Panel Table

Success factors of Gigawatt plant: a mix between lessons learnt and innovation

With the nuclear renaissance underway, both gigawatt-scale reactors and SMRs offer benefits to support the global target of decarbonizing the energy mix, enabling the deployment of AI, and ensuring reliable access to electricity worldwide. At WNE 2025, I had the privilege of moderating a panel of 4 speakers focused on large power reactors and the key success factors for their deployment. The discussion revolved around finding the right balance between leveraging lessons learned and replication on one side and fostering innovation to achieve additional efficiency on the other.

Moderator

Nathalie Patin
Global Business Development Director Egis

Speakers:

Estelle Obert
EDF, Construction Performance Leader EPR2

Anni Jaarinen
Fortum, Vice President Nuclear Services

Lou Martinez Sancho
Westinghouse, Chief Technology Officer

Julianne den Decker
Candu Energy, Senior Vice President Operations

Nathalie Patin:

Global Business Development Director, Egis

Ontario is very proud of completing refurbishment projects on time and on budget. What lessons learned can you share with us, and how might they be transferable to Europe, for example to the Cernavodă project in Romania?

Julianne den Decker

Candu Energy,
Senior Vice President Operations

AtkinsRéalis

Julianne den Decker:

Maybe I should start by explaining what a CANDU refurbishment is. CANDU reactors are quite different. They operate with pressure tubes inside the reactor. To life-extend a plant, it's necessary to replace all of the internal components of the reactor, including the pressure tubes. Because of the CANDU design, we use very specialized robotic tools to perform much of the work.

Because we have a fleet of CANDU reactors around the world, we've been able to use these robotic tools across different projects and take advantage of all the lessons learned from previous work. There is an aspect of both technical workability and plant operations that we improve with each project.

The site itself is a little different each time. There are existing infrastructure and an active base in place. Delivering on time and on budget comes down to the human side as well, especially the training that goes into it.

Refurbishment is very different from a new build. In this kind of life-extension situation, full rehearsals are very important. We use a combination of full digital rehearsals and very extensive mock-ups to train all crews.

We have a core team of technical staff who rotate between projects worldwide. At the same time, we train a significant local workforce, whether in Canada or elsewhere, including materials, utilities, and operations. It's a combination of training the core technical team, who then train the on-site staff.

Planning and executing all the work carefully is essential. In terms of how this relates to new builds, digital rehearsals are a very important part of the process.

Nathalie:

The nuclear industry closely follows the construction progress of the two units at HPC and the replication strategy for SZC. Could you share some insights regarding the process of implementing lessons learned from one unit to the next? What are the key topics to leverage the fleet effect?

Estelle Obert

EDF,
Construction Performance Leader EPR2

EDF

Estelle Obert:

I worked for five years on HPC. I started in civil works as a project manager and then became the head of the joint design office, which is the site engineering office, with about 300 people working on-site to adjust the design and facilitate construction.

What I can share is that the EPR is a family. This is a strength for EDF because there is a lot of communication between projects to share experience. Another aspect specific to EDF is that for EPRs, there is only one customer, which is EDF EPR Operations. This simplifies requirements significantly. When you have a single customer for multiple EPR units, it's easier to stabilize the design and ensure it doesn't change between units.

There is an ongoing exception due to the new context in which we operate the EPR. EDF asked the EPR fleet team to incorporate two changes into the design. First, larger rooms within the EPR area to ease maintenance during LPGs, which is crucial to optimize the reactor's availability. Second, due to the growth of renewables, the EPRs must be able to reduce their output twice a day, which is a significant change compared to the existing fleet.

The current EPR fleet in France includes 57 reactors. These are the main changes we have seen between the last fleet and the new units.

Regarding lessons learned, when I worked on EPR policy, we observed that between Unit 1 and Unit 2, non-conformance reports for civil works decreased by 70%. This improvement is largely due to the learning curve and accumulated knowledge. Teams must first complete the work once to replicate it more efficiently on subsequent units.

We found that the optimal time gap between units is between 10 and 24 months. Up to 24 months, it's still possible to transfer knowledge effectively, but beyond that, workforce changes and people may have moved to other companies or roles. For the EPR 2-unit course, which covers six units, the programme is designed to maintain a good pace between units: enough time to apply lessons learned, but not so long that the core team changes. The minimum gap is around 10–15 months.

A challenge we face is moving personnel between sites. After the COVID pandemic, it has become more difficult for staff to relocate for periods that can last up to three years.

Nathalie :

AP1000 is now running in China and in the US, and you have a pipeline of projects in Europe in different countries. What is your view of deployment of the fleet effect when the units are in different countries with different regulations?

Lou Martinez Sancho

Westinghouse,
Chief Technology Officer

Westinghouse

Lou Martinez Sancho:

I think most of the points have already been shared by my peers. Basically, we have multiple licenses covering these constructions. As you mentioned, we already have six reactors in operation, 2 in the US and 4 in China, and the upcoming pipeline in the US and Europe. We use the same design without major changes. All the licenses are in place, and the design is fully modular. One lesson learned is that this modularity helps us leverage the knowledge and experience across the fleet.

Second is the licensing process. Each country has its own regulators. It's much simpler when starting in a new country with a reactor that is already fully licensed. For the US fleet, or countries where we already engage with the regulator, this is even easier. A lot of data analysis is required, but it streamlines the process.

Third is the supply chain. Westinghouse's business model builds locally while maintaining a global supply chain. Major suppliers follow the projects globally, but local workforce involvement adds tremendous value in each country. This also helps with lessons learned and ensures consistency across projects. This is a key part of the AP1000 family approach.

Finally, the workforce is the most challenging. For licensing and supply chain, lessons learned are easily transmitted between units, but the workforce is highly local. We now engage universities, national labs, and trade unions to prepare the workforce for upcoming projects. Success depends not just on engineers but also on electricians, welders, and field personnel who must be ready from day one of operations.

COVID has intensified these challenges. Many critical trades are harder to mobilize, and incentives are more difficult. To address this, we are introducing new technologies, digitalization, and AI to streamline work, train the workforce efficiently, and attract the next generation to these projects.

Nathalie:

Anni, with your position today, you are both supporting Fortum's nuclear new build program and bringing your expertise as an operator to various countries, including newcomers to the nuclear industry. You also have extensive experience in decommissioning and waste management. Could you share how the overall lifecycle is considered when planning a new unit, particularly regarding waste management? And what lessons have you learned from your own experience?

Anni Jaarinen

Fortum,
Vice President Nuclear Services

fortum

Anni Jaarinen:

I'll start by giving a bit of background on Fortum. Fortum is an energy utility focused in the Nordics, with nuclear and hydro production. Our nuclear fleet is located in the Nordic region. We fully own the Lovisa power plant in Finland, which operates VVER units. At Lovisa, we also operate our own low and intermediate-level waste repository. Additionally, we co-own units in Olkiluoto, Finland, and in Forsmark and Oskarshamn in Sweden. We are involved with the final disposal of nuclear fuel as well. We co-own Posiva, which handles final disposal in Finland, and we are stakeholders in SKB, a similar company in Sweden.

In the Nordics, we are involved in almost every aspect of nuclear operations, which makes considering the full lifecycle of nuclear units very relevant. When planning a new build, there are two key reasons why the lifecycle must be considered from the early phases: sustainability and cost.

First, sustainability. Nuclear waste management is vital for public acceptance. Even though public support for nuclear energy is relatively high in Europe, it must be earned every day. Safe and stable production is essential, but transparency in waste management is equally critical. Waste must be handled sustainably, and volumes minimized to ensure public trust.

Second, cost. Waste management strategies must consider final disposal plans and targets for minimizing waste from the very beginning. This includes treatment methods, systems, processes, storage for intermediate stages, logistics, and space requirements. Planning for these factors early ensures correctly scaled treatment and storage solutions, prevents bottlenecks, and avoids overspending. This approach reduces waste volumes sent to intermediate storage and ultimately lowers the volumes requiring final disposal.

By integrating sustainability and cost considerations from the start, you achieve lower OPEX while maintaining transparency and public trust. The early planning of waste logistics and operational space is crucial to designing efficient and sustainable new-build projects. Estelle mentioned that EPR designs now allow more space for operations and maintenance, which is an excellent example of this approach.

Nathalie:

We went through the lessons learned questions. Now let's see how, in addition to this lessons learned from the previous project, how can we include some innovation in our upcoming new projects.

Candu Energy announced in 2023 the launch of CANDU MONARK, a generation 3+ of 1000MW reactor. The technology leverages heavily past CANDU design. Do you have some insights to share with us regarding innovation considered in the deployment of future project?

Julianne den Decker:

I would say this really builds on many of the topics that have already been discussed. It's about finding the right balance between incorporating elements that are proven and well understood, and introducing innovation. These are very complex machines that need to operate reliably for 60 to 80 years, so it's essential that operators are comfortable with the technology.

For example, operators want to maintain the same fuel supply. In the case of CANDU reactors, we refuel online, using a very complex refuelling machine that must operate with extremely high reliability.

Over the years, we've accumulated a lot of lessons learned on how to improve these systems. What operators generally do not want in a new design is something completely new and uncertain. So the challenge is how to introduce innovation while preserving features that have been proven over decades.

With CANDU MONARK, we have deliberately kept the same fuel channel design and many of the key features of the fuel handling system. At the same time, we have introduced targeted innovations. One particularly interesting feature of CANDU reactors is their ability to produce medical isotopes while the reactor is operating. In older plants, isotope production relied on add-on cooling systems. With CANDU MONARK, this capability has been integrated into the design from the very beginning, making isotope production easier and more flexible, and allowing operators to produce a wider range of isotopes.

Overall, this approach allows us to maintain familiar, proven features so that operators see MONARK as an evolution rather than a completely new technology, while still incorporating innovations that improve performance and flexibility.

Nathalie:

Estelle, the EPR2 fleet represents a great opportunity to deploy innovation in both design and construction. Could you share with us some of the key areas you are targeting?

Estelle Obert:

The first objective is to replicate what has already been used and has performed well in the past. Innovation can then be introduced during the design and construction phases, but it also continues throughout the operating phase of a nuclear power plant. I myself was Managing Director of an EPR plant in France, and I can say that operating teams are able to innovate even on reactors that are already 20 years old.

For example, we have developed new systems and AI-based tools to improve the management of electronics. This shows that innovation does not stop once the plant is built, and it's important to keep that in mind.

Innovation is really a capability, or a talent. For EPR2, we are focusing on innovation in two main areas. The first is design. Thanks to AI and IT tools, our objective is to improve data communication between teams. Interfaces between teams are often where issues or delays can occur, so improving this is critical.

We are now using a 4D model for design, not just 3D, but with the schedule integrated into the model. This innovation helps technicians and engineers in their daily work, making design activities easier, more efficient, and more attractive. This is especially important for younger generations, who are looking for engaging and meaningful career paths.

We also aim to eliminate tasks that do not add value. For instance, in design activities such as the so-called "green box," engineers may need to check thousands of drawings in a 3D model to ensure there are no clashes. AI is extremely useful for this type of task. It can detect potential clashes, highlight the issues, and allow engineers to simply validate or reject them, which significantly simplifies their work.

Innovation is also reflected in the way we organize and manage projects. We are changing how we work with industrial partners through what we call extended enterprises. We bring partners into a shared working environment much earlier in the project lifecycle than we did in the past.

For example, we are already working closely with the four main contractors to develop more efficient construction methods. We will apply the same approach to the installation of high-tech equipment and later to commissioning activities. Innovation therefore spans the entire lifecycle of the plant, from design and construction through to commissioning and operation.

Nathalie:

Lou, as Executive Vice President for R&D and Innovation, could you share some insights on the advanced construction methodologies being considered to secure and optimize project timelines and costs for large nuclear units? You have extensive experience in this area at Westinghouse and how do you see innovation, particularly in construction methodologies, evolving?

Lou Martinez Sancho:

I would highlight two major technology areas that are being used today. The first one is Artificial Intelligence. The good news for the nuclear industry is that we have a very large amount of data, which allows us to implement AI tools in a very safe and controlled way.

The second area is materials. I'm deliberately starting at the technology level, because we can't really talk about advanced construction unless we master the fundamental building blocks: the digital side and the materials side. Once those are in place, you can move toward additive concrete, robotics, and automation.

In a way, we are working on two major sets of building blocks, and we are driving significant

progress in both. AI tends to get a lot of attention because it is very visible and powerful. We can already do many things with it. For example, at our booth you can see how we apply AI specifically to the construction of AP1000 projects. This is possible because the design is fully modular, and that modularity is a key enabler of advanced construction.

We work with partners such as Google Cloud and Databricks, but we also use very specific, in-house AI tools throughout the entire lifecycle, from design to construction, and through operations and customer support. This significantly accelerates integration and execution.

On the materials side, our industry is traditionally very conservative. In material science, we are often quite advanced in analysis and qualification, but when it comes to construction materials, especially for nuclear applications, we tend to be cautious. There is only a limited range of concrete types that are approved by regulators for nuclear use.

That said, while the nuclear island itself is highly constrained, there are many auxiliary buildings where we have more flexibility to innovate. In addition, new projects, such as microreactors, SMRs, and designs like the AP300, act as strong innovation accelerators. They allow us to test and learn, and then transfer those innovations to larger projects over time.

We are also working closely with start-ups, including some present here today, on technologies such as 3D concrete printing. This may sound futuristic, and it is not something we are deploying at scale today, but we need to start the R&D work now. Especially for SMRs, this could become very relevant in the future.

There are two key aspects to this technology. The first is the additive concrete material itself, we have already produced some very impressive structural blocks. The second is reinforced concrete and how reinforcement is integrated. This changes construction sequencing completely compared to traditional nuclear construction. That's where digital tools and AI become essential: starting from the BIM model, defining sequences, programming robots, and ensuring everything remains fully compliant with regulatory requirements.

We are also looking at new types of reinforcement, including ceramics and advanced metallic materials. Over the next 10 to 15 years, these innovations could represent a major asset for the industry, particularly for structures requiring enhanced protection. The research is still at an early stage, but it is progressing. We already have early demonstrators developed with partners, including within Westinghouse, and I strongly believe this is a key direction for the future of nuclear construction.

Nathalie:

The nuclear industry is complex, and sometimes it is more efficient to replicate what already works rather than to optimize and innovate. From an operator's perspective, what kind of balance do you expect between lessons learned and innovation?

Anni Jaarinen:

A lot has already been said about innovation, but from my role in Nuclear Services at Fortum, I can share a slightly different perspective. As mentioned, we are currently working on our own new-build pre-project. We are assessing whether to invest in new nuclear capacity in Finland or in Sweden. At this stage, we have downselected three technologies: the Westinghouse AP1000, the EDF EPR, and the PWRX-300 from GE Hitachi. So, I'm very pleased to hear from Lou and Estelle about the innovation activities underway within the companies behind these technologies.

From an operator and owner perspective, risk mitigation is absolutely critical in new nuclear projects. In our pre-project phase, we are therefore working on several topics to derisk the project as early as possible. When it comes to technology derisking, this is really where our approach to innovation comes in, but it is more about ways of working and processes than about technology itself.

Concretely, we have started a pre-licensing process for all three technologies. The objective is to create a joint discussion platform involving the technology provider and the Nordic regulators. This means having the Finnish regulator, STUK, and the Swedish regulator, SSM, around the same table to discuss the design features of the technologies at an early stage.

This approach helps ensure that the design can be justified from a regulatory perspective and, most importantly, that we can avoid late design changes, as Lou mentioned earlier. Avoiding design changes and achieving a harmonized design across the Nordics is a key objective for us. That is precisely why we are investing effort in pre-licensing.

From an owner's perspective, this way of working can be seen as a form of innovation in itself, an innovation in project preparation and risk reduction, implemented very early in the project lifecycle.