge on the NEA website.

General Interest



Annual Report 2020

NEA No. 7568. 96 pages.

http://oe.cd/nea-2020-en

Rapport annuel 2020

AEN n° 7569. 96 pages.

http://oe.cd/nea-2020-fr

Nuclear Energy Agency

28 pages.

Also available in French, Chinese and Russian.

Available online at:
http://oe.cd/neabrochure

Nuclear technology development and economics

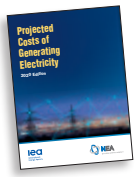
Nuclear Energy Data 2020/Données sur l'énergie nucléaire 2020

NEA No. 7556. 124 pages.

Available online at:
https://oe.cd/brownbook

Nuclear Energy Data is the Nuclear Energy Agency's annual compilation of statistics and country reports documenting nuclear power status in NEA member countries and in the OECD area. Information provided by governments includes statistics on total electricity produced by all sources and by nuclear power, fuel cycle capacities and requirements, and projections to 2040, where available. Country reports summarise energy policies, updates of the status in nuclear energy programmes and fuel cycle developments.

In 2020, the COVID-19 pandemic has highlighted the importance of electricity security in modern societies. Although the long-term implications for electricity generation are difficult to assess, during the crisis nuclear power continued to support the security of supply and has been, together with renewables, one of the most resilient electricity sources. In 2019, nuclear power continued to supply significant amounts of low carbon baseload electricity, despite strong competition from low-cost fossil fuels and renewable energy sources. Governments committed to having nuclear power in the energy mix advanced plans for developing or increasing nuclear generating capacity, with the preparation of new build projects making progress in countries such as Finland, Hungary, Turkey, the United Kingdom and Russia. Further details on these and other developments are provided in the publication's numerous tables, graphs and country reports.



Projected Costs of Generating Electricity – 2020 Edition

NEA No. 7531. 220 pages.

Available online at:
https://oe.cd/nea-egc-2020

This joint report by the International Energy Agency (IEA) and the Nuclear Energy Agency (NEA) is the ninth in a series of studies on electricity generating costs. As countries work towards ensuring an electricity supply that is reliable, affordable and increasingly low carbon, it is crucial that policymakers, modellers and experts have at their disposal reliable information on the cost of generation. This report includes cost data on power generation from natural gas, coal, nuclear, and a broad range of renewable technologies. For the first time, information on the costs of storage technologies, the long-term operation of nuclear power plants and fuel cells is also included. Also for the first time, the report is also accompanied by an online Levelised Cost of Electricity Calculator. The calculator allows for easy download of all data tables in the report, and empowers the user to examine the impact of changing select variables, such as the discount rate, fuel prices or the cost of carbon.

The detailed plant-level cost data for 243 power plants in 24 countries, both OECD and non-OECD, is based on the contributions of participating governments and has been treated according to a common methodology in order to provide transparent and comparable results. Low-carbon electricity systems are characterised by increasingly complex interactions of different technologies with different functions in order to ensure reliable supply at all times. The 2020 edition of *Projected Costs of Generating Electricity* thus puts into context the plain metric for plant-level cost, the levelised cost of electricity (LCOE). System effects and system costs are identified with the help of the broader value-adjusted LCOE, or VALCOE metric. Extensive sensitivity analyses and five essays treating broader issues that are crucial in electricity markets round out the complementary information required to make informed decisions. A key insight is the importance of the role the electricity sector plays in decarbonising the wider energy sector through electrification and sector coupling.

The key insight of the 2020 edition of *Projected Costs of Generating Electricity* is that the levelised costs of electricity generation of low-carbon generation technologies are falling and are increasingly below the costs of conventional fossil fuel generation. Renewable energy costs have continued to decrease in recent years and their costs are now competitive, in LCOE terms, with dispatchable fossil fuel-based electricity generation in many countries. The cost of electricity from new nuclear power plants remains stable, yet electricity from the long-term operation of nuclear power plants constitutes the least cost option for low-carbon generation. At the assumed carbon price of USD 30 per tonne of CO_2 and pending a breakthrough in carbon capture and storage, coal-fired power generation is slipping out of the competitive range. The cost of gas-fired power generation has decreased due to lower gas prices and confirms the latter's role in the transition. Readers will find a wealth of details and analysis, supported by over 100 figures and tables, that establish the continuing value of the *Projected Costs of Generating Electricity* as an indispensable tool for decision-makers, researchers and experts interested in identifying and comparing the costs of different generating options in today's electricity sector.

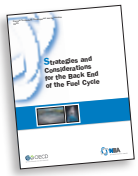
Small Modular Reactors: Challenges and Opportunities

NEA No. 7560. 52 pages.

Available online at:
https://oe.cd/nea-7560

Small Modular Reactors (SMRs) are gaining recognition among policymakers

and industry players as a promising nuclear technology. SMRs can be defined as nuclear reactors with a power output between 10 MWe and 300 MWe that incorporate by design higher modularisation, standardisation and factory-based construction levels enabling more predictable delivery models based on the economies of series. Today, more than 50 concepts are under development covering a wide range of technology approaches and maturity levels. The value proposition of the SMR technology also includes potential financing and system integration benefits. These attractive features, however, rely on a business case that requires the development of a global SMR market to become economically viable. Large-scale deployment of SMRs faces several technical, economic, regulatory and supply chain challenges and will need considerable governmental efforts and efficient international collaborative frameworks to be realised in the next decade.



Strategies and Considerations for the Back End of the Fuel Cycle

NEA No. 7469. 68 pages.

Available online at: https://oe.cd/nea-7469

A wealth of technical information exists on nuclear fuel cycle options – combinations of nuclear fuel types, reactor types, used or spent nuclear fuel (SNF) treatments, and disposal schemes – and most countries with active nuclear power programmes conduct some level of research and development on advanced nuclear fuel cycles. However, perhaps because of the number of options that exist, it is often difficult for policy makers to understand the nature and magnitude of the differences between the various options.

This report explores the fuel cycle options and the differentiating characteristics of these options. It also describes the driving factors for decisions related to both the development of the fuel cycle and the characteristics resulting from implementing the option. It includes information on the current status and future plans for power reactors, reprocessing facilities, disposal facilities, and the status of research and development activities in several countries. It is designed for policy makers to understand the differences among the fuel cycle options in a way that is concise, understandable, and based on the existing technologies, while keeping technical discussions to a minimum.

Uranium 2020: Resources, Production and Demand

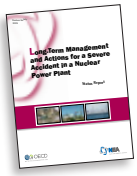
NEA No. 7555. 480 pages.

Available online at: https://bit.ly/uranium-2020

Uranium is the raw material used to produce fuel for long-lived nuclear power facilities, necessary for the generation of significant amounts of low-carbon electricity and other uses, such as heat and hydrogen production, for decades to come. Although a valuable commodity, major producing countries limited total production in recent years in response to a depressed uranium market. Uranium production cuts have unexpectedly deepened with the onset of the global COVID-19 pandemic in early 2020, leading to some questions being raised about future uranium supply.

This 28th edition of the "Red Book", a recognised world reference on uranium jointly prepared by the Nuclear Energy Agency (NEA) and the International Atomic Energy Agency (IAEA), provides analyses and information from 45 producing and consuming countries in order to address these and other questions. The present edition reviews world uranium market fundamentals and presents data on global uranium exploration, resources, production and reactor-related requirements. It offers updated information on established uranium production centres and mine development plans, as well as projections of nuclear generating capacity and reactor-related requirements through 2040.

Nuclear safety and regulation



Long-Term Management and Actions for a Severe Accident in a Nuclear Power Plant

Status Report

NEA No. 7506. 208 pages.

Available online at: https://oe.cd/3MW

As the Fukushima Daiichi nuclear power plant (NPP) accident illustrates, many challenges have to be faced in maintaining safety over the long term in a damaged NPP following a severe accident. These comprise maintaining and monitoring a stabilised and controlled state of the damaged plant; implementing provisions against further failures; evaluating the plant damaged state from a physical and radiological standpoint and ranking related risks; preparing and achieving fuel retrieval (either fuel assemblies stored in spent fuel pools or fuel debris from damaged reactors); and managing safely plant recovery and accident waste. All these actions are to be conducted protecting plant personnel from radiation exposure.

This status report reviews knowledge and experience gained through long-term management (LTM) of the Three Mile Island, Chernobyl and Fukushima Daiichi accidents, by identifying and ranking main issues and knowledge gaps. It also reviews the existing regulations and guidance, practices, technical bases and issues considered in member countries of the Nuclear Energy Agency regarding LTM of a severely damaged nuclear site. Finally, it proposes recommendations and areas for future investigation to enhance LTM of an NPP as regards necessary knowledge and provisions development, particularly for the optimisation of management of contaminated cooling waters.

Nuclear Power Plant Operating Experience

From the IAEA/NEA International Reporting System for Operating Experience – 2015-2017

NEA No. 7482. 70 pages.

Available online at: https://oe.cd/3MV

The International Reporting System for Operating Experience (IRS) is an essential system for the international exchange of information on safety related events at nuclear power plants worldwide. The fundamental objective of the IRS is to enhance the safety of nuclear power plants through the sharing of timely and detailed information on such events, and the lessons that can be learnt from them, to reduce the chance of recurrence at other plants. The first edition of this publication covered safety related events reported between 1996 and 1999. This seventh edition covers the 2015-2017 period and highlights important lessons learnt from a review of the 246 event reports received from participating states during those years. The IRS is jointly operated and managed by the OECD Nuclear Energy Agency (OECD/NEA) and the International Atomic Energy Agency (IAEA).

Radiological protection and human aspects of nuclear safety

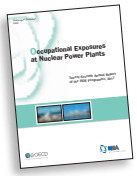
Methods for Assessing and Strengthening the Safety Culture of the Regulatory Body

NEA No. 7535. 106 pages.

Available online at: https://oe.cd/nea-7535

It is essential that organisations in the nuclear community maintain a healthy safety culture to achieve common goals regarding the safe operation of nuclear facilities and the safe use of nuclear material. Regulatory bodies are no exception, as a key element of the interconnected system which includes licensees, research institutions, technical support organisations, as well as governmental organisations and other stakeholders. By their very nature, regulatory bodies deeply influence the safety culture and the safety of the organisations they regulate and oversee. Based on their regulatory strategy, the way they carry out their daily oversight work, the type of relationship they cultivate with licensees, the values they convey and the importance they give to safety, regulatory bodies profoundly impact the licensees' safety culture, their sense of responsibility for safety and, by extension, the safety of their installations.

Regulatory bodies apply a number of methods, practices and approaches to foster and sustain a healthy safety culture. This report provides an overview and practical examples to build the regulatory bodies' safety culture competence and to perform self-reflection and self-assessment with regard to their own safety culture and its impact on the safety culture of the organisations they oversee. Drawing directly from the experiences from OECD Nuclear Energy Agency member countries, the report discusses effective methods to disseminate safety culture throughout the regulatory body, to build competence in safety culture, and to develop self-reflection and self-assessment activities. Finally, the report presents ten conclusions based on lessons learnt and best practices to inspire managers to continuously develop their regulatory body's safety culture.



Occupational Exposures at Nuclear Power Plants

Twenty-Seventh Annual Report of the ISOE Programme, 2017

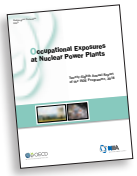
NEA No. 7510. 124 pages.

Available online at: https://isoe-network.net/publications/pub-resources/isoe-annual-reports/4331-isoe-annual-report-2017/file.html

This 27th Annual Report of the International System on Occupational Exposure (ISOE) Programme presents the status of the Programme in 2017.

As of 31 December 2017, the ISOE programme included 76 participating utilities in 31 countries (346 operating units; 55 shutdown units; 8 units under construction), as well as 28 regulatory authorities in 26 countries. The ISOE database includes occupational exposure information for over 489 units, covering over 85% of the world's operating commercial power reactors.

This report includes global occupational exposure data and analysis collected in 2017, information on the programme events and achievements as well as principal events in participating countries.



Occupational Exposures at Nuclear Power Plants

Twenty-Eighth Annual Report of the ISOE Programme, 2018

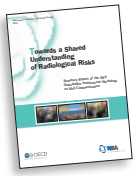
NEA No. 7536. 134 pages.

Available online at: https://isoe-network.net/publications/pub-resources/pub-annual-reports/4583-isoe-annual-report-2018/file.html

This 28th Annual Report of the International System on Occupational Exposure (ISOE) Programme presents the status of the Programme for the year of 2018.

As of 31 December 2018, the ISOE programme included 76 Participating Licensees in 31 countries (352 operating units; 61 shutdown units; 10 units under construction), as well as 28 regulatory authorities in 26 countries. The ISOE database includes occupational exposure information for 500 units, covering over 85% of the world's operating commercial power reactors.

This report includes a global occupational exposure data and analysis collected and accomplished in the year of 2018, information on the Programme events and achievements as well as principle events in participating countries.



Towards a Shared Understanding of Radiological Risks

Summary Report of the NEA Stakeholder Involvement Workshop on Risk Communication

NEA No. 7554. 74 pages.

Available online at: https://oe.cd/nea-7554

The decisions made about exposure to ionising radiation tend to be driven by subjective judgements about the health risks that radiation exposure may cause. In order to reach decisions that are effective and sustainable, it is essential for nuclear safety regulators, governments, nuclear facility operators and other nuclear energy decision makers to communicate scientific, technical and regulatory information regarding radiological and other risks to all stakeholders. Communicating such information can be complex since people judge and evaluate risks differently depending on the context and on their perceptions of risk.

In this context, the Nuclear Energy Agency (NEA) organised the "Stakeholder Involvement Workshop on Risk Communication: Towards a Shared Understanding of Radiological Risks" in September 2019. The workshop provided an opportunity for participants to share perspectives and lessons learnt in risk communication, identifying what has been effective and what has been less effective in the various cases. By understanding how situation-specific factors influence risk communication, a common framework addressing such circumstances can begin to emerge.

This report attempts to capture the collective wisdom generated over the three days of interactions in the hope that the knowledge gained from this workshop will benefit governments and citizens alike.

Radioactive waste management

International Roundtable on the Final Disposal of High-Level Radioactive Waste and Spent Fuel

Summary Report

NEA No. 7529. 54 pages.

Available online at: https://oe.cd/nea-7529

Worldwide consensus exists within the international community that geological repositories can provide the necessary long-term safety and security to isolate long-lived radioactive waste from the

human environment over long timescales. Such repositories are also feasible to construct using current technologies. However, proving the technical merits and safety of repositories, while satisfying societal and political requirements, has been a challenge in many countries.

The Ministry of Economy, Trade and Industry of Japan, the United States Department of Energy Office of Nuclear Energy and the OECD Nuclear Energy Agency co-organised a forum for discussion with the aim of developing a strategy for addressing this challenge through international co-operation. At the International Roundtable meetings, policymakers from 15 countries and the International Atomic Energy Agency gathered and shared knowledge about public understanding and technological development related to final disposal.

This report is a summary of the discussions held and experiences shared during the two sessions of the International Roundtable on Final Disposal of High-Level Radioactive Waste and Spent Fuel, held on 14 October 2019 and 7 February 2020 in Paris, France.

National Inventories and Management Strategies for Spent Nuclear Fuel and Radioactive Waste

Methodology for Common Presentation of Data

NEA No. 7424. 66 pages.

Available online at: https://oe.cd/3x4

Radioactive waste inventory data are an important element in the development of a national radioactive waste management programme since these data affect the design and selection of the ultimate disposal methods. Inventory data are generally presented as an amount of radioactive waste under various waste classes, according to the waste classification scheme developed and adopted by the country or national programme in question. Various waste classification schemes have thus evolved in most countries, and these schemes classify radioactive waste according to its origin, to criteria related to the protection of workers or to the physical, chemical and radiological properties of the waste and the planned disposal method(s).

The diversity in classification schemes across countries has restricted the possibility of comparing waste inventories and led to difficulties in interpreting waste management practices, both nationally and internationally. To help improve this situation, the Nuclear Energy Agency proposed to develop a methodology that would ensure consistency of national radioactive waste inventory data when presenting them in a common scheme. This report provides such a methodology and presenting scheme for spent nuclear fuel and for waste arising from reprocessing. The extension of the methodology and presenting scheme to other types of radioactive waste and corresponding management strategies is envisaged in a second phase.

Storage of Radioactive Waste and Spent Fuel

NEA No. 7406. 62 pages.

Available online at: https://oe.cd/3x5

Safety remains the most important factor in managing radioactive waste and spent fuel resulting from the generation of nuclear energy. General consensus has emerged worldwide that deep geological repositories are the safest option for long-lived radioactive waste, and that constructing repositories is feasible using current technologies. However, until repositories become available, radioactive waste must be managed safely and securely so that the risks posed to human health and to the environment over the long timescales involved are minimised.

This report examines the predisposal phase of radioactive waste management programmes in NEA member countries for all types of waste from high-level to intermediate- and low-level waste, and spent fuel. It reviews regulations, policies, strategies and financial issues in member countries, as well as best practices both in terms of storage and transport. The report is primarily directed at decision makers with a technical knowledge of the subject.

Two decades of Safety Case Development: An IGSC 20th Anniversary Brochure

NEA No. 7562. 48 pages.

Available online at: https://oe.cd/nea-igsc-20

The NEA Integration Group for the Safety Case (IGSC) has served as the most important and effective international platform for developing and integrating the science and engineering necessary to underpin geological disposal. Through its work, the IGSC has demonstrated that deep geological repositories are a safe and effective approach for the disposal of higher activity radioactive wastes and spent nuclear fuel. In its 20th anniversary year, the IGSC reflects on two decades of evolution of the safety case concept through nearly 20 key publications. The main topics addressed by the IGSC are safety assessment methodologies, constructing multiple lines of evidence, organisational and strategic issues, operational and feasibility aspects, regulatory requirements and stakeholder interactions. Together, these topics build confidence in the safety case.

Decommissioning of Nuclear Installations and Legacy Management

Optimising Management of Low-level Radioactive Materials and Waste from Decommissioning

NEA No. 7425. 110 pages.

Available online at: http://oe.cd/nea-7425

Low-level and very low-level waste represent the vast majority of radioactive waste by volume from decommissioning activity at nuclear facilities around the world, but they are only a small fraction of the radiological inventory. The availability of the appropriate waste management infrastructure, including a robust process and procedures for managing waste, waste disposal routes and an appropriate safety culture, are key components of an optimal approach to decommissioning. Recognising the important role of an effective waste management strategy in the delivery of a successful decommissioning programme, the former NEA Working Party on Decommissioning and Dismantling (WPDD) established an expert group in 2016 – the Task Group on Optimising Management of Low-Level Radioactive Materials and Waste from Decommissioning (TGOM) – to examine how countries manage (very) low-level radioactive waste and materials arising from decommissioning.

This report explores elements contributing to the optimisation of national approaches at a strategic level, describing the main factors and the relationships between them. It also identifies constraints in the practical implementation of optimisation based on experience in NEA member countries.

Nuclear science and the Data Bank

Chemical Thermodynamics – Second Update on the Chemical Thermodynamics of Uranium, Neptunium, Plutonium, Americium and Technetium

Volume 14

NEA No. 7500. 1 506 pages.

Available online at: https://oe.cd/nea-tdb-14

This volume is the 14th in the OECD Nuclear Energy Agency (NEA) Chemical Thermo–dynamics series. It is the second update of the critical reviews published, successively, in 1992 as Chemical Thermodynamics of Uranium, in 1995 as Chemical Thermodynamics of Americium, in 1999 as Chemical Thermodynamics of Technetium, in 2001 as Chemical Thermodynamics of Neptunium and Plutonium and in 2003 as the first Update on the Chemical Thermo–dynamics of Uranium, Neptunium, Plutonium, Americium and Technetium.

A team, composed of nine internationally recognised experts, has critically reviewed all the relevant scientific literature for the above mentioned systems that has appeared since the publication of the earlier volumes. The results of this assessment, carried out following the guidelines of the NEA TDB Project , have been documented in the present volume, which contains new tables of selected values for formation and reaction data and an extensive bibliography. The database system developed at the NEA Data Bank ensures consistency within the recommended data sets. This volume will be of particular interest to scientists carrying out performance assessments of deep geological disposal sites for radioactive waste.

International Handbook of Evaluated Criticality Safety Benchmark Experiments

NEA No. 7520. DVD.

The International Criticality Safety Benchmark Evaluation Project (ICSBEP) Handbook contains criticality safety benchmark specifications that have been derived from experiments that were performed at various critical facilities around the world. The benchmark specifications are intended for use by criticality and safety analysts as well as nuclear data evaluators to validate calculational techniques and data. The handbook is produced by the ICSBEP working group, under the aegis of the OECD Nuclear Energy Agency (NEA). While co-ordination and administration of the ICSBEP is undertaken by the NEA, each participating country is responsible for the administration, technical direction, and priorities of the project within their respective countries.

The evaluated criticality safety benchmark data in the 2020 edition are presented in nine volumes. These volumes span over 70 000 pages and contain 582 evaluations with benchmark specifications for 5 053 critical, near-critical or subcritical configurations, 45 criticality alarm placement/shielding configurations with multiple dose points for each, and 237 configurations which have been categorised as fundamental physics measurements that are relevant to criticality safety applications.

International Handbook of Evaluated Reactor Physics Benchmark Experiments

NEA No. 7521. DVD.

The *International Handbook of Evaluated Reactor Physics Benchmark Experiments* contains reactor physics benchmark specifications that have been derived from experiments that were performed at nuclear facilities around the world. The benchmark specifications are intended for use by reactor designers, safety analysts and nuclear data evaluators to validate calculation techniques and data. While co-ordination and administration of the International Reactor Physics Evaluation (IRPhE) project is undertaken by the OECD Nuclear Energy Agency (NEA) at the international level, each participating country is responsible for the administration, technical direction and priorities of the project within their respective countries. The information and data included in this handbook are available to NEA member countries, to all contributing countries and to others on a case-by-case basis. Example calculations are presented; however, these do not constitute validation or endorsement of the codes or cross-section data.

The 2020 edition of the International Handbook of Evaluated Reactor Physics Benchmark Experiments contains data from 168 experimental series that were performed at 56 nuclear facilities. A total of 164 of the 168 evaluations are published as approved benchmarks. The remaining four evaluations are published as draft documents only. The cover of the handbook shows the Transient Reactor Test (TREAT) Facility at Idaho National Laboratory (INL), United States. Newly evaluated measurements from TREAT have been added to this edition of the handbook.

Nuclear law

Nuclear Law Bulletin No. 104

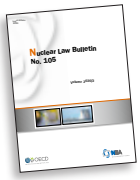
Volume 2020/1

NEA No. 7533. 88 pages.

Available online at: https://oe.cd/nea-nlb-104

The *Nuclear Law Bulletin* is a unique international publication for both professionals and academics in the field of nuclear law. It provides readers with authoritative and comprehensive information on nuclear law developments. Published free online twice a year in both English and French, it features topical articles written by renowned legal experts, covers legislative developments worldwide and reports on relevant case law, bilateral and international agreements as well as regulatory activities of international organisations.

The 104th edition of the Nuclear Law Bulletin includes Case Law from Australia, Japan and the United States, as well as national reports from nine countries, reports on intergovernmental activity and the complete text of the Exposé des motifs of the Paris Convention as amended by the Protocols of 1964, 1982 and 2004 and the Recommendation on the application of the reciprocity principle to nuclear damage compensation funds.



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Feature articles and studies in this issue include: "Environmental impact assessments and long-term operation of nuclear power reactors: increasing importance of environmental protection in the European Union?", "Forging a clear path for advanced reactor licensing in the United States: approaches to streamlining the NRC environmental review process" and "Slovak legal system for ensuring feasible nuclear back-end system implementation".

Publications of Secretariat-serviced bodies

Generation IV International Forum (GIF) Annual Report 2020

90 pages.

Available online at: https://www.gen-4.org/gif/jcms/c_177498/gif-2020-annual-report

This thirteenth edition of the Generation IV International Forum (GIF) Annual Report covers 2020. In 2020, the GIF, as have all, had to adapt its way of working to the worldwide COVID-19 pandemic situation. In the face of this, all GIF members made their best efforts to produce deliverables and fulfil their objectives in an optimized manner.

In 2020 the GIF organization started its transition towards a new communications approach through a rebranding of its logo and website. This transitional phase will lead the Generation IV International Forum to a new approach in line with the current situation: more virtual meetings and exchanges; a powerful and updated GIF website to ease and simplify interactions between members; and regular communication through high standard monthly webinars and newsletters. Thus the GIF is ready to enter its third decade of existence in the particular context of a new energy paradigm and an unpredictable sanitary situation.

2018 GIF Symposium Proceedings

524 pages.

Available online at: https://www.gen-4.org/gif/jcms/c_117863/2018-gif-symposium-proceedings

The Generation IV International Forum (GIF) Symposia are public scientific events aimed at disseminating the results of international collaborative research performed within the Forum. The first GIF Symposium was held in Paris, France in 2009, the second in San Diego, United States in 2012 and the third in Chiba, Japan in 2015. This fourth GIF Symposium, held in Paris on 16-17 October 2018, was designed to inform and educate audiences beyond the GIF community. Its objective was to report the achievements of the Forum in developing nuclear energy systems that are aligned with today's global sustainable development goals. In particular, the fourth GIF Symposium outlines a credible GIF path towards achieving the goals of the updated GIF R&D Roadmap, leading to the demonstration and deployment of innovative nuclear energy systems that will establish nuclear energy as a valuable part of the global, long-term sustainable carbon-free energy mix.

Workshop on New Challenges Facing Nuclear Regulators

28-29 May 2018

Available online at: https://www.ifnec.org/ifnec/jcms/g_13446/ifnec-idwg-report-workshop-on-new-challenges-facing-nuclear-regulators

The objectives of the workshop *New Challenges Facing Nuclear Regulators* was to share information on the following themes:

- Regulatory Approaches for New Large Reactors by Established Regulators
- Regulatory Approaches by New Regulators
- Challenges in Regulating Small Modular Reactors

Workshop on Nuclear Energy Beyond Electricity

24 September 2019

Available online at: https://www.ifnec.org/ifnec/jcms/g_13741/idwg-report-workshop-on-nuclear-energy-beyond-electricity

Industrial heat production, district heating by cogeneration of electricity and heat, hydrogen and synthetic fuels for transport could and should be new territories conquered by nuclear energy, especially with a view to help decarbonise those sectors. This workshop discussed the broad topics of non-electric applications of nuclear energy, and then addressed the key role that high temperature reactors (HTRs) could play to provide both electricity and process heat applications. The last session of the workshop focused on the role of hydrogen, one of the most promising low carbon energy vectors – which can be produced thanks to nuclear energy, and in particular from HTRs, and discussed other innovations such as micro-reactors.

NEA web-based events: A typology

- **NEA WebChat:** An online dialogue led by Director-General William D. Magwood, IV with leaders in the sector on the major issues of the day, open to the public.
- **Expert Roundtable:** A roundtable conversation with experts and an extended Q&A session, aimed at a specialist audience, open to the public.
- **NEA Webinar:** Presentation of recent NEA work, usually the release of an NEA flagship publication, for a general audience, open to the public.
- **Online Workshop/Meeting:** A traditional NEA meeting or workshop held remotely, open to NEA delegates.

NEA WebChats

H.E. Mohamed Al Hammadi, Chief Executive Officer of the Emirates Nuclear Energy Corporation (ENEC) – 17 September 2020

As the leader of the first nuclear power plant project in the Arab world, H.E. Mohamed Al Hammadi discussed the Barakah Nuclear Energy Plant and share first-hand the experiences and perspectives of a nuclear newcomer country. The conversation covered:

- The benefits nuclear energy is bringing to the United Arab Emirates (UAE)
- How nuclear energy fits into the UAE Energy Strategy
- The UAE's approach to capacity building for the local nuclear industry.

The video recording of this WebChat is available at: https://youtu.be/gv218ewHVh0

Rafael Mariano Grossi, IAEA Director-General – 15 October 2020

The International Atomic Energy Agency (IAEA) and the NEA are collaborative organisations that work very closely together to advance global nuclear safety and technology. The heads of both organisations discussed the outlook for global nuclear power development. The conversation also covered:

- The nexus between commercial nuclear power and nuclear proliferation
- The role that nuclear energy could play in achieving climate goals
- IAEA support to member state efforts in addressing the COVID-19 pandemic

The video recording of this WebChat is available at: https://youtu.be/Uc_t6eotPK8

Shawn Tupper, Associate Deputy Minister of Natural Resources Canada – 25 November 2020

Canada has a full-spectrum industry and nuclear energy is an important component of the country's electricity supply. As such, Associate Deputy Minister Tupper and Director-General William D. Magwood, IV discussed Canada's role in nuclear technology development and exchanged perspectives on the clean energy transition. The conversation also covered:

- Carbon neutrality
- Future of nuclear power
- Stakeholder engagement
- The new normal

The video recording of this WebChat is available at: https://youtu.be/TdM5cd7D6ck

Olivier Gupta, Director General, French Nuclear Safety Authority (ASN) - 23 March 2021

Director General Olivier Gupta, who also serves as Chair of the Western European Nuclear Regulators Association (WENRA) discussed multilateral co-operation in nuclear regulation and shared his perspectives on the role of the regulator in enhancing global nuclear safety. The conversation also covered:

- Harmonisation of nuclear safety approaches
- Lessons learnt from the Fukushima Daiichi accident
- Nuclear regulation in a post-COVID-19 world

The video recording of this WebChat is available at: https://youtu.be/WNARJq951zk

Larissa Shasko and Stephen King, Nuclear Education, Skills and Technology (NEST) Framework Fellows – 8 April 2021

The NEA hosted a discussion with NEST Fellows Larissa Shasko and Stephen King to explore the importance of education, training, and knowledge management to the nuclear sector. Dr Antonella Di Trapani, Head of the NEA Nuclear Education Team, engaged in a discussion with the fellows about their NEST experiences and the value they have seen thus far from their participation in the programme. Afterwards, these representatives of the next generation nuclear experts had a conversation with NEA Director-General William D. Magwood, IV on the future of nuclear energy.

The video recording of this WebChat is available at: https://youtu.be/ypFh5uELN04

Expert Roundtables

Progress in HLW management and the sustainability of nuclear energy – 12 November 2020

The NEA organised an expert roundtable discussion on 12 November 2020 on the sustainability of nuclear energy in the context of the management and disposal of high-level radioactive waste. The event brought together experts from around the world who discussed the progress made in managing nuclear waste and the development and implementation of deep geological repositories. In addition to addressing the scientific and technical issues, they also explored the societal challenges in this area.

Moderator

- **William D. Magwood, IV**, NEA Director-General

Discussants

- **Rita Baranwal**, Assistant Secretary for Nuclear Energy, United States Department of Energy (DOE)
- **Hiroyuki Umeki**, Executive Director, the Nuclear Waste Management Organization of Japan (NUMO), and Chair of the NEA Radioactive Waste Management Committee (RWMC)
- **Jamal Al Ahbabi**, Radioactive Waste Management Director, Radioactive Waste Management, Emirates Nuclear Energy Corporation (ENEC)
- **Patrick Landais**, High Commissioner, French Alternative Energies and Atomic Energy Commission (CEA)
- **Patrick Ledermann**, President, Foundation of the National Academy of Technologies of France (NATF), and Chair of the NEA Committee for Technical and Economic Studies on Nuclear Energy Development and the Fuel Cycle (NDC)
- **Jean-Paul Minon**, Former General Manager, Belgian Agency for Radioactive Waste and Enriched Fissile Materials (ONDRAF/NIRAS), and Former Chair of the NEA Radioactive Waste Management Committee (RWMC)
- **Ryo Nasu**, Director of the Radioactive Waste Management Division, Agency for Natural Resources and Energy, Japan's Ministry of Economy, Trade and Industry (METI)
- **Jessica Palmqvist**, Head of the Division of Research and Development, Swedish Nuclear Fuel and Waste Management Company (SKB)

The video recording is available at: https://www.youtube.com/watch?v=u5UVaaEnCIk

Projected Costs of Electricity Production 2020 – 9 December 2020

The Nuclear Energy Agency (NEA) and the International Energy (IEA) hosted an expert roundtable discussion on 9 December 2020 to explore findings from the 2020 edition of *Projected Costs of Generating Electricity,* the ninth report in the series on the levelised costs of electricity (LCOE) jointly prepared every five years by the two agencies. The key conclusions of the report and policy implications were explored in a discussion hosted by NEA Director-General William D. Magwood, IV. He was joined by Peter Fraser, Head of the IEA Gas, Coal and Power Markets Division and Jan Horst Keppler, Senior Economic Advisor at the NEA.

The video recording is available at: https://youtu.be/MzrqiPKXihg

Disruptive Technologies for Nuclear Safety Applications: From NI2050 to Disruptive Technologies – 16 March 2021

Innovative digital technologies are transforming whole industries by improving their efficiency, safety and reliability. It is necessary for the nuclear sector to embrace these disruptive technologies and to accelerate nuclear innovation in order to ensure the continued enhancement of nuclear safety and competitiveness worldwide, while attracting the younger generation to nuclear careers.

In this context, together with the Korea Atomic Energy Research Institute (KAERI) and the Korean Nuclear Society (KNS), the NEA organised a series of webinars to explore the use of disruptive technologies in nuclear applications and discuss the future shape of nuclear safety systems. The first event in the series focused on the bridge from the NEA Nuclear Innovation 2050 Initiative (NI2050) to Disruptive Technologies for Nuclear Safety Applications.

Diane Cameron, Head of the NEA Division of Nuclear Technology Development and Economics.

Panellists

- **Hamid Aït Abderrahim**, Deputy Director General, SCK•CEN
- **Ramzi Jammal**, Executive Vice-President and Chief Regulatory Operations Officer, Regulatory Operations Branch, Canadian Nuclear Safety Commission (CNSC)
- **Ik Jeong**, Director of the Strategy Research Division, Korea Atomic Energy Resarch Institute (KAERI)
- **Kemal Pasamehmetoglu**, Executive Director for the Versatile Test Reactor (VTR) Project, Idaho National Laboratory Energy Resarch Institute
- **Fiona Rayment**, Chief Science and Technology Officer, United Kingdom National Nuclear Laboratory (NNL)

The video recording is available at: https://youtu.be/49O6tjBD-sA

Using Disruptive Technology for Nuclear Safety Applications – 30 March 2021

The second in a series of webinars with the Korea Atomic Energy Research Institute (KAERI) and the Korean Nuclear Society (KNS) provided an overview of emerging digital technologies and key factors affecting their adoption in the nuclear sector. The panellists discussed the effects and possible implementation of these technologies for nuclear safety applications. They also addressed the regulatory viewpoints on safety innovations, as well as examples and lessons learnt from other industries.

Moderator

- **William D. Magwood, IV**, NEA Director-General

Panellists

- **Mark Foy**, Chief Nuclear Inspector, United Kingdom Office for Nuclear Regulation (ONR)
- **Alistair Nolan**, Senior Policy Analyst, Organisation for Economic Co-operation and Development (OECD)
- **Jin-Ho Park**, Senior Vice President of Nuclear Safety Research, Korea Atomic Energy Research Institute (KAERI)
- **Steven Wood**, Senior Commercial Manager, Digital Catapult

The video recording is available at: https://youtu.be/VUzK3X_yEbQ

Disruptive Technologies for Nuclear Safety Applications: Data Innovations for the Future of Nuclear Safety – 13 April 2021

The third in a series of webinars with the Korea Atomic Energy Research Institute (KAERI) and the Korean Nuclear Society (KNS) focussed on digital transformation. Discussion centred on the prospects for data innovations such as artificial intelligence, augmented reality, big data, wireless communications and the Internet of things. Panellists discussed the application of data-driven technologies for the improvement of nuclear operations and continued enhancement of nuclear safety. They also examined the lesson learnt from the implementation of these technologies in other industrial sectors, such as the steel sector.

Moderator

- **Diane Cameron**, Head of the NEA Division of Nuclear Technology Development and Economics.
- **Dominique Boina**, Project manager, French Nuclear Safety Authority (ASN)
- **Vincent Champain**, Senior Executive Vice President, Information Technology, Digital Performance and New Business, Framatome
- **Abhinav Gupta**, Professor of Structural Engineering and Mechanics, North Carolina State University (NCSU), and Director of the Center for Nuclear Energy Facilities and Structures (CNEFS)
- **Ho Yong Kang**, Principal Research Scientist, Electronics and Telecommunications Research Institute (ETRI)

The video recording is available at: https://youtu.be/hfrtRdtKZ7o

Sustaining Experimental Capacities for Safety, Industry and Science: Launch of the NEA Framework for Irradiation Experiments (FIDES) – 20 April 2021

The NEA launched a new multilateral effort, the Framework for Irradiation Experiments (FIDES), to preserve and strengthen the global fuel and materials experimental capacity to the benefit of a broad community of users from around the world. FIDES will support the experimental needs of nuclear safety regulators, technical support organisations, research institutions and industry by establishing a network of research facilities in order to perform high-priority experiments to verify the safety and performance of fuels and materials. FIDES will help preserve the remaining facilities as well as the related experimental know-how for future generations. An expert roundtable discussion was held on 20 April 2021 to discuss the importance of FIDES and the experiments it will support. The panel addressed why the research reactors are essential in advancing technologies such as accident-tolerant fuels and supporting the use of new materials in nuclear plants and how FIDES can help sustain the world's experimental capacities.

Moderators

- **William D. Magwood, IV**, NEA Director-General
- **Tatiana Ivanova**, Head of the NEA Division of Nuclear Science.

Discussants:

- **Raymond Furstenau**, Director of the Nuclear Regulatory Research Office, United States Nuclear Regulatory Commission (NRC)
- **Takehiko Nakamura**, Director General of the Nuclear Safety Research Center, Japan Atomic Energy Agency (JAEA)
- **Jean-Christophe Niel**, Director-General of the French Institute of Radiation Protection and Nuclear Safety (IRSN), and Chair of the NEA Committee on the Safety of Nuclear Installations (CSNI)
- **Takanari Ogata**, Deputy-Director of the Nuclear Technology Research Laboratory, Associate Vice President, Central Research Institute of Electric Power Industry (CRIEPI)
- **Kemal Pasamehmetoglu**, Executive Director of the Versatile Test Reactor Project, Idaho National Laboratory (INL), and Chair of the NEA Nuclear Science Committee (NSC)
- **Alexander Tuzov**, Director-General of the Research Institute of Atomic Reactors (RIAR) and Director-General of the Institute of Physics and Power Engineering (IPPE)

The video recording is available at: https://youtu.be/NVSO5NRxEFg

Disruptive Technologies for Nuclear Safety Applications: Cyber Security Enhancements for Nuclear Safety Applications – 27 April 2021

The fourth in a series of webinars with the Korea Atomic Energy Research Institute (KAERI) and the Korean Nuclear Society (KNS) discussed cyber security risks associated with the use of data-sharing technologies and increased connectivity in the nuclear sector. Panellists provided examples and viewpoints on safety standards that are being developed in order to address these risks, such as threat detection modules, vulnerability analyses and cybersecurity trainings and exercises.

Moderator

- **Diane Cameron**, Head of the NEA Division of Nuclear Technology Development and Economics.

Panellists

- **Chul Hwan Jung**, Technical Specialist, Canadian Nuclear Safety Commission (CNSC)
- **Jeong Ho Lee**, Director of the Division of Cyber Security, Korea Institute of Nuclear Nonproliferation and Control (KINAC)
- **Jun Young Son**, Senior Engineer, Korea Atomic Energy Research Institute (KAERI)
- **Christopher Spirito**, Nuclear Cyber Security Consultant, Idaho National Laboratory (INL)
- **Hyunjin Yoon**, Senior Researcher, Korea Electronics and Telecommunications Research Institute (ETRI)

NEA Webinars

International School of Nuclear Law: Hot topics, expert views – 2 October 2020

While the 2020 edition of the ISNL was cancelled due to the ongoing COVID-19 pandemic, the NEA hosted a virtual roundtable discussion on 1 October 2020 to celebrate what would have been the 20th anniversary of this unique course. The event brought together ISNL lecturers, representing the NEA, the International Atomic Energy Agency (IAEA), public and private sectors, and academia, who discussed recent developments in international nuclear law.

Introduction

- **William D. Magwood, IV**, NEA Director-General
- **Ximena Vásquez-Maignan**, Head, Office of Legal Counsel, NEA
- **Philippe Augé**, President, University of Montpellier
- **Peri Lynne Johnson**, Legal Adviser and Director, Office of Legal Affairs, International Atomic Energy Agency (IAEA)
- **Patrick Reyners**, Secretary General, International Nuclear Law Association (INLA)
- **Paul Bowden**, ISNL Programme Leader, Partner at Freshfields Bruckhaus and Deringer LLP, and Honorary Professor of Law, Nottingham Law School

Session 1: Fundamental Nuclear Safety Conventions

- **Lisa Thiele**, Senior General Counsel, Canadian Nuclear Safety Commission (CNSC)
- **Wolfram Tonhauser**, Section Head, Nuclear and Treaty Law Section, Office of Legal Affairs, International Atomic Energy Agency (IAEA)
- **Stephen G. Burns**, Former Chairman, United States Nuclear Regulatory Commission (NRC)

Session 2: Licensing and Permitting for Nuclear Activities

- **William D. Magwood, IV**, NEA Director-General
- **Ximena Vásquez-Maignan**, Head, Office of Legal Counsel, Kimberly S. Nick, Deputy Head, Office of Legal Counsel, NEA
- **Paul Bowden**, ISNL Programme Leader, Partner at Freshfields Bruckhaus and Deringer LLP, and Honorary Professor of Law, Nottingham Law School

Session 3: Security and Safeguards

- **Sonia Drobysz**, Programme Director for National Implementation, VERTIC (the Verification Research, Training and Information Centre)
- **Cristian de Francia**, Legal Officer, Non-Proliferation and Policy Making Section, Office of Legal Affairs, International Atomic Energy Agency (IAEA)
- **Laura Rockwood**, Director, Open Nuclear Network

Session 4: Liability, Insurance and Trade

- **Ximena Vásquez-Maignan**, Head, Office of Legal Counsel, NEA
- **Mark Tetley**, Insurance Consultant and former Managing Director, Power Nuclear & Construction Division, Price Forbes & Partners Ltd.
- **William Fork**, Partner, Pillsbury Winthrop Shaw Pittman LLP

The video recording is available at: https://www.youtube.com/watch?v=7W8sQQVWCVw

The Fukushima Daiichi Nuclear Power Plant Accident, Ten Years On: Progress, Lessons and Challenges – 3 March 2021

This year marks 10 years since the Great East Japan Earthquake on 11 March 2011 and the subsequent Fukushima Daiichi nuclear accident. On this occasion, the Nuclear Energy Agency launched a report to survey the aftermath, lessons, and achievements in Japan and the global nuclear community in the decade since the accident. The report also analyses the current challenges stemming from the accident, and makes policy recommendations to the international nuclear community in nine different areas. The NEA hosted an expert roundtable to present the new report, review the effects of the accident and reflect on future perspectives.

Moderator

- **William D. Magwood, IV**, NEA Director-General

Discussants

- **Claire Cousins**, Chair, International Committee for Radiation Protection (ICRP)
- **Ingemar Engkvist**, Chief Executive Officer, World Association of Nuclear Operators (WANO)
- **Olivier Gupta**, Director General, the Nuclear Safety Authority (Autorité de Sûreté Nucléaire – ASN)
- **Richard Meserve**, Senior of Counsel, Covington & Burling, LLP, and former Chairman of the United States Nuclear Regulatory Commission (NRC)
- **Hajimu Yamana**, President, the Nuclear Damage Compensation and Decommissioning Facilitation Corporation (NDF)
- **Rosa Yang**, EPRI Fellow, the Electric Power Research Institute (EPRI)
- **Mike Weightman**, Consultant; former Chief Inspector of Nuclear Installations and Chief Executive Officer, the United Kingdom Office for Nuclear Regulation (ONR)

The video recording is available at https://youtu.be/QqN216lIKMk

Special Events

A Global Nuclear Engineering Commencement – 27 August 2020

The graduating classes of 2020 and 2021 experienced a unique time in history. Due to the Coronavirus (COVID-19) pandemic, many students did not receive traditional ceremonies and festivities, and transitioned or attempted to transition to professional careers at a time of great uncertainty and economic upheaval.

In this context and with the support of the European Nuclear Education Network (ENEN), the NEA held an online event to celebrate and recognise the accomplishments of the graduating classes of 2020 and 2021, especially those within the nuclear science and technology fields. Opening remarks were delivered by NEA Director-General Magwood, followed by a keynote address by Rita Baranwal, Assistant Secretary for Nuclear Energy, United States Department of Energy (DOE).

The traditional charge to the graduates was given by Anne White, Professor and Head of Nuclear Science and Engineering, SoE Distinguished Professor of Engineering at Massachusetts Institute of Technology (MIT). The event also featured remarks by:

- **Agneta Rising**, Director General of the World Nuclear Association
- **Chris Levesque**, President and Chief Executive Officer of TerraPower (who also read a special message to the graduates from TerraPower Chairman Bill Gates [see below]);
- **Joerg Starflinger**, ENEN President and Executive Director of the University of Stuttgart Institute of Nuclear Technology and Energy System (IKE);
- **James E. Hansen**, Professor at Columbia University's Earth Institute;
- **Katie Mummah**, MSc Class of 2020 and PhD candidate in Nuclear Engineering and Engineering Physics at University of Wisconsin-Madison;
- **Haruka Okazaki**, final year undergraduate student in nuclear engineering at the University of Fukui, Japan.

The video recording of the ceremony is available at: https://youtu.be/jdoRlxpTgSg

Welcoming Bulgaria to the NEA – 19 January 2021

On 1 January 2021, Bulgaria became the 34th member of the OECD Nuclear Energy Agency (NEA) and its Data Bank. On the occasion of this accession, a special ceremony was held online to welcome Bulgaria to the NEA.

Prime Minister of Bulgaria Boyko Borissov, Minister of Energy of Bulgaria Temenuzhka Petkova, OECD Secretary-General Ángel Gurría and OECD Deputy Secretary-General Ulrik Vestergaard Knudsen made brief statements at this official ceremony. NEA Director-General William D. Magwood, IV officiated the ceremony.

https://youtu.be/PZYrkb-_9uY

Online Workshops/Meetings

A full list of all NEA meetings and workshops held remotely is available on the NEA website Delegates' Area at www.oecd-nea.org/tools/meeting/.

Version: June 2021

The Nuclear Energy Agency (NEA) is an intergovernmental agency established in 1958. Its primary objective is to assist its member countries in maintaining and further developing, through international co-operation, the scientific, technological and legal bases required for a safe, environmentally sound and economical use of nuclear energy for peaceful purposes. It is a non-partisan, unbiased source of information, data and analyses, drawing on one of the best international networks of technical experts.

The NEA has 34 member countries: Argentina, Australia, Austria, Belgium, Bulgaria, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Luxembourg, Mexico, the Netherlands, Norway, Poland, Portugal, Korea, Romania, Russia, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The NEA co-operates with a range of multilateral organisations, including the European Commission and the International Atomic Energy Agency.

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