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BIG PICTURE
Nuclear fuel factory

YGN
Swedish YGN visit

Nuclear Future

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NUCLEAR SUBMARINES

PEOPLE

LEADERSHIP, DEI AND ACADEMIA

NET ZERO

FUNDING NEW NUCLEAR



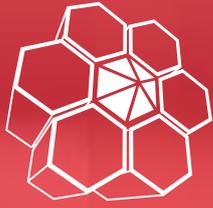
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FASCINATING INSIGHTS SHOW THE DEPTH AND BREADTH OF OUR INCREASINGLY DIVERSE SECTOR

I hope you have all enjoyed an excellent summer. Even within this typically quiet period, there continues to be significant activity in the UK nuclear sector following the Chancellor's statement from the Spending Review, with several announcements including: the Final Investment Decision for Sizewell C; an interim report from the nuclear regulatory taskforce on regulatory reform, identifying key opportunities in streamlining the regulatory process; and the Northwood Declaration between France and the UK on the strategic nuclear deterrent.

This edition of *Nuclear Future* highlights the depth and breadth of activities covered by the nuclear industry, including waste, materials, energy, defence, security and finance. This shows just what a huge variety of roles and associated responsibilities there are across our sector, and underlines the importance of ensuring that our workforce is full of skilled people to carry out the myriad of roles available.

The Nuclear Institute now has more than 5,000 members and we recognise the key role we can play through many of our activities, including: the nuclear professionalism standard; chartership, membership and fellowship awards; mentoring, learning and CPD programmes; the activities run by our engaging branches and Young Generation Network; and the provision of NI endorsements for academic programmes, together with our Nuclear Societies affiliation scheme.



Fiona Rayment

In this edition, we focus on fuelling the fleet of our nuclear submarines; offer insight into how private financing of nuclear can enable our net zero ambitions; hear from academia on the importance of industry collaboration; investigate the role of leadership in developing new facilities; and find out about the ongoing work of Racial Equality in Nuclear.

This edition's cover provides some fascinating industry insight, with a behind-the-scenes look at the vital work being carried out at Sellafield from its CEO, Euan Hutton. As I mentioned, this is a very diverse industry...

Yours,

Fiona

GET PUBLISHED IN THE JOURNAL

Since the inception of the British Nuclear Energy Society in the 1950s, readers of *Nuclear Future* and its predecessors have been able to read technical papers on contemporaneous issues facing the nuclear sector.

Nuclear Future welcomes papers across a wide spectrum of nuclear-related topics, including science, engineering, medicine, safety, security, non-proliferation safeguards, regulation, law, economics, human factors, and project delivery. All published papers are registered with a DOI, ensuring they are accessible for national and international citation. Each year, the Nuclear Institute recognises excellence through the prestigious Pinkerton Prize, awarded to the most outstanding paper. Submission details can be found in the Journal section.

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“If you play on the word significance, what is Sellafield? It's doing many things of significance...”

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New group launched to help streamline industrial nuclear

A new consortium aimed at accelerating the deployment of advanced nuclear heat and power solutions for industrial applications has been launched by the global vendor-neutral technology and standards organisation The Open Group.

The Industrial Advanced Nuclear Consortium includes founding members from Chevron, ConocoPhillips, ExxonMobil, Freeport-McMoRan, Nucor, Rio Tinto and Shell.

The consortium will aim to leverage combined integration and project delivery expertise to define the requirements for the application of nuclear technology to provide process heat and power for their

respective industries. Its primary objectives include: standardising interfaces and sourcing terminology; adopting risk-appropriate design practices; and developing open frameworks and business guidelines.

Working with technology providers, EPC companies and the wider industry, the consortium plans to: advocate for the alignment and streamlining of nuclear regulatory approval and permitting processes with industrial facility project timelines; collaborate across the nuclear ecosystem to standardise interfaces between nuclear and industrial facilities; and promote business models for the delivery of

nuclear-generated heat and power to reduce costs and improve schedules.

Steve Nunn, President and CEO of The Open Group, said: "There is an urgent need to better leverage nuclear energy to address the application of heat and power solutions. We believe an open-architecture approach can enable cost-effective solutions that can be replicated to drive this adoption. By bringing together large industrial end users and the supplier community, we can draw on the huge amount of expertise in project delivery, reduce costs and schedule uncertainty, and deliver nuclear projects that serve the needs of the industry."

SOURCE: WNN

Aalo breaks ground on experimental reactor

Aalo Atomic has broken ground at a site next to Idaho National Laboratory's Materials and Fuels Complex for construction of its first experimental extra modular nuclear reactor, the Aalo-X.

The company was selected as one of the advanced reactor projects to receive support under the US Department of Energy's (DOE's) Nuclear Reactor Pilot Programme.

Aalo plans to complete construction and achieve criticality by 4 July 2026, the



goal date set by the DOE for at least three test reactors to reach criticality under the programme, to expedite the testing of advanced reactor designs it announced in June.

The initiative is part of the Reforming Nuclear Reactor Testing at the DOE executive.

"Our selection is a significant catalyst for achieving our goal of going from 'founding to fission' in less than three

years – a feat many deemed impossible just a year ago," said Aalo Atomic CEO and co-founder Matt Loszak.

He added that the ground-breaking ceremony was "a testament to the potential that can be unlocked when public entities and private companies partner together in the critical interest of the nation".

SOURCE: WNN

Aalo plans to complete construction and achieve criticality by 4 July 2026"

NEWS IN BRIEF

Norwegian nuclear project developer Norsk Kjernekraft and energy developer Ocean-Power are to cooperate on the development of concepts of floating nuclear power plants based on small modular reactors.

China's National Nuclear Safety Administration has issued a construction licence for Units 1 and 2 at the Jinqimen nuclear power plant in Ningbo, Zhejiang province, clearing the way for initial concrete to be poured for the foundation of the reactor building of the first unit.

The Indian government has set out the key features of its Nuclear Energy Mission to achieve 100 GWe of nuclear capacity by 2047, featuring plans for new large-capacity reactors, as well as small modular reactors.

The US Nuclear Regulatory Commission has revised the duration of its licensing design certifications from 15 years to 40 years, extending Westinghouse's AP1000 approval to 2046.

US microreactor developer Last Energy said it remains on track to obtain a site licence decision for its South Wales project by December 2027 after completing a Preliminary Design Review with UK regulators for its PWR-20 design.

Westinghouse has signed memorandums of understanding with six UK suppliers to support nuclear new-build projects based on its AP1000 and AP300 reactor technologies in the UK and around the world.

NEWS IN BRIEF

The Heysham 1 and Hartlepool advanced gas-cooled reactor nuclear power plants have been given a lifetime extension of 12 months by operator EDF, enabling them to continue generating electricity until March 2028.

The UK's Nuclear Decommissioning Authority has been allocated £154 million to develop specialised capabilities for plutonium disposal. The five-year investment will allow the group, working with supply-chain partners, to design, install and operate specialist laboratory facilities at Sellafield.

US-based nuclear fusion firm Commonwealth Fusion Systems has revealed that its latest Series B2 funding round has raised around \$3 billion in capital since it was spun out of the Massachusetts Institute of Technology in 2018 – about one-third of the total capital invested in private fusion companies worldwide.

DID YOU KNOW?

The Curiosity and Perseverance Rovers on Mars use Radioisotope Thermoelectric Generators (RTGs) to provide reliable energy in the harsh environment. Dust, cold and lack of sunlight would cripple solar-powered machines, but Perseverance's RTGs – which are small nuclear batteries powered by decaying plutonium dioxide – are designed to last around 14 years, with zero maintenance.

Source: NASA

Task force calls for reforms to UK nuclear regulation

An independent government task force has concluded its investigations with a call for a “radical, once-in-a-generation” reform of the UK’s nuclear regulatory system to remove potential barriers to new nuclear projects, after describing the system as “unnecessarily slow, inefficient and costly”.

The task force, announced by the Prime Minister in February, was led by John Fingleton, former CEO of the Office of Fair Trading, with the objective of speeding up the approval of new reactor designs and streamlining how developers engage with regulators.

The report stated: “Over time, the regulation of civil and defence nuclear programmes has become increasingly complex and bureaucratic, leading to huge delays and ballooning costs, often for marginal benefit. With the UK’s ambitious civil and defence programmes set to expand to meet energy security, net zero and deterrent demands, a reset is needed.”

The report called for change in “several critical

areas” while maintaining the highest safety standards. This includes eliminating overly complex and inconsistent regulatory processes, risk-averse cultures and outdated planning frameworks.

The taskforce has identified six areas where it sees the greatest opportunity for a radical reset. It now intends to build on the “emerging thinking” set out in this interim report and work with stakeholders to continue fleshing out potential recommendations, which will be published later this year.

Fingleton said: “Our interim report identifies our main concerns with the current system, which we think is not fit for purpose, with a view to recommending a once-in-a-generation reset. We now

invite views from interested parties on what solutions will better enable the UK to achieve the huge benefits nuclear power offers.”

The Office for Nuclear Regulation (ONR) said it recognises the task force’s early identification of “some regulatory challenges amid the current growth of the nuclear sector” and will further develop its enabling approach to ensure it “regulates proportionately”.

ONR Chief Executive and Chief Nuclear Inspector Mike Finnerty said: “Our discussions with the task force have been extremely productive. We will continue to work with the team, providing further regulatory expertise to help inform the final report in a way that supports innovation.”

SOURCE: WNN

The regulation of civil and defence nuclear programmes has become increasingly complex

ONR Focus: Grant awarded to support AI deployment

The UK’s Office for Nuclear Regulation (ONR) has been awarded more than £260,000 by a government office to support the deployment of AI in nuclear installations. The project will run for six months and will focus on AI in computer vision and data classification, using sandboxing – isolating and observing potentially malicious or untrusted computer code in a controlled, separate environment – to explore how

regulation can support the industry to safely realise the potential benefits of AI.

The project will explore examples of how AI can be used to analyse, interpret and categorise data in nuclear installations. It will focus on test cases such as interpretation of weld radiographs, which is especially relevant to new-build and operating facilities, and the use AI for nuclear waste characterisation,

including determining waste properties and sorting and segregating intermediate-level waste from low-level waste.

ONR said it was “open to any ideas that fall within the remit of the project”. Paolo Picca, the ONR’s Innovation Lead, said the project will provide the UK nuclear industry with the opportunity to come together and discuss key enablers of innovation and how regulation can support the implementation of innovative solutions.

Heating SMR to be assessed



The developer of a new water-cooled SMR with a thermal power of 30 MW, specifically designed to supply urban heating networks with carbon-free energy, has signed a letter of intent for the potential installation of a module at a site in southern France, for possible connection to the centre's heating network.

The agreement, between developer Calogena and the French Alternative Energies and Atomic Energy Commission (CEA), could see

the company's CAL30 module, which will operate at low pressure and low temperature, deployed on the CEA's site in Cadarache as early as 2030.

The CEA is a public research organisation that plays a key role in nuclear innovation, notably by supporting the French industrial sector, and major research programmes. Its Cadarache site is dedicated to research platforms and technological development in carbon-free energies.

SOURCE: WNN

University project aims to boost UK supply of nuclear graphite

Four British universities have been awarded funding to develop critical technologies in support of next-generation nuclear energy technology deployment and address two of the UK's most pressing nuclear challenges: securing a sustainable supply of nuclear graphite; and managing irradiated graphite waste.

Most power reactors in commercial operation use light or heavy water as a moderator, but advanced reactor designs, including high-temperature gas-cooled reactors and molten salt reactors, use graphite.

The five-year ENLIGHT (Enabling a Lifecycle Approach to Graphite for Advanced Modular Reactors) programme,

led by the University of Manchester in collaboration with the universities of Oxford, Plymouth and Loughborough is supported by an £8.2 million grant from UK Research and Innovation's Engineering and Physical Sciences Research Council, higher education institutions, and £5 million from industry partners.

It will seek to: develop processes for decontaminating, recycling and reusing irradiated graphite; design new graphite materials to withstand extreme conditions in AMR environments; and understand how these materials behave in novel AMR conditions to improve its lifespan.

SOURCE: WNN

ATOMIC HABITS BOOK CLUB

Recommendation

The 'Atomic Habits Book Club' offers member recommendations on favourite books, made available with exclusive discounts. To find out more, visit <https://nuclearinstitute.myshopify.com/collections/book-club-recommendations>

Ichi-F: A Worker's Graphic Memoir of the Fukushima Nuclear Power Plant

by Kazuto Tatsuta

Nominated by Andy Meek: "Kazuto Tatsuta was an amateur artist who signed up for the dangerous task of cleaning up the Fukushima Daiichi Nuclear Plant, which the workers came to call 'Ichi-F'. This is the story of that challenging work, of the trials faced by the local citizens, and of the unique camaraderie that built up between the mostly blue-collar workers."

The strongest earthquake in Japanese history hit the Tohoku region on 11 March, 2011. In the aftermath, Japan experienced its worst nuclear disaster at the Fukushima Dai-ichi (Fukushima #1, or

'Ichi-F') nuclear plant. One of the workers in the clean-up effort gives an insider's look in this graphic memoir.

This is a unique first-person account of the hard grind of nuclear clean-up operations at the working level, with all the encumbrance of administration, safety precautions and procedures. Seen through the eyes of an artist, this humane story creates a vivid sense of place in a way that text and technical descriptions cannot.

This book is now available in our book store at a special discounted price – and remember, members can get a further discount.

Newcleo scales back UK operations

Reactor developer Newcleo has suspended its programme to develop lead-cooled fast reactors in the UK and will reduce its 150 staff to a smaller team that will maintain its presence in the UK. The French company said this would enable it to "concentrate the group's resources on territories committed to realising a closed fuel cycle (including the reuse of spent nuclear fuel) and those who are more substantively supportive of the development of AMR technologies".

Newcleo headquartered itself in the UK in 2021 and says it had "engaged with successive

government administrations" in relation to accessing the UK's stock of stored plutonium, which it planned to recycle for use as new fuel for its reactors.

In January, however, the UK government announced that its stockpile of 140 tonnes of civil plutonium – stored at Sellafield in Cumbria – will be immobilised and disposed of in a geological disposal facility (see other news story).

Newcleo relocated its headquarters to Paris last year, but its continued presence in the UK will allow it to "ramp up its activity should the outlook for AMRs in Britain improve".

SOURCE: WNN

Microsoft WNA membership a 'game-changing moment'

Microsoft has become the first of the global tech giants to join the World Nuclear Association (WNA), underscoring the growing recognition of nuclear energy as an essential foundation for powering the digital economy and achieving climate goals.

It has signed long-term agreements for nuclear partnerships, including a 20-year power purchase agreement with Constellation Energy to restart the Crane Clean Energy Center – formerly known as Three Mile Island Unit 1. Microsoft also has one of the first power purchase deals with fusion energy technology company Helion.

"Microsoft's membership

of the Association is a game-changing moment for our industry," said WNA Director General Sama Bilbao y León. "When one of the world's most innovative technology companies recognises nuclear energy as essential to their carbon-negative future, it sends a powerful signal."

Bilbao y León said the partnership promises to "accelerate nuclear deployment at the scale needed to meet climate goals and the growth in energy demand from data centres" and added that nuclear energy "isn't just part of the technology sector's energy strategy - it's essential to it."

SOURCE: WNN

Could nuclear waste power future fusion?

Researchers at US-based Los Alamos National Laboratory have unveiled simulations showing how radioactive nuclear waste could be repurposed to generate tritium, the rare hydrogen isotope that fuels nuclear fusion, suggesting that decades of stored waste could help unlock cleaner, virtually limitless energy.

Tritium is produced as a byproduct in the heavy water used as moderator and coolant in Candu reactors, with a reported 130g of tritium generated annually in a typical reactor. A single 1,000 MW fusion reactor would require more than 55 kg of tritium per year,

far beyond current supply.

Physicist Terence Tarnowsky's proposal centres on accelerator-driven systems that bombard spent nuclear fuel with particles. This, he says, can trigger reactions that generate neutrons, which can then be harvested to produce tritium through a series of nuclear transitions.

Simulations suggest that a 1,000 MW system could produce about 2 kg of tritium annually. A key advantage of the system would be production efficiency, with more than 10 times as much tritium created as a fusion reactor at the same thermal power.

SOURCE: Nucnet

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BY THE NUMBERS:

Uranium mining

In the past 60 years, uranium has become one of the world's most important energy minerals. It is mined and concentrated similarly to many other metals and used almost entirely for making electricity, with a small proportion also used for medical isotopes and marine propulsion. Here are some of the numbers behind it.

92 The atomic number of uranium, meaning that it has 92 protons

6 The number of naturally occurring isotopes containing uranium – of which the most common is U-238, with a relative abundance of 99.3%

0.7 The percentage of naturally occurring U-235, which is used in nuclear power stations

67,000 The current demand for uranium, in tonnes per year

5,925,700

The amount of uranium, in tonnes, that exists on the Earth and is feasibly available and financially viable through mining, as estimated in 2023

52 The percentage of the world's uranium that exists in the three highest-resourced countries – Australia (28%), Kazakhstan (14%) and Canada (10%)

0.1 The percentage of uranium typically found in mining ore – greater than 1,000 parts per million – although in some Canadian mines it is as high as 20%

85 The percentage of uranium, by mass, found in the uranium oxide concentrate material known as yellowcake – the raw material for fuel production



20 The total number of countries that have some form of uranium mining

57 The percentage of the world's total uranium currently produced by the top 10 uranium mines – in Canada (1), Namibia (2), Kazakhstan (4), Australia (2), and Niger (1).

6,928 The amount of uranium, in tonnes, that was produced by the largest-producing uranium mine, Cigar Lake in Canada in 2022 – 14% of the world's total

46 The percentage of uranium that comes from conventional open pit and underground mining, with around 50% from in situ leach (ISL) and 4% recovered as a by-product of other mining

600 The depth, in metres, of some of the world's deepest underground uranium mines

90 The number of years that the existing measured uranium resources will last, if used at the current rate of consumption

SOURCE

World Nuclear Association <https://world-nuclear.org/information-library/nuclear-fuel-cycle/mining-of-uranium/uranium-mining-overview>

To join, volunteer and get involved, find your nearest branch on the NI website and get in touch: www.nuclearinst.com/NI-Regional-Branches

Hidden Disabilities Sunflower Network

NI HQ

Contributor: James Barker

The Nuclear Institute and YGN have joined the Hidden Disabilities Sunflower Network, supporting its strategic aims of fostering a truly inclusive and representative membership base. The Hidden Disabilities Sunflower symbol is globally recognised, and is designed to indicate that an individual has a non-visible disability and may require additional support, assistance or patience.

Sunflower lanyards will be made available at upcoming events, starting with the Institute's Volunteer Forum and the YGN Annual Seminar and Dinner this autumn, to promote an inclusive environment and make events more accessible.

Robert Gofton, CEO of the Nuclear Institute, said: "This is a meaningful step in our ongoing commitment to inclusion. In a sector where visibility and safety are paramount, it's just as important to acknowledge the less visible challenges that some of our members and visitors face.

"The Sunflower symbol is a quiet, but powerful way to show that we're here to offer understanding and support, all without requiring anyone to explain themselves. It's a small change that can make a big difference in creating a more welcoming and accessible environment for everyone".



This is a meaningful step in our ongoing commitment to inclusion"

Exceptional talks in speakers' competition

Central England Branch

Contributor: Alex Thomas

The audience at this year's Branch speakers' competition was treated to four exceptional talks capturing diverse topics from the nuclear industry.

The winner, by a narrow margin, was Dev Mistry, for a presentation titled 'Strategic Stability Under Stress: Nuclear Dynamics in Asia', which investigated the evolving security architecture in Asia, shaped by China's projected nuclear expansion and its wavering adherence to 'no first use'. It also considered the impact on India's posture, the cascading effects on regional deterrence with Pakistan, and the growing risks of miscalculation amid

provocations – questioning whether, as India enhances its capabilities, a new arms race is inevitable.

Rubel Miah's 'Burning Truths Windscale's Legacy and the Nuclear Narrative' presentation gave a fascinating insight into the 1957 Windscale fire as both a technical catastrophe and a communications failure. It reflected on how public perception of nuclear energy has been shaped by storytelling – or its absence – and argued for transparent and resonant narratives in rebuilding public trust and driving energy policy forwards.

Ciara Bates offered insight into fusion development, diving

into the design of a matter-injection system at UKAEA's STEP project, in a talk titled 'Fusion on Track: Engineering Insights from Roller Coasters to Plasma'. Adam Way, meanwhile, presented 'Facing Opposition: Making the Case Against Nuclear to Strengthen Advocacy'. This offered a compelling case against nuclear power through economic, environmental and temporal challenges – not to undermine its potential, but to strengthen pro-nuclear advocacy through deeper understanding, urging the industry to engage more meaningfully with dissent and evolve its messaging.

Talking 'Better' About Nuclear Project Management SIG

Contributor: James Barker

Communications around nuclear are changing.

To address this, the branch, in collaboration with the Association for Project Management, is hosting an event called 'We Need to Talk – Better – About Nuclear', in which Professor Adrian Bull MBE HonFNUcl, from the Dalton Nuclear Institute, will provide an expert review of communication and stakeholder engagement from the nuclear industry to the public and other interested parties.

The British public has had a turbulent relationship with the idea of getting energy from splitting atoms. Various, the nuclear world has been seen as peacemaker, polluter, pioneer and power source. The image of nuclear – in the form of power generator, waste generator or deterrent

– is inextricably linked to the worlds of geopolitics, media, environmental issues, public health, risk perception and more.

This talk offers insight into historical perspectives, current trends and future improvements. It will summarise how public attitudes to nuclear have changed from the start of the industry in the 1950s to the present day, and the external drivers that have shaped those views. It will also examine how the way the industry communicates – or doesn't! – could be critical to its future.

The event will take place at the Ridgeway House Hotel in Didcot on Thursday 30 October, with doors opening at 17:30 for an 18:00 start, concluding by 20:00. Light refreshments will be provided.

Discover all about digital Digital SIG

Contributor: Becky Hughes

Building on the sell-out success of the 2024 Digital Conference, the NI Digital SIG is hosting a two-day event at Culham, in Oxfordshire, in October. This will provide an opportunity for professionals to congregate, network and share views on the issues, opportunities and challenges affecting the application and implementation of digital advances in the nuclear sector.

Fusion will be the topic of the opening day, with the second day focusing on Design and Build, including SMR, AMR and large-scale. Delegates are able to attend for either a single day or on both days, and NI members will receive discounted rates. Thank you to sponsors Dassault Systemes (platinum), Digilab and PA Consulting.

Visit nuclearinst.com/events

To find out more about events taking place near you, contact your nearest branch or visit www.nuclearinst.com/Events

Navy STEM training day success

Central England Branch

Contributor: Alex Thomas

HMS Sultan, the Royal Navy's primary engineering training establishment, welcomed 270 students from Year 7 to a full day of STEM learning at its annual SULSTEMIC event, where the Central England Branch ran workshops introducing students to nuclear energy and its importance in meeting our increasing energy needs.

The event introduces young people to Royal Navy engineering and the wider world of science, technology, engineering and mathematics. The role of nuclear in defence was discussed, focusing on the UK submarine fleet and the crucial role played by the Navy's

scientists and engineers, all of whom train at HMS Sultan.

The students explored drone piloting, submarine simulations and helicopter fault diagnosis, while marine engineering sessions offered hands-on experience with generators and ship buoyancy testing. Other STEM professionals from industry contributed demonstrations in AI, 3D printing and thermal imaging, highlighting the latest advancements and practical uses of technology. All attendees were also treated to lunch and a Royal Navy Field Gun display.

The Branch members in attendance challenged students

on their current understanding of the nuclear industry and engaged them in discussions on increasing energy requirements, the need to reduce greenhouse gas emissions and the role of nuclear defence in an increasingly unstable geopolitical landscape.

Captain Mark Hamilton, commanding officer at HMS Sultan, said: "Engineering is where innovation meets practical problem-solving, creating solutions that shape our world. At SULSTEMIC 2025, we're showcasing how the skills learned in school translate into exciting technological applications that power our Navy's operations globally."

Agenda shaping up for 2025 Modelling Conference

Modelling Conference Organising Committee

Contributor: Rebecca Hughes

The eighth Annual Modelling in Nuclear Science and Engineering Conference will take place in London on 6-7 November, with NI members able to save at least £100 on the full ticket price.

The opening day will include a keynote talk from Professor Andreas Kyprianou, Director of the Centre of Mathematical and Computing Sciences at the University of Warwick, who will present on licensing challenges faced by new reactor

designs. This will be followed by a talk on the application of AI in nuclear safety technology from Dr David Luxat, Sandia National Laboratories.

The second day will include keynotes from Catrin Davies, Professor in Structural Integrity at Imperial College, London, and Dr Paolo Picca, from the Office for Nuclear Regulation, who will present a regulator's perspective on the opportunities and challenges of using AI in the nuclear industry.

The agenda will continue to be developed leading up to the conference, which brings together the modelling community to share best practice in techniques to help improve design and operation of nuclear energy generation, processing and storage facilities, including power plants, to protect society by improving the safety of these facilities.

For full information visit nuclearinst.com/events

Ally of the Year award for Branch leader

Central England Branch

Contributor: James Barker

Branch Outreach lead Robin Cowley was Highly Commended for Ally of the Year at the WiN Global Awards in London, for his support of an inclusive workplace at Nuclear Waste Services (NWS). On

LinkedIn, Cowley said: "I rarely talk about my involvement with the NWS Gender Balance Network, as it's more about supporting others than getting recognition. I will also admit to a degree of ambivalence when

it comes to being nominated for an award that, in a perfect world, wouldn't need to exist. Nonetheless, to have my efforts in working towards a more inclusive workplace recognised in this way is really special."

NI University Network launched

North West Branch / NAILS (Nuclear Academic and Industry Liaison Subcommittee)

Contributor: Sophie Cooper

A landmark event on 24 October will see the launch of the NI's new University Network, spearheaded by the North West Branch of the NI – with the University of Sheffield's Applied Nuclear Society at Sheffield (ANSS) joining as the first member of the group.

The ANSS is a student-led organisation dedicated to preparing the next generation of nuclear professionals. Its mission is to create opportunities for industry engagement, enhance the skills of members and promote public understanding of nuclear technologies. By fostering collaboration between students and industry professionals, it serves as a platform for aspiring nuclear specialists to develop their knowledge, networks and career prospects.

Sheffield is the first university to join the network, with various others registering their interest. As well as bringing together societies from across the UK, the network has close ties to NI bodies such as NAILS (Nuclear Academic and Industry Liaison Subcommittee), YGN and the local branches.

The launch event takes place in the Ideas Space (Sir Robert Hadfield Building, S1 3JD) at the University of Sheffield, where attendees will hear technical talks, meet industry professionals, and connect with students with an interest in the future of nuclear technology.

Register your attendance here: <http://bit.ly/4m6fYpe>



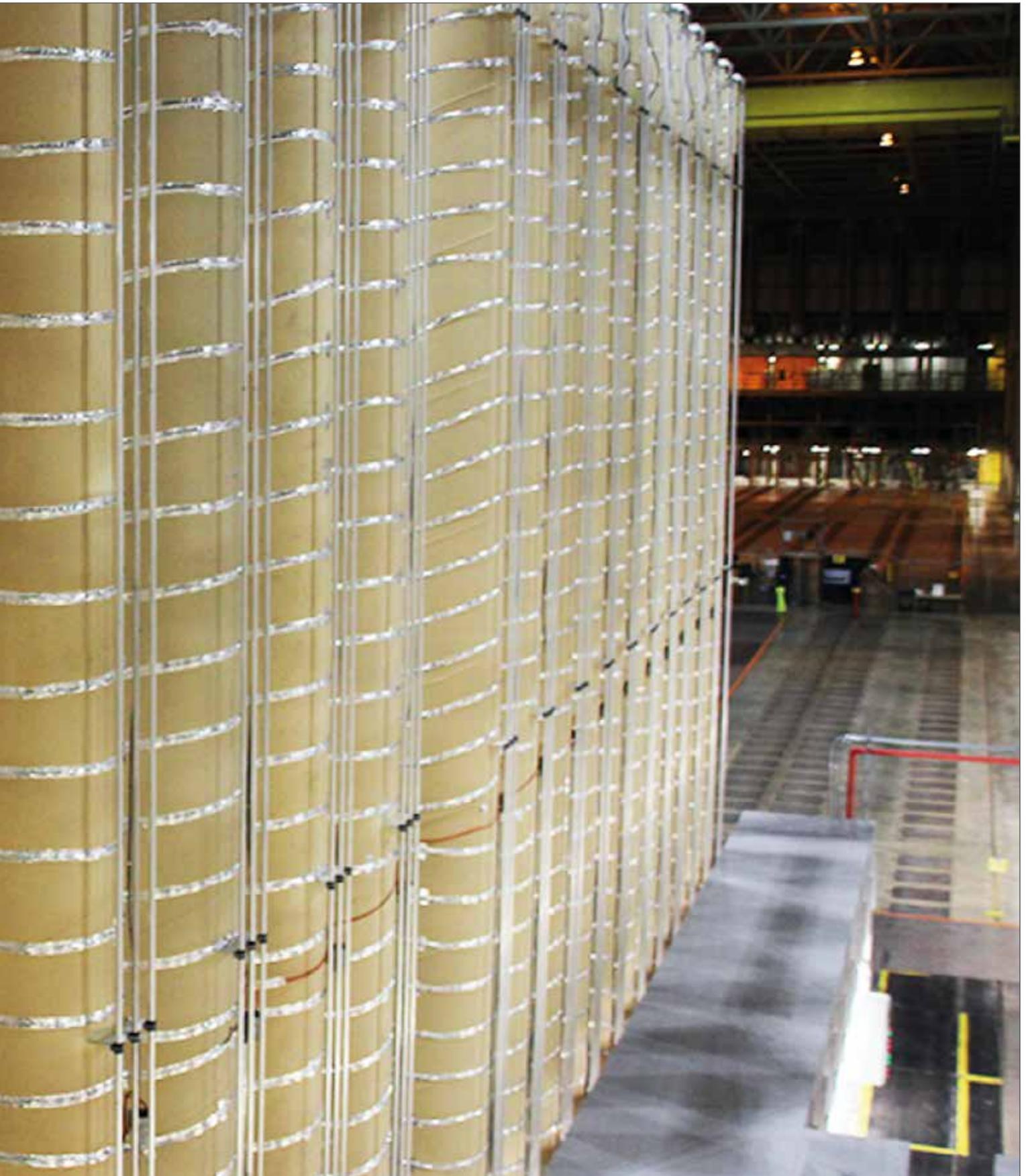
WORLD-FIRST FUEL CASCADE

This is the Piketon Advanced Centrifuge Cascade – a pioneering first-of-a-kind High-Assay, Low-Enriched Uranium (HALEU) fuel production facility in Piketon, Ohio, USA.

As the only source of HALEU enrichment in the Western world, this important development plant is run by the American Centrifuge Operating LLC – a subsidiary of Centrus Energy – and recently entered the third phase of its development.

Phase I was completed in 2023, when the cascade of advanced centrifuges was brought into production, delivering an initial 20kg of product. Phase II then called for the production of 900kg, which was achieved in June. Phase III now sees continued production to 30 June next year, with options for up to a further eight years of production, at the US Department of Energy's (DoE) sole discretion.

HALEU fuel enriched to between 5% and 20% of the fissile uranium-235 isotope will be needed to fuel many of the advanced reactor designs that are under development. The material produced at Piketon will be used as part of the DoE's HALEU allocation process to support the fuel qualification and testing of advanced reactor designs.



Two covers. One publication.

Introducing *The Journal to Nuclear Future* – and how you can be a part of it

As noted in the President's message in the May/June edition of *Nuclear Future*, we have been making some changes to the layout to ensure we are delivering the content you want to read. You will have noticed some further, more significant changes to this edition – namely the 'flip format' cover on the front and back. Now, whichever way you pick up your physical copy, you'll have a front cover to lead you into the edition.

We have made this change to give the technical papers section a greater prominence and highlight its distinct identity from the main magazine.

Since the founding of the British Nuclear Energy Society in the 1950s, *Nuclear Future* and its predecessor publications have provided readers with technical papers addressing the pressing issues of the time. Publishing papers from members in our journal not only showcases expertise but also advances our shared ambitions for energy security, surplus and the practical wisdom needed to shape a sustainable nuclear future.

We are proud to continue this tradition and invite you to be part of it.



WHO CAN WRITE FOR THE JOURNAL?

We warmly invite our members – both individual and company – as well as contributors from academia, industry and government to continue to submit high-quality papers and share expert knowledge with other members. All technical papers are peer reviewed to ensure suitability for publication.

Reflecting our broadening membership base, *Nuclear Future* welcomes papers across a wide spectrum of nuclear-related topics, including:

- nuclear science and engineering
- nuclear medicine
- nuclear safety, security and safeguards
- nuclear law and regulation
- nuclear skills
- nuclear decommissioning
- radioactive waste management
- economics of the nuclear industry
- human factors
- project management and the delivery of nuclear major projects.

While journal articles are often associated with academic researchers, there is equally great benefit for industrial organisations to submit papers for peer-reviewed publication.

The launch of a new facility, technique, product or service can be communicated through corporate channels, press releases etc. but an in-depth paper written for those familiar with the industry offers an additional route to potential customers or collaborators.

Of course, writing and refining a paper requires time and effort from individuals, but it is a valuable professional development opportunity for employees to demonstrate they can communicate technical detail to a specialist audience. It is also an opportunity in itself for collaboration.

As an example, the March/April 2025 edition saw an excellent paper from members of our SMR Special Interest Group discuss issues relating to new SMR siting. This was produced between four authors from four different organisations and could not have been more topical, coming out just ahead of the SMR Competition outcome announcement by Great British Energy – Nuclear.

INTERNATIONAL CITATION

Since the start of 2025, all papers published in the *The Journal* have been registered with a Digital Object Identifier (DOI). This ensures they are accessible for national and international citation – which is of particular



importance and value for academic authors – by providing a permanent and enduring link to the resource, even if URLs expire over time.

DOI registration also means each individual paper now has a unique URL, allowing authors to share their work beyond the *Nuclear Future* readership, boosting citation opportunity and readership. The Technical Editor will provide guidance on preparation of papers and advise on suitable dates for submission of abstracts and papers.

For details on how to submit papers to *The Journal*, please contact the Technical Editor, Dr Alastair Baker, at technicaleditor@nuclearinst.com

PINKERTON PRIZE FOR BEST PAPER

In addition to the benefits of publishing a paper, any published author in *The Journal* becomes eligible for the Institute's Pinkerton Prize. Awarded each year, it recognises excellence for the most outstanding paper of significant technical or scientific merit.

JB (John Brownlie) Pinkerton was the founder of the Institution of Nuclear Engineers (INuCE), which was one of the predecessor organisations that eventually formed the Nuclear Institute.

You may have seen this prize awarded at the NI/NIA Annual Dinner in London, and this year it has been awarded as part of the Nuclear Institute Volunteer Awards in Warrington. All previous winners of the Pinkerton Prize, dating back to the foundation of the Nuclear Institute in 2009, can be found on our Awards and Prizes webpage.

“Publishing papers from members showcases expertise and advances our shared ambitions for energy security, surplus and the practical wisdom needed to shape a sustainable nuclear future”

Pinkerton Prize 2024 winner Carol Tansley, Vice-President, Projects of X-Energy and NI President Professor Fiona Rayment



JOIN THE EDITORIAL COMMITTEE AS CHAIR OR EXPERT MEMBER

The overall strategy and direction of the content published in *Nuclear Future* is led by the Institute's Editorial Committee. Meeting quarterly, it comprises a mix of subject matter experts from all parts of the nuclear industry to act as specialist technical referees and advisers. The committee also provides advice, suggestions and contacts for emerging themes and issues that may be relevant for publication.

We welcome applications for new members of the committee to help continue to drive the relevance, interest and value of *Nuclear Future*. If you're interested in joining the Editorial Committee, please contact the Technical Editor and include your area(s) of expertise.

We are currently looking to appoint a new Editorial Committee Chair to replace Professor Laurence Williams OBE FREng FIMechE FNUcl, whose 11 years of dedicated service in the role have come to an end. The Chair is known as the 'Honorary Editor' of *Nuclear Future* and is appointed by the Nominations Committee.

Laurence is an Emeritus Professor of Nuclear Safety and Regulation, a Visiting Professor at Bangor University Nuclear Futures Institute, a Visiting Research Fellow at Imperial College London, and a member of the High Scientific Council of the European Nuclear Society. Prior to entering academia, he held a number of high-profile roles including for the Nuclear Decommissioning Authority and the IAEA Commission on Safety Standards.

We are incredibly grateful for Laurence's extended service on the Editorial Committee and his commitment to *Nuclear Future*.

Nuclear Future editor Will Gray said: "Laurence has been a tremendous leader, always driving the conversation forward and imparting his fascinating and insightful knowledge to guide the way. The Editorial Committee plays a vital role in the editorial process and has been instrumental in supporting the evolution of *Nuclear Future*, maintaining standards while ensuring it continues to remain current for a new generation of nuclear experts."

For all information on writing for *Nuclear Future*, see the new-look *The Journal* section or visit nuclearinst.com/nuclear-future



Pioneering holistic management at the Future Materials Campus

By Sharif Narouz, Programme Director, Future Materials Campus, AWE

The Atomic Weapons Establishment (AWE) holds end-to-end responsibility for the design, manufacture and maintenance of the warheads that form an integral part of the UK's nuclear deterrent. Its multi-billion-pound Future Materials Campus (FMC) programme will provide the infrastructure and critical capabilities to support this long into the future.

The programme will renew existing facilities for the manufacture of nuclear components and storage of nuclear materials; provide improved science and analysis capabilities; and invest in new capabilities for nuclear material recovery. Having worked on major national projects for Transport for London, Network Rail, Crossrail and others during my career, nothing compares to the scale and complexity of FMC.

SYSTEMS-BASED LEADERSHIP

To meet this challenge, we have spent a significant amount of time designing an approach that balances the tension of delivery with getting the best holistic systems-based outcome. This required us to think about two overlapping principles: how we organise the programme from a delivery standpoint, and how we organise the programme from a management standpoint.

Management considerations include the flow of work instructions, assurance, safety, workforce management and much more, as well as managing external interfaces, governance arrangements and setting the overall strategic direction of delivery. Delivery considerations include how we bring together the myriad partners across the lifecycle of the programme to form a fully integrated delivery organisation.

Untangling the multitude of requirements for these arrangements was a substantial undertaking in itself. My role is to bring together and co-ordinate the many minds needed to create a robust organisational design, including experts in construction, engineering and manufacturing, project managers, commercial and legal teams, safety leads and the wider AWE organisation and various government teams.

I adopted a 'design; test' approach. Experts led in their respective areas, developing ideas and proposing designs, and we'd meet regularly to socialise and test them as a team. My role was to identify and eliminate conflicting demands and iterate the designs through consensus to ensure continual alignment. Testing wasn't limited to internal teams; we also met frequently with industry partners to present potential models and ask for their input to shape the programme they may eventually bid to deliver.

This organisational design is now complete, and its efficient operation will form the bedrock of our long-term success in managing schedule, budget, delivery and assurance.

PERFECT PARTNERS

When working with supply chain companies, it is vital to find partners who mirror your own company values and ways of working at every level. I have seen the industry change over the years in parallel to how it approaches major projects. Historically, supply chain relationships were far more transactional. The core of my leadership ambition at FMC is in ensuring we move away from solely contractual client-supplier relationships and



No single party has all the answers to the challenges we face, so it's critical to work in partnership to identify, contribute and implement solutions that work for everyone"

instead build long-term partner relationships that are mutually beneficial.

No single party has all the answers to the challenges we face, so it's critical to work in partnership to identify, contribute and implement solutions that work for everyone. Projects can't be done alone, yet they are made or broken by the people who deliver them. At AWE, we operate in a more highly regulated environment than most – which puts more pressure and accountability on effective leadership.

Safety and security are at the heart of everything we do. AWE is independently regulated by several organisations including the Office for Nuclear Regulation (ONR); Defence Fire Risk Management Organisation; Defence Nuclear Safety Regulator (DNSR); and the Environment Agency. These require us to meet a significant number of laws and regulations, including having appropriate designs for nuclear plant and equipment, trained and suitably experienced staff and managing nuclear waste safely and effectively.

HUMBLE LEADERSHIP

Teams need to understand a clear vision and purpose of the organisation amid its vastly complex and sensitive work. I try to achieve this by maintaining my own authenticity in the way I communicate, approach problems and pitch what we're doing on FMC. For me, authenticity

is about self-awareness and how that manifests in your work. It's about understanding your own strengths and playing to those, and looking to add others with different strengths needed in your programmes. Authentic leadership is about bringing these diverse and unique teams together and developing an open and encouraging environment so that people actively complement and challenge ideas and delivery.

I also believe in the principle of the incomplete leader. We all have strengths and weaknesses and being part of a diverse and dynamic leadership team, with differing skill sets, allows for differing perspectives in the decisions we make. Thinking about that authentic self-awareness, I know my strengths lie in strategy development, organisational design and team motivation. A team that also features other skill sets needed for the programme helps complete the picture, and it's down to me to lead effectively, motivate and tune them to what we're trying to deliver.

Leading FMC is more than a job to me, it is about contributing towards our national nuclear legacy, and it is a privilege to hold that responsibility. To those who are at an earlier stage of their career and aspiring to one day lead large teams, remember that the journey to successful leadership is paved with resilience and a willingness to embrace challenging ideas.

Building diversity through groups and events

By Richard Metcalfe, Learning and Development Lead, Racial Equality in Nuclear

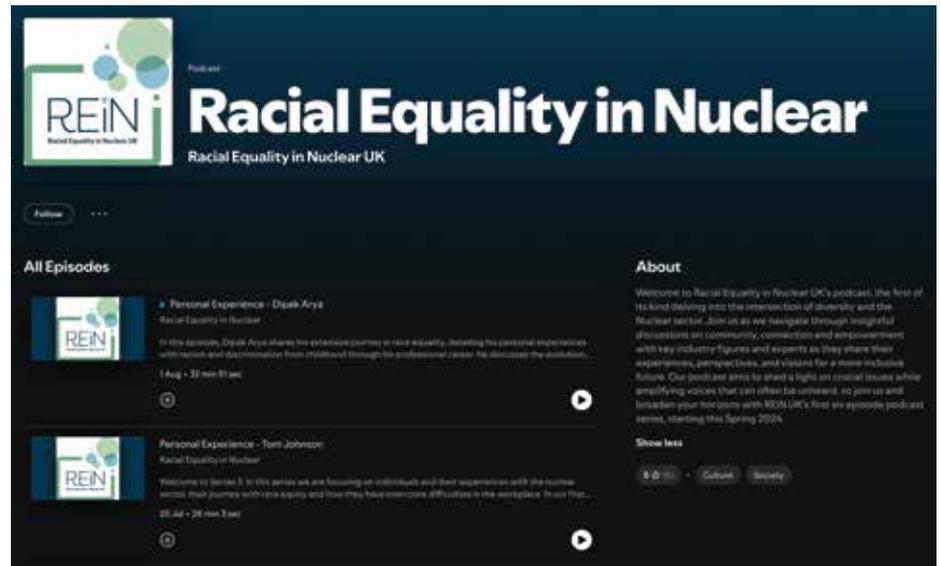
The journey towards being an advocate for marginalised groups is continuous and evolving. This is especially so in the workplace and within industries that have historically faced challenges in diversity, equity and inclusion (DEI). My journey has been marked by many impactful activities and experiences aimed at fostering a more inclusive and equitable environment in the nuclear sector.

Employee Resource Groups (ERGs) are extremely valuable, as they offer a safe space for people from marginalised groups, and allies or advocates, to find a community, share experiences, discuss ongoing issues in the world and raise concerns without fear of retribution. They are open to all and are an asset to any organisation. When run successfully, they support people in bringing their full and best selves to work.

ERGs can be responsible for organising events, in conjunction with their organisation, to allow those who are most passionate to provide input into how culturally significant days are acknowledged and celebrated. In the events I have run as an ERG lead, colleagues have expressed appreciation for the opportunity to share their heritage and learn about others, leading to a more inclusive and cohesive work environment.

Exchanges at events such as 'Bring a Dish' day, for celebrating cultures through food, have sparked conversations about different backgrounds, encouraging curiosity and giving people new experiences in the workplace. This helps everyone to acknowledge that your culture should be celebrated and the importance of it should not be 'left at the door' when you come to work.

Events serve as a critical educational tool for people to understand the disparity of experiences between different groups of people. A session on unconscious bias, for example, can highlight how decision-making and workplace interactions can be influenced by thoughts of which we are unaware and judgements that we cannot control, as well as teaching attendees how to begin to combat this and work towards being more inclusive.



These sessions can lead to difficult conversations and, sometimes, confrontation, and in these moments it is important to acknowledge your level of responsibility and relative privilege – whether it is calling people into a constructive conversation, taking things offline when necessary and if hurtful things are being said, or understanding the reporting lines and how action can be taken.

In the nuclear sector, many people can feel isolated and like they are not seen within the traditional workplace setup – for example, a new joiner moving to Cumbria, where access to halal supermarkets is limited or the primary after-work social event is going to the pub. To keep all employees engaged, and to address the retention challenge that faces the industry, there is a need to amplify the voices of marginalised groups across the sector.

This is where Racial Equality in Nuclear (REiN) comes in. We aim to improve the experience of people of colour in the nuclear sector by providing resources, safe spaces and community. We act as a voice for those who feel they are not heard. We support the improvement of companies' social value propositions by acting as a partner for activities, sharing learning from across the sector and being a critical friend for planned DEI initiatives.

To support this amplification, REiN has started a podcast series that highlights the disparities in experiences for people within the nuclear sector, and acknowledges the journey that people of colour and allies are on. This platform provides a space for individuals to share their stories, challenges, and successes. By bringing these experiences to the forefront, the podcast raises awareness about the unique obstacles faced by people of colour, the crucial role of allies, and the need for targeted interventions to address these issues.

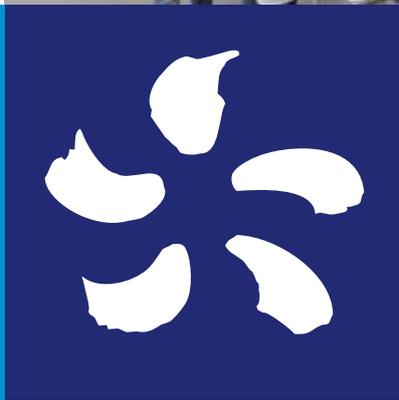
The initiatives run by REiN are aimed at improving DEI within individual companies, but also set a precedent for the industry as a whole. By demonstrating the tangible benefits of a diverse and inclusive workforce, we hope to encourage organisations to adopt practices that will tangibly improve the experience for people from marginalised groups.

The DEI journey is ongoing, and there is still much work to be done. However, the lessons that myself and others have learned provide a strong foundation for continued progress. By promoting awareness, celebrating diversity and amplifying marginalised voices, we can create a more inclusive and equitable nuclear sector, for all of us.



Find out more

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The value of industry and academia collaboration

The future of UK nuclear is driven, in many ways, by the research carried out across the nation's academic establishments – but without a connection between them and the commercial operations that can benefit, there is no progress. Events such as the Universities' Nuclear Technology Forum (UNTF) – one of the oldest nuclear engineering meetings globally – play a vital role in offering a platform for students and early-career researchers to showcase their projects, as well as expand their nuclear networks.

The UNTF is now run annually, with rotating university hosts, having been resurrected post-pandemic in 2022 thanks to the support of the Nuclear Institute and its Nuclear Academic and Industry Liaison committee. That first event back was hosted by Bangor University, then the University of Bristol, with the University of Leeds running it the following year. This time, the baton passed to the University of Strathclyde, in Glasgow, with two days of presentations, talks, poster sessions and networking.

Led by Dr Joanna Renshaw in the Department of Civil and Environmental Engineering, the event, sponsored by Rolls-Royce and the Nuclear Institute, ran in July and brought together 55 delegates focused on seven core research themes: waste management and disposal; decommissioning and remediation; reactors (fission and fusion); recycle and fuels; materials; robotics; and radiochemistry.

The meetings at the event were invaluable for students, who were able to develop connections that would otherwise have been far more challenging to achieve.

The winner of the best oral presentation was Jacob Taylor, an Associate of the Nuclear Institute from Bangor University. His talk on 'Intentional forensics of oxide nuclear fuels' outlined the use of isotopically perturbed dopants as a way to give nuclear fuels a unique and traceable isotopic fingerprint.

"UNTF 2025 was a fantastic opportunity to meet and socialise with researchers in my field," said Taylor. "It provided a great platform to network and invite collaboration,



and the opportunity to interact with industry members gave me an opportunity to discuss my future career aspirations."

THE IMPORTANCE OF COLLABORATION

Interaction between academic researchers and the wider industry is vital to ensure the research and development carried out at universities is focused on directly combating real-world challenges or advancing understanding of new technologies that are commercially relevant for the future of nuclear. To that end, this year's conference was attended by representatives from many major organisations, including Sellafield Ltd, the Nuclear Decommissioning Authority, UK National Nuclear Laboratory and the Office for Environmental Protection.

Stephen Hepworth, from Sellafield Ltd, said: "Attendees of UNTF are normally PhD students and are often funded partially or wholly by industrial organisations that are looking for solutions and to develop subject-matter experts in a particular area. This gives PhD students a fantastic opportunity to make connections, explore the sector and have an impact early on in their career.

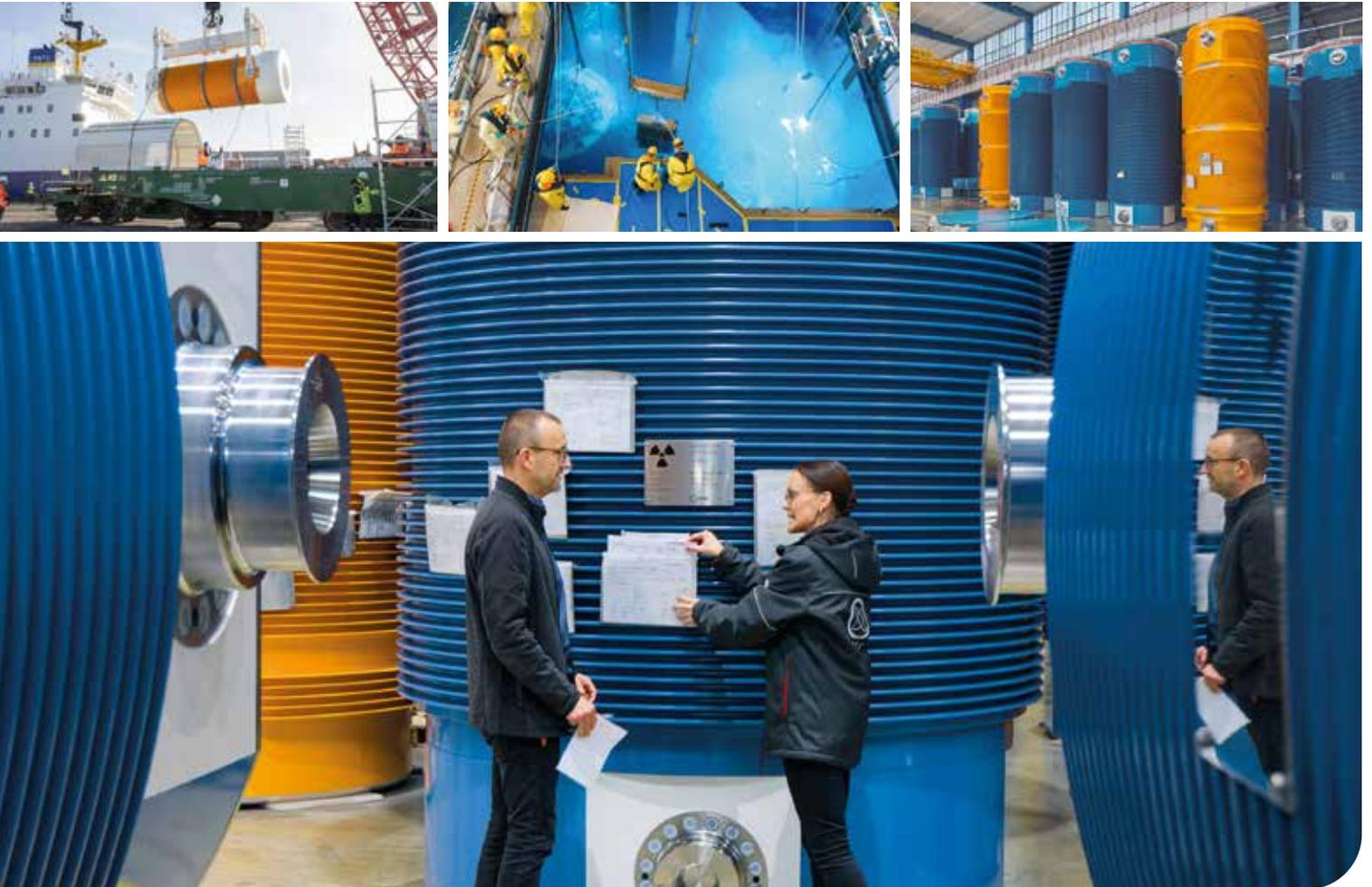
"For industry, it allows them to access the expert knowledge, and often facilities, that are available at universities that they

do not have in-house or could not build capability for easily."

Planning and preparations for next year's UNTF are already under way, with a return to Sheffield for the first time in 10 years. The conference will be hosted by the University of Sheffield on 8-9 July 2026, led by the University's Immobilisation Science Laboratory and SMASH (Sustainable Materials at Sheffield) research groups.

In the meantime, discussions and collaborations from the latest event will evolve, and connections will continue to deliver new opportunities, demonstrating the value – and increasing importance – of bringing the traditionally divergent parties of education and industry together to drive new nuclear innovation.

UNTF provided a great platform to network and invite collaboration, and to interact with industry"



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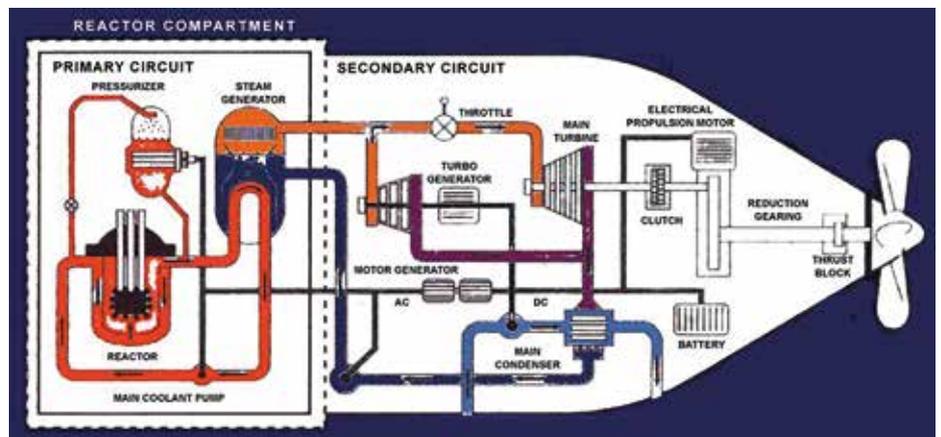
Fuelling the fleet – the reactors and workforce behind the UK’s submarines

By Oliver Armitage, Rolls-Royce Submarines Limited

As a nation, the UK has been designing, building, operating and maintaining nuclear-powered submarines for more than 60 years⁽¹⁾, a fact very few nations can match – and the strategic importance of having this capability cannot be overstated. The signing of the UK-US Mutual Defence Agreement in 1958 was a pivotal moment in the defence capabilities of the UK. It facilitated the exchange of nuclear materials, technology and information between the UK and US, and we’ve not looked back since.

Nuclear propulsion, unlike conventional diesel power, is air independent, quieter (allowing the UK fleet to remain undetected) and removes the need for refuelling throughout the submarine’s lifetime, thus enabling UK submarines to stay submerged for a length of time that is limited only by the amount of food that can be stored onboard.

This capability extends patrol lengths and gives the UK a truly global presence in international waters – but delivering it and sustaining it across decades of service requires more than machinery. It requires people – specifically Nuclear Suitably Qualified and Experienced Personnel (NSQEP) – and as the demand on the UK’s



Layout of the UK submarine’s nuclear reactor plant (2)

submarine programme grows ever higher, the need for nuclear skills is growing fast.

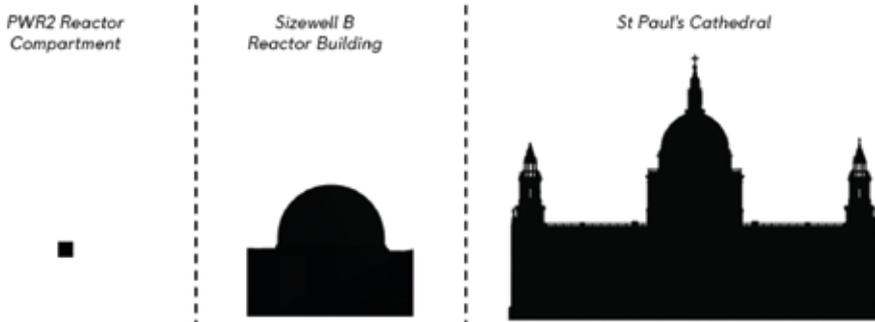
SUBMARINE TECHNOLOGY

The propulsion technology that facilitates this strategic capability is powered by the Nuclear Steam Raising Plant (NSRP). Designed and built by Rolls-Royce Submarines Limited (RRSL) in Derby, the NSRP is part of a wider Nuclear Reactor Plant that, in principle, is no different from the Pressurised Water

Reactor (PWR) technology used to power Sizewell B (the UK’s only operational civil PWR power plant) and Hinkley Point C (the UK’s newest, soon to be operational, civil PWR power plant).

A PWR nuclear reactor works by heating pressurised primary coolant, which, in turn, transfers its heat to a secondary circuit to create steam via a large heat exchanger called a steam generator. This steam is used to generate electricity via a turbogenerator. The obvious difference that separates the naval NSRP from land-based civil power applications is the use of a steam turbine to rotate a propeller shaft to power the submarine through the water.

Another striking difference is the size and power density. The surface area to volume ratio of the PWR2 plant is far higher than that of Sizewell B and, as such, so is the neutron leakage from its reactor core. This means that the difference in power from Sizewell B to PWR2 does not correlate with the difference in size, but, remarkably, the NSRP technology has the same high-level functionality as that in Sizewell B – to produce steam to ultimately create power.



Roughly to scale – Based on an 10.7 m hull diameter of an astute class submarine (3)

Size comparison of a PWR2 reactor compartment

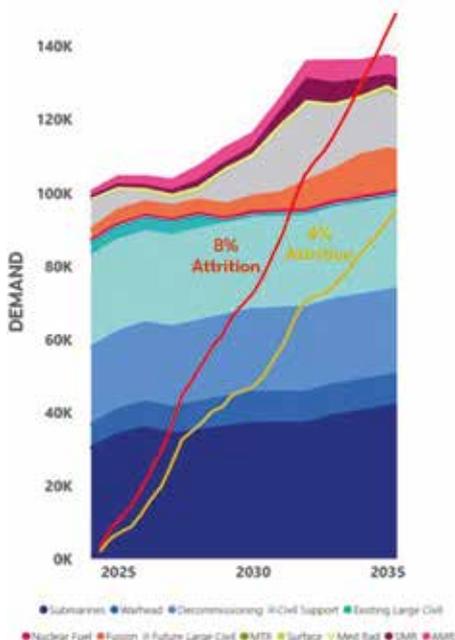
Some of the less obvious differences separating the designs of a naval PWR from its civil-power counterparts are driven by the requirements placed on a submarine to be battle ready and a dynamic military asset. These requirements lead to a huge divergence in design from the civil power plants, including:

- **Dynamic operating environment:** Submarine reactors must tolerate rapid power changes while also remaining operational through a large spectrum of changes in pitch and roll
- **Fuel longevity:** Modern submarine reactors are designed to last several decades without the need for refuelling
- **Battle resilience:** Naval systems are designed to withstand shocks from potential torpedo strikes, flooding, and seawater ingress to components within the reactor.

The engineering challenges associated with achieving all of this in such a small space have driven decades of UK innovation to power Royal Navy submarines more than 18 million miles across the globe⁽⁴⁾. But the future brings even greater demands.

NEW SUBMARINES, NEW CHALLENGES

The submarine programme is entering a new era. The UK's next-generation deterrent, the Dreadnought Class, is due to hit the water in the early 2030s⁽⁵⁾. Powering each of these four ballistic missile submarines is RRSL's latest PWR3 reactor – a generational leap in capability, safety and endurance.



Nuclear industry cumulative recruitment requirements by sector



THE UK'S SUBMARINES

The Royal Navy operates Attack Submarines (SSN, Ship Submersible Nuclear) and Ballistic Missile Submarines (SSBN, Ship Submersible Ballistic Nuclear) – and both are key components of the UK's defence and national security.

ATTACK SUBMARINES (SSNS)

These conventionally armed, nuclear-powered submarines protect the UK's nuclear deterrent from hostile activity and detection. They also support global operations, contributing to the protection of maritime task groups and providing global strategic intelligence and reconnaissance gathering.

Astute Class

These vessels measure 97m in length, with a displacement of 7,400 tonnes, and are fitted with advanced sonar, carry Spearfish torpedoes, and can deliver Tomahawk Land Attack Cruise Missile capability. They are the first to use high-specification video technology to scan the horizon, rather than a traditional optical periscope.

SSN-AUKUS

Currently under development, in partnership with the US and Australia, for the Royal Navy and Royal Australian Navy, the design and manufacturing process of SSN-AUKUS will be a complex, multi-decade undertaking. Construction of the UK's vessels will take place principally at BAE Systems' Barrow-in-Furness shipyard.

BALLISTIC MISSILE SUBMARINES (SSBNs)

These nuclear-armed and nuclear-powered submarines maintain the UK's Continuous at Sea Deterrent, guaranteeing the UK's safety by patrolling the seas at all times since April 1969.

Vanguard Class

Larger than the Astute Class, the Vanguard Class submarines measure around 150m in length and have a displacement of 15,900 tonnes. Each one is armed with Trident II D5 missiles carrying UK nuclear warheads. They are powered by a Pressurised Water Reactor and fitted with two periscopes, which are combined into an optronic mast on the submarine's fin.

Dreadnought Class

The Dreadnought Class will begin to replace the Vanguard Class from the early 2030s. Each vessel will be of similar size and displacement, but the design will incorporate a range of scientifically advanced electronic systems, sensors and tactical weapons, as well as housing the Trident II D5 missile system. Each able to accommodate 130 crew members.

SOURCE: www.gov.uk



Rolls-Royce's Nuclear Skills Academy (left); the Glasgow site office opening (right)⁽⁸⁾⁽⁹⁾



Beyond this, the AUKUS alliance – a trilateral agreement between Australia, the UK and the US – has flipped the UK's submarine industry on its head with an announcement, in June 2025, that there are plans to construct up to 12 advanced UK attack submarines from the late 2030s onwards⁽⁶⁾. These will eventually replace the Astute Class and demand cutting-edge propulsion systems, advanced sensors, and a marked increase in platform performance.

Together, these programmes represent the most intense period of submarine design and build activity the UK has ever undertaken. This, in turn, leads to a need for employees, from a wide range of disciplines, who have the experience and background in the nuclear industry to tackle the complex challenges that lie ahead. In other words, a burgeoning need for NSQEP.

The sector is currently facing a skills shortage, as noted by the *National Nuclear Strategic Plan for Skills*, published in 2024 by the Nuclear Skills Delivery Group (NSDG). It is projected that the UK will need to fill more than 40,000 new jobs by 2030 and will need a staggering 150,000+ new recruits by 2035⁽⁷⁾.

Those figures are not just to reach the ambition of 24 GW of civil nuclear power generation capacity by 2050, but also to deliver on the requirements in defence – and

the submarines sector is at the sharp end of this challenge.

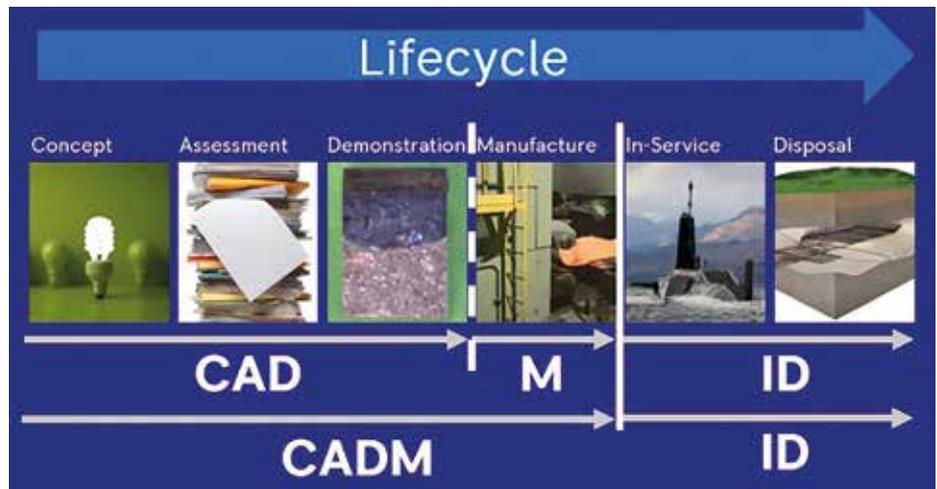
A STRATEGIC APPROACH TO SKILLS

One way to combat the issue is to take the approach of RRSL, which is developing a Strategic Workforce Planning capability. This modelling-based strategy will look to de-risk the ability to acquire and develop the NSQEP resources needed for both extant programme delivery and significant programme

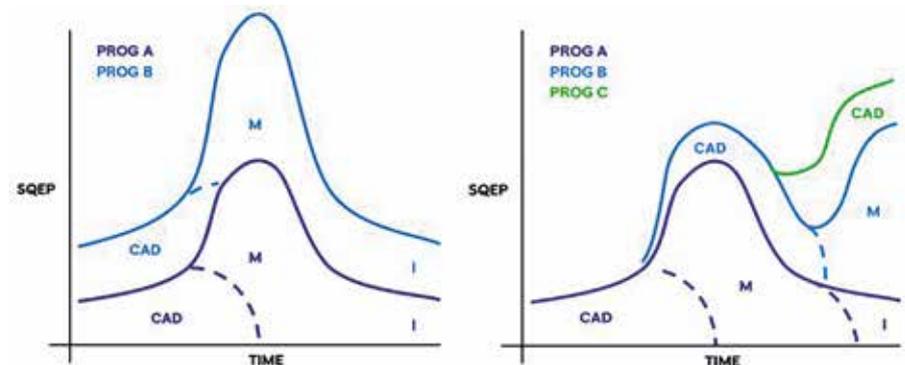
expansion associated with AUKUS. The problem boils down to one fundamental consideration: the supply must match the demand or the UK will fall short of its aspirations of returning to global leadership in nuclear technology and submarine capability.

The supply is a complex aspect to model accurately, as it relates to a number of factors, including: the capability available 'off the shelf'; the capability that can be generated from existing and new talent pools; what capability needs to be developed through 'green labour' development pathways; the rates of voluntary and natural attrition; the time to produce NSQEP; and the productivity rate of each development pathway on their journey towards achieving NSQEP.

It is also important to consider the macro view of the problem: an island with an ever-growing list of employers and demands, all vying for a reducing number of people because of attrition to other industries or retirement. That's why, instead of focusing solely on recruiting 'ready-made' employees within the



The CADMID Lifecycle



The principal behind resource phasing opportunity of RRSL programmes

“The future has never looked so promising for the UK submarine programme.”

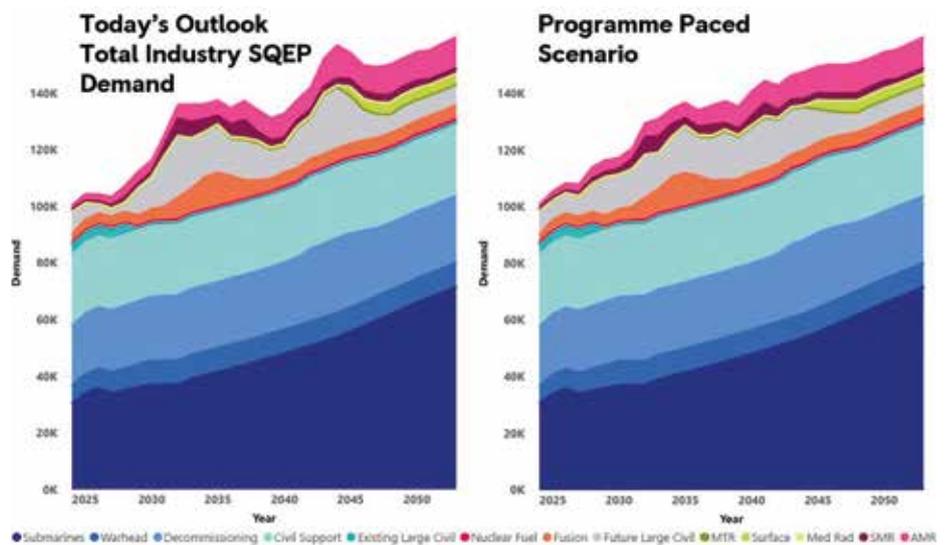
industry, companies such as RRSL are also putting significant investment into growing their own talent.

Opened in 2022, the Nuclear Skills Academy (NSA) is a purpose-built facility packed with classrooms and hands-on learning facilities – such as lathes, electronic soldering workstations, and welding and hand machining shops – designed to train and introduce 200 new degree apprentices to the RRSL business each year for the next decade. With the backing of the Royal Navy, as well as key industry, academic and governmental organisations, the NSA is set to make a significant contribution to the essential pipeline of employees that RRSL needs.

But that isn't the whole picture. When setting about increasing the workforce at the scale RRSL and other nuclear industry organisations will need over the coming decade, it is important to consider that regions can become saturated while others might remain untapped. To address this, RRSL opened satellite offices in Glasgow, Cardiff and Bristol in 2024, as part of a drive to continuously attract new talent.

The demand side is another complex aspect to model, with consideration needed for the current and future workforce needs. Effective modelling also needs to account for potential productivity improvements because of technological advancements in tools such as artificial intelligence and automation.

The challenge of meeting the overall resource demand is certainly non-trivial. As such, it is sensible to break this problem down into bite-sized pieces. This can be done through the lens of the Concept, Assessment, Demonstration, Manufacture, In-Service and Disposal (CADMID) engineering lifecycle. Each step through the cycle will be critical



Quantified resource phasing opportunity across the nuclear industry

to ensuring the successful delivery of future programmes such as AUKUS, but each one will require different skills at different times. Smart resource optimisation between programmes could go some way to alleviating these peak demands on any given skill set.

The correct approach to phasing of programmes could lead to relatively smaller peaks and troughs in NSQEP resource. This smoothing of workforce demand reduces the boom-and-bust hiring cycles that have historically plagued the sector, to enable greater stability of NSQEP resource over time, ultimately making the sector more attractive to new talent and better at retaining good talent.

Phasing work to accommodate resource availability happens in many industries, and even in other areas of Rolls-Royce, where new product design programmes are scheduled to accommodate existing design programmes

and avoid resource peaks. However, the benefits are accentuated the larger you cast your net. If phasing of resource was done across the whole submarine sector, or even across the whole nuclear industry, the benefits would be game-changing. With the right coordination across industry and government, we can unlock a more stable, scalable pipeline of NSQEP talent.

The future has never looked as promising for the UK submarine programme, with future demands in place to design and deliver cutting-edge NSRP designs providing significant growth opportunities. However, growth brings uncertainty in how these demands will be met. The future is not only about the technology in the submarines; it's about the people developing and delivering it.

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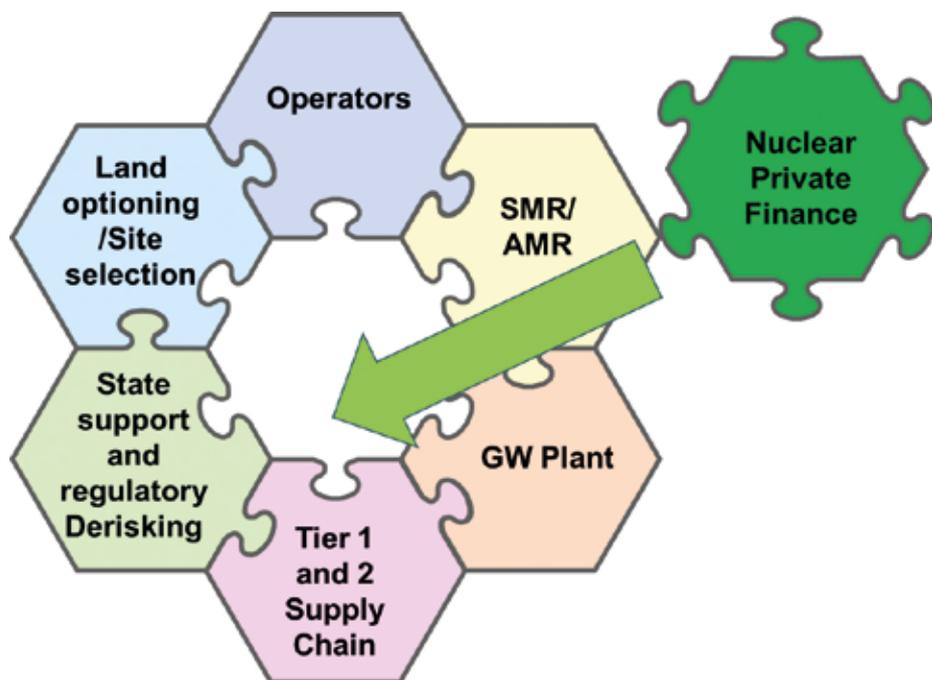
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Credit: LA(Phot) Paul Halliwell/MOD

Funding the nuclear net zero future

By Jasbir Sidhu, former NI President and Managing Partner, Nuclear Capital



As governments and industries worldwide commit to achieving net zero emissions by 2050, attention has turned to nuclear as a valuable source of energy that can drive decarbonisation in this timescale. Renewables such as wind and solar still dominate public discourse, but nuclear power is regaining recognition as a critical element of a sustainable energy mix because of its 24/7, 365 delivery capability.

A recent report from the International Energy Agency (IEA), *The path to a new era for nuclear energy*, suggests nuclear power generation is likely to break records in 2025 as electricity demand accelerates – but the legacy hangover of escalating build costs, project overruns and financing must be addressed. The key findings of the report were:

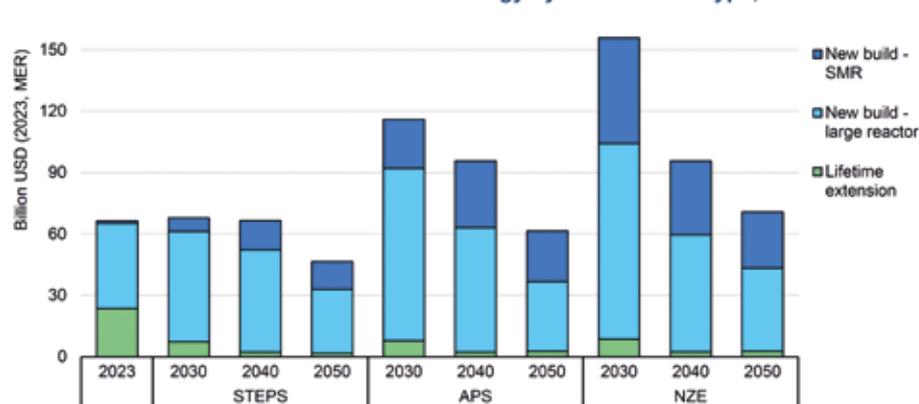
1. Renewed momentum behind nuclear energy has the potential to open a new era for nuclear power, with 70 GW of new nuclear capacity under construction globally. This is one of the highest levels in the past 30 years, with more than 40 countries around the world planning to expand nuclear's role in their energy systems.

2. SMRs offer exciting growth potential, with the first commercial units expected online in the mid-2030s.
3. China, India, South Korea and Europe are likely to have new reactors, while several in Japan are forecast to return to generation. French output should also increase.
4. Electricity demand is expected to

increase around the world, fuelled largely by the move to a low-carbon economy. This includes data centres, electric vehicles and heat pumps, as well as many low-carbon industrial processes.

5. New generation capacity from a range of technologies will be needed to keep pace with the rapid demand growth.
6. Major challenges need to be addressed, including how to finance new nuclear projects while ensuring reliable and diversified supply chains for building and fuelling them.
7. Delivering on time and budget is critical – in the US and Europe, new projects are, on average, around eight years late, with budgets 2.5 times above planned.
8. Nuclear's share is declining in the West – in the 1990s, Europe had a share of 35%, but now it is 25% and, in 10 years, it will be less than 15%.
9. Nuclear's share is increasing in the East – China's stable policies support new nuclear. It is currently responsible for half of all commercial plants under construction, putting it on course to overtake the US and Europe as the world's top nuclear power by 2030.
10. Russia will continue to be a major player, with 23 of the 52 reactors that have started construction worldwide since 2017 being of Russian design (and 25 of Chinese design).

Global investment in nuclear energy by scenario and type, 2023-2050



IEA. CC BY 4.0.

Notes: MER = market exchange rate; SMR = small modular reactor; STEPS = Stated Policies Scenario; APS = Announced Pledges Scenario; NZE = Net Zero Emissions by 2050 Scenario. Source: IEA (2024), *World Energy Outlook 2024*.

11. New era for nuclear energy will require significant investment, with the rapid growth scenario suggesting the required annual investment would need to double to US\$ 120 billion by 2030, which cannot rely exclusively on public finances.
12. Private investors, major banks and tech companies are showing interest in the European nuclear industry, but governments need to reduce risks to encourage investment by guaranteeing contracts and cutting regulation.

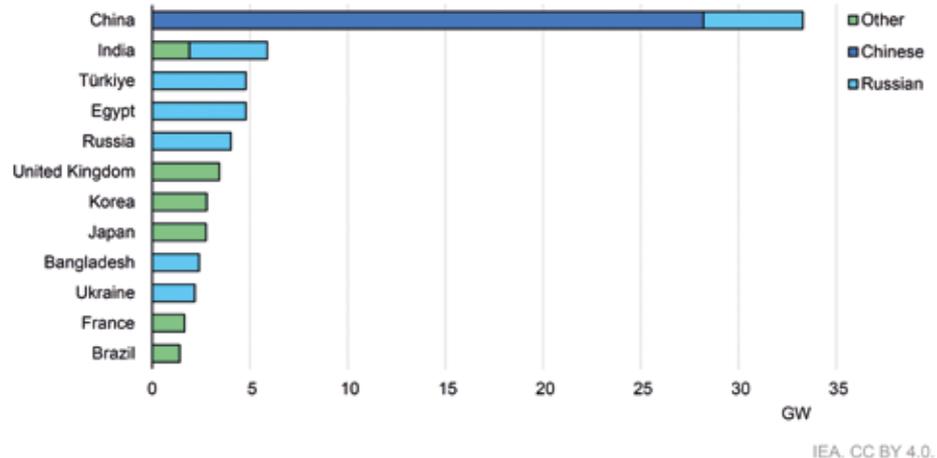
Six months on from the publication of this report, the need for nuclear and investment continues to hit the headlines. The tech giants are pushing the cause of new nuclear with vigour while international financial institutions, such as the World Bank, have openly supported nuclear. Specifically, Apollo Global has agreed to provide £4.5 billion of debt capital to the Hinkley Point C project.

The UK has committed to achieving net zero emissions by 2050 and, as part of this goal, it plans to expand its nuclear capacity significantly from around the 8 GW that the fleet provides today. One of the biggest barriers to development is the high upfront capital cost and long timeline to completion. To address this, the UK introduced the Regulated Asset Base (RAB) model, which allows developers to begin recovering some costs from consumers during construction, rather than having to wait until the plant is operational. This significantly reduces investor risk, lowers the cost of financing and spreads the burden of funding over time, making it easier for pension funds and institutional investors to take part. The RAB model is being used for Sizewell C and is expected to play a major role in future nuclear developments.

The UK government has committed public funds to nuclear, including direct equity investments and grant funding for development work. It is also encouraging private sector involvement by offering policy stability, planning support and incentives for green investment. As a result, there is growing interest from institutional investors, including pension funds and infrastructure firms, especially when stable returns and government backing are part of the deal.

In July, the UK government finally signed the final investment decision for Sizewell C. It has confirmed it will take an initial 44.9% stake to become the single biggest equity shareholder in the project. The new Sizewell C shareholders include La Caisse, with 20%, Centrica, with 15%, and Amber Infrastructure, with an initial 7.6%. This

Nuclear power capacity under construction by region and national origin of technology, as of December 2024



Source: IEA analysis based on IAEA PRIS database (Accessed 10 January 2025).

comes alongside EDF taking a 12.5% stake in the project.

The government suggests the total equity and debt finance made available, at around £45 billion, will exceed the target construction cost of around £38 billion (2024 prices) to allow for a buffer or contingency in case costs overrun. The project will be funded by a mixture of equity and debt – £8.8 billion in equity from the government and the other investors, and £36.6 billion in debt, which will be provided by the National Wealth Fund (NWF), the UK government's principal investor and policy bank. It will provide the majority of the project's debt finance, working alongside Bpifrance Assurance Export (£5 billion), to help support the building of the power plant.

Interest payments will be part-funded by a levy on all electricity users of an estimated £1 per month for the decade-long construction phase. This was justified by the government's Value for Money assessment, which suggested that Sizewell C could reduce the cost of a low-carbon electricity system by around £2 billion per year on average, once operational. Attracting other investors to the project was made possible by the strong government commitment and the RAB delivery model – a government support

package to protect investors from high-impact low-probability risks – and other guarantees.

In the United States, nuclear power already provides a significant share of electricity, but new plant construction has been limited by high costs and regulatory complexity. The current US administration has the desire to re-establish the US as the global leader in nuclear energy, setting the objective of quadrupling US nuclear capacity to 400 GW by 2050, but significant private financing will be needed to meet this challenge. Recent policy shifts have brought renewed focus on preserving existing plants and developing next-generation reactors, and the US government has introduced substantial funding programmes to support nuclear energy, including grants for advanced reactor development, credits for keeping existing plants open and loan guarantees to support construction. Private companies such as TerraPower, NuScale Power and X-energy are developing advanced nuclear technologies, including SMRs, and attracting significant private capital.

France remains one of the world's most nuclear-dependent countries, generating around 70% of its electricity from nuclear power. Recent moves to classify nuclear

“There is growing interest from institutional investors, especially when stable returns are part of the deal.”

energy as 'green' under the EU's sustainable finance taxonomy have opened the door for greater investment across Europe. This means nuclear projects can now access green bonds and environmental, social and governance (ESG) funding, provided they meet safety and waste-management standards. China and Russia, meanwhile, both operate state-owned energy giants capable of delivering massive infrastructure projects with long-term planning and central funding.

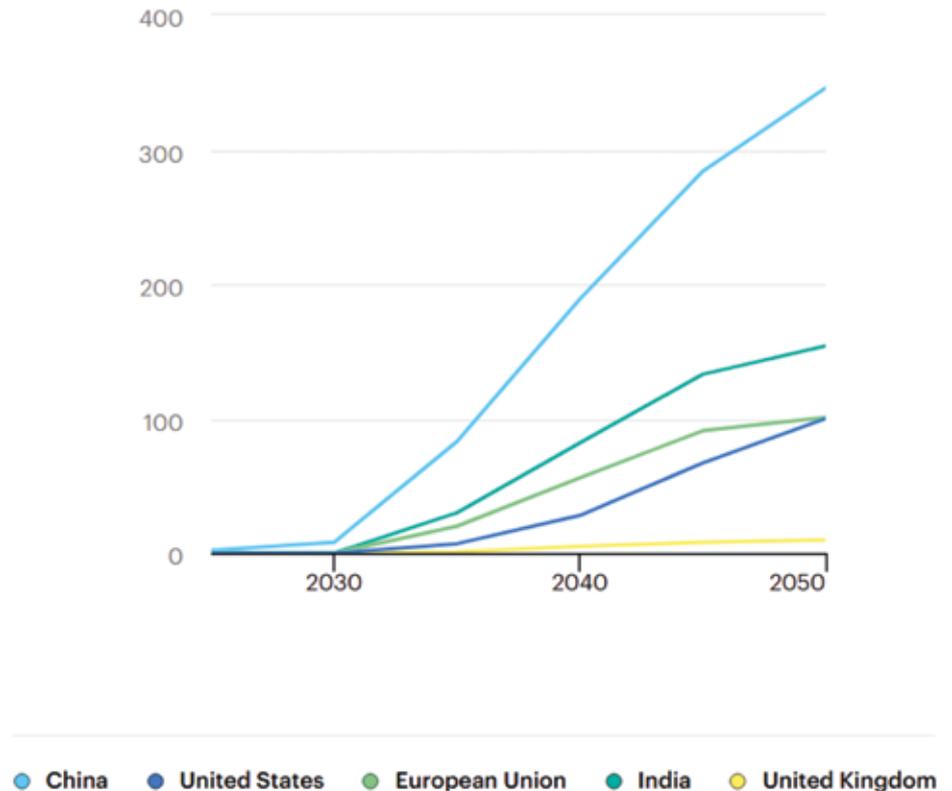
Despite this momentum, nuclear development still faces significant financing challenges, including:

1. High upfront costs: nuclear plants are difficult to fund without government support or long-term guarantees because they are capital-intensive, with costs often running into the tens of billions.
2. Long timelines: investors must be willing to wait many years before seeing returns as it can take a decade or more to plan, permit and build a large nuclear plant.
3. Public and political concerns: nuclear remains controversial in many countries because of concerns over safety, waste and past accidents, despite being seen as essential for climate goals.
4. Competition from renewables: it is hard for nuclear to compete purely on economic grounds, as solar and wind power have become much cheaper, are supported by financial incentives and are quicker to deploy.
5. Waste management: permanent disposal of radioactive waste is a challenge and solutions remain a work in progress in many countries, affecting public perception and raising long-term cost concerns.

The global shift towards green and sustainable investment is beginning to reshape how nuclear projects are financed. As governments and investors adopt

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The global shift towards green and sustainable investment is beginning to reshape how nuclear projects are financed.”

Number of Small Modular Reactors in selected regions in the Announced Pledges Scenario, 2025-2050



environmental criteria, nuclear is increasingly being included in green financing strategies. Green bonds, climate funds and ESG investments are starting to support nuclear, particularly in jurisdictions where it is recognised as a low-carbon energy source. This evolving financial landscape could help to unlock billions in investment for nuclear power, especially for emerging technologies such as SMRs.

In 2021, Canada's Bruce Power issued the world's first nuclear green bond, a CDN\$500 million offering that was used in refurbishing existing nuclear reactors. The Bruce Power issue was considered to be a watershed moment in changing how nuclear power can be categorised and financed. Nine months later, in 2022, Ontario Power Generation followed with a similar CDN\$300 million green bond for plant refurbishment projects.

In January 2025, EDF successfully priced a green senior bond issuance in two tranches for a nominal amount of CDN\$750 million (the 'CAD Green Bonds').

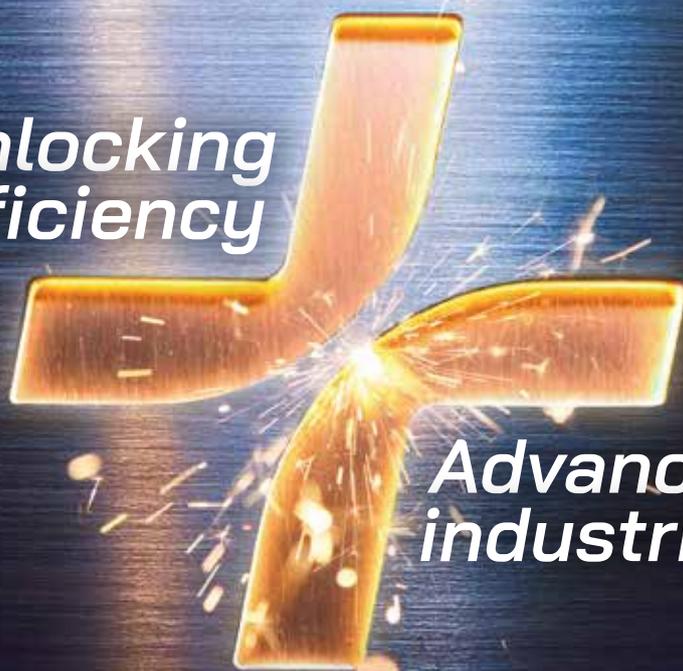
These funds will be allocated to investments in relation to the lifetime extension of the existing French nuclear reactors, as defined in EDF's Green Financing Framework and aligned with the European taxonomy. This transaction enables EDF to finance its strategy and objective to contribute to achieving carbon neutrality by 2050.

Challenges remain, but the funding landscape for nuclear is evolving rapidly. With the right mix of public support, private investment and regulatory clarity, it should enable nuclear energy to become a cornerstone of a cleaner, more resilient global energy future.

To read the IEA report, visit: www.iea.org/reports/the-path-to-a-new-era-for-nuclear-energy

Nuclear Capital is spearheading the drive to attract private capital into nuclear. It aims to tap into the huge global expansion in large-scale nuclear and emerging SMRs and Advanced Nuclear Technologies by assisting institutions and private nuclear interested parties in deploying capital into nuclear.

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Young nuclear professionals shine in Zagreb

The European Nuclear Young Generation Forum (ENYGF) returned this summer with energy and ambition, as more than 200 young professionals, industry leaders and academics gathered in the lively city of Zagreb, Croatia – home of the inaugural event in 2005.

A celebration of collaboration, innovation and shared commitment to a sustainable nuclear future, ENYGF has long been a key event for early-career professionals in the sector and this year's edition, which marked the tenth running of the biennial event, did not disappoint.

The programme was packed with technical sessions covering everything from advanced reactor technologies and nuclear safety and security to the latest thinking on decommissioning and waste management.

It wasn't just about theory; attendees got stuck into hands-on workshops that offered practical skills and real-world insights, with sessions on media training, gender dimensions in engineering and AI in action, giving participants tools that they could take back to their day jobs.

Importantly, the forum also shone a light on the human side of nuclear safety. Sessions on human factors, organisational culture, education, communication and public outreach highlighted the importance of psychological safety, effective communication and decision-making in maintaining safe and resilient nuclear operations, reminding everyone that people are at the heart of safe nuclear operations.

Attendees were offered technical tours of the Krško Nuclear Power Plant and INTEC, highlighting Croatia's nuclear expertise, and there were visits to Plitvice Lakes and Zagreb city, to experience the country's natural beauty and cultural heritage.

One of the most talked-about themes this year was AI. As the technology continues to make its way into safety-critical industries, the forum explored its potential uses in nuclear and the possible pitfalls. Key topics included

predictive AI, ethical considerations and the importance of transparency and accountability in AI-driven processes.

Speakers emphasised the need for strong governance and cross-disciplinary collaboration to make sure AI supports, rather than undermines, nuclear safety. The discussions were lively, forward-looking and showed how seriously the sector is taking these emerging technologies.

ON THE EUROPEAN STAGE

The YGN made a strong impression in Zagreb, with delegates actively contributing to technical and non-technical sessions. A real highlight was the UK team's performance in the Innovate for Nuclear (I4N) competition.

This is an international showcase for bold, creative ideas that could reshape the future of nuclear, sponsored by Rolls-Royce, and the team delivered a standout presentation that blended technical depth with innovative thinking.

ENYGF 2025 was not just a technical forum – it was a statement of intent. As the nuclear industry faces growing pressure to deliver clean, secure and affordable energy, the event made it clear that young professionals will be central to that mission.

Delegates left Zagreb energised and inspired, having made new connections and gained fresh perspectives. For the UK's NI YGN, the experience reinforced the value of international collaboration and the power of shared learning.

Jake Moorman (NWS), YGN International Liaison representative, said: "ENYGF was a brilliant event that helped us identify further opportunities to collaborate with our European colleagues and enhance our international network. The I4N European Final also provided a fantastic opportunity to showcase the exceptional talent the UK YGN has to offer, and the team did an incredible job."

Attention now turns to the next edition of the forum, set to take place in Italy in 2027, and the ideas, partnerships and momentum that was sparked in Zagreb are already setting the stage for what is coming next.

By Omal Jayawardena, Sellafield Ltd



Intro to Nuclear New Build 2025

Somerset's historic Cannington Court played host to the third Introduction to Nuclear New Build programme, bringing together early-career starters, industry leaders and nuclear specialists to explore the state of nuclear new build in the UK – and the pivotal role it plays in the nation's energy future.

The two-day event, sponsored by EDF and delivered by the YGN, was opened by event lead Pravin Piramanayagam, who set the tone for discussion and learning. The keynote address came from Stuart Crooks CBE, CEO of Hinkley Point C (HPC), who shared memories from his career and advice for the early-career professionals in attendance.

The broad, big-picture agenda continued with Dr David Cole, Energy Strategy Director at Sizewell C, delivering an in-depth exploration on the UK's need for Sizewell C and why nuclear remains an essential part of the UK's low-carbon mix. Mike McLean, AMR/SMR Market Lead at AtkinsRéalis, then offered a forward-looking view on the future of nuclear power, from gigawatt-scale plants to small modular and advanced reactors. This was followed by Dr Michelle Tilly's presentation on the lessons learned moving from HPC's Unit 1 to Unit 2, showcasing the increase in work completed on Unit 2 with less labour because of the improvements implemented on site to safety, efficiency and scheduling.

The first afternoon saw a dynamic careers panel discussion, featuring senior figures from across the sector, including leaders



from HPC, Great British Energy – Nuclear, the Nuclear Decommissioning Authority, Sizewell C and the Office for Nuclear Regulation (ONR). The panel tackled questions on career development and advice, and nuclear project development and delivery. Mike Roberts, of Great British Energy – Nuclear, outlined the organisation's role in securing Britain's energy future, while Dr Diego Lisbona, of ONR, spoke about how early engagement and the Generic Design Assessment process support the UK's ambitious new reactor pipeline.

Tom Godfrey, from Rolls-Royce SMR, closed the opening day's talks with a session on the safety and licensing challenges of developing the UK's home-grown small modular reactor, with drinks and a barbecue concluding the day.

The second day moved from theory to first-hand experience and began with an interactive session inside a HPC reactor control room simulator. The experience gave attendees a taste of the control room environment and the operational challenges of running a nuclear plant. There was also the chance to look around the HPC visitor centre and its exhibits before delegates took a bus tour of Hinkley Point C, visiting key areas of the site to see up close the scale and complexity of its engineering.

The afternoon sessions widened the horizon, with Professor Chris Waldon, Chief Engineer of the UK's Spherical Tokamak for Energy Production programme, outlining the ambition to deliver the UK's first-of-a-kind commercial fusion plant – a bold leap towards the next generation of clean energy.

Carl Dalby, of the Nuclear Decommissioning Authority, then closed the technical sessions with a thought-provoking talk on artificial intelligence and digital innovation in nuclear, covering opportunities, readiness and the risks of adopting cutting-edge technology in a highly regulated environment.

The successful event made it clear that the UK's nuclear sector is entering a transformative period. From delivering HPC and progressing Sizewell C, to advancing SMRs, AMRs and even fusion, the industry is tackling the twin challenges of net zero and energy security head on. For young professionals, the event was more than just an overview; it was a call to action – and with new-build projects offering opportunities across engineering, safety, digital and regulatory roles, the next generation will be central to shaping the UK's nuclear future.



Swedish YGN visits UK nuclear sites



The YGN had the pleasure of hosting two different groups from the Swedish YGN equivalent as they visited the UK for an educational trip, focusing on the themes of safety and decommissioning. On a short, but jam-packed itinerary, the groups visited several sites across England and meet many members of the UK YGN.

The Swedish YGN is structured very differently from its UK equivalent, with membership lasting only a year and a total of around 60 active members at any one time. In its active year, the Swedish YGN splits its members into groups with loosely defined themes and each group organises and attends one domestic and one international trip that align with their group's theme. In contrast, the UK offers ongoing YGN membership for any Nuclear Institute member under the age of 37 and currently has more than 1,500 members.

The decommissioning group began its three days of activities with a guided tour of Sellafield and a visit to the Lake District. A guided tour of Springfields with Westinghouse and a meal in Preston followed. The visit concluded with a visit to the Manchester Science and Industry Museum.

The safety group kicked off with a social event and dinner with French colleagues from HPC in Bristol followed the next day by a guided tour of Hinkley Point B and C with EDF. They also had a tour of the AMRC 'Factory 2050' with Rolls-Royce SMR in Sheffield, and a visit to Birmingham's Thinktank Science Museum.

After completing their visits, the Swedish YGN members had a chance to reflect on their experiences in the UK and answer a few questions:

Why did you choose to host your trip in the UK?

Safety Group (SG): We were interested in the safety aspects of different reactor technologies. One of our main attractions to the UK was the opportunity to see the full lifecycle of reactors, including the concept design of SMRs; the construction of new European Pressurised Reactors (EPRs); and the Advanced Gas-cooled Reactor (AGR) fleet coming to their end of life. The UK's pro-nuclear stance and forward-looking approach made it a natural choice for our trip.

Decommissioning group (DG): The key reason for choosing the UK was to learn about its

waste management and decommissioning processes. By comparing the plans of the UK and Sweden, we aimed to learn from each other's challenges and solutions.

What were you hoping to see while in the UK – and did you manage to see it?

SG: Two of our main goals were to see an AGR and an EPR, which we were delighted to do by visiting both Hinkley Point B and Hinkley Point C in one day. We were also very interested in learning about the Rolls-Royce SMR concept and its historical work in the nuclear field. We had the opportunity to visit its fascinating Factory 2050 in Sheffield, and were impressed by learning about its manufacturing concepts. Unfortunately, we ran out of time to visit the Culham Centre for Fusion Energy.

DG: We saw much more than expected at both sites and felt incredibly welcomed. At Sellafield, we were interested in the overall decommissioning progress, future plans and waste routes on-site. Thanks to Evie Smith, who planned our great tour, and Jack Pike, who guided us, we got to see everything we wished for and even more. It was an engaging and fun day where



we also learned about the UK YGN and Sellafield’s history. At Westinghouse, we aimed to see the fuel fabrication process and its waste treatment plant. We were eager to hear about its decommissioning challenges and related work. Matthew Hutcheon and his colleagues planned a full day for us and guided us through both plants. We participated in some very interesting presentations and discussions regarding future work and foreseen challenges in decommissioning. We left with a wealth of

knowledge and insights, far exceeding our initial expectations.

What information and contacts will you take back to Sweden?

SG: The purpose of our trip was mainly to broaden our views and build up a network. We learned a lot about AGR technology, EPR construction, SMR modular design and safe electricity production in a controlled environment. We also met a lot of people from EDF, Rolls-Royce SMR, the UK YGN and

Women in Nuclear – so plenty to take back! **DG:** Seeing the challenges that Westinghouse and Sellafield face has humbled us. We are returning to our respective workplaces with a broader perspective. Some of the key learnings we are taking back include: that operational records are crucial to understanding the history of plant and components and are essential for proper waste treatment; that the Swedish Westinghouse plant could benefit from the uranium-contaminated waste-handling equipment at Springfields (one of our group members, who works at Westinghouse in Västerås, is still in contact to exchange learnings and thoughts); that finding people willing to work in remote locations, such as power plants, can be challenging and that collaborations with universities and trainee programmes are effective ways to increase attractiveness; and that building new facilities is sometimes necessary for decommissioning, even though it may feel counterintuitive. We are incredibly grateful for everyone’s helpfulness and willingness to share their work, as well as for answering all of our questions.

CONCLUDING THOUGHTS

Following the success of the visits, the Swedish YGN plans future trips and has extended an invitation for the UK YGN to pay them a visit too. This programme was not just about swapping ideas, it was about building real connections between early career nuclear professionals across countries. By coming together, sharing experiences and learning from each other, both young generation groups are setting the stage for future collaboration and innovation. As both countries navigate the challenges ahead, these developing networks will be key to pushing the nuclear industry forward.

“
Both young generation groups are setting the stage for future collaboration and innovation.”



Q&A with **Sam Kitchen**



Sam Kitchen is an engineer on the graduate scheme at Assystem, currently seconded to Rolls-Royce SMR. He is actively engaged with the YGN and is a regular volunteer. He discusses his career, his YGN experiences and his recent success at the Innovate for Nuclear (I4N) UK competition.

What drew you to a career in nuclear engineering?

My interest in the nuclear industry began while I was at university. Sustainability and achieving net zero 2050 had always interested me, but it was only during my studies that I started to learn how the nuclear

industry plays an enormous role in the UK's low-carbon energy mix. When I finished my degree, I searched within the nuclear industry, and Assystem's rotational two-year graduate scheme stood out to me. I'd been in rotational schemes for previous work experience and they're fantastic for discovering unknown elements that you enjoy – especially if the opportunity arises to travel while working on different projects.

How has your experience been of the Assystem graduate scheme?

I've really enjoyed my time so far. I've had the opportunity to work in the latter stages of a large civil nuclear new-build project, and have

recently started contributing to the leading UK SMR project, which I'd like to continue for the foreseeable future. The opportunity to work on many projects across a range of technical roles has been fantastic for my development, especially with additional encouragement to do extracurricular tasks, such as YGN volunteering and outreach events, alongside my work.

How did you hear about the NI and the YGN and what inspired you to engage with them?

When I joined Assystem, I was encouraged to join the NI as an associate member and to become involved with the different events

it hosts. However, it was only this year that I became active within the YGN. I got involved because I've had a great experience working in the nuclear sector and I'd like to share my experiences with others who are considering working in this industry. Our YGN company catalyst, Sean Brown, is also very active in sharing upcoming events as part of our internal networks, ensuring I'm always in the loop.

What participation/volunteering have you done with the YGN?

I've mainly participated in STEM outreach events, going around the country to promote the nuclear industry to secondary school and sixth-form students. I do this because, when I was one of those students, I really enjoyed seeing what each stand represented, and I'd never been to a stand for the nuclear industry before! I enjoy introducing our sector to students who would enjoy a career in nuclear, and the events have helped me to further develop my understanding of the industry and improve my public speaking skills. It is very rewarding to see students who had never considered nuclear showing enthusiasm for it.

You participated in the I4N UK competition earlier this year – what was your innovation?

Together with my colleagues James Guard and Ellis Matthews, we developed a mobile nuclear-powered desalination vessel. We came up with the idea because the theme was economic development and we understood how the nuclear industry in the UK is growing rapidly – yet, not too long ago, jobs in the nuclear new-build industry were scarce. So, with water scarcity becoming a massive and growing issue, we thought why not construct one of these vessels and send it to a country that struggles with that problem? This would promote our nuclear workforce and help those struggling to produce enough drinking water.

What other innovations were you competing against and how did you do?

At the UK final, two teams presented the use of fungi – which can be seen growing in Chernobyl reactor four – to decrease the radioactivity of spent fuel. Another presented a not-too-dissimilar idea from ours, using a nuclear-powered vessel to clean up the global plastic waste patches, with the additional energy generated enabling it to convert the waste to biofuel while in motion. The results were very close, but we won, with deserved thanks to our team mentor, Mark Longland, who assisted us with his project management expertise.

That gave you the opportunity to compete in the European final in Croatia – what was your experience like there?

Attending the event at the European Nuclear Young Generation Forum (ENYGF) was an incredible experience. We attended the entire week-long conference, going to technical talks and presenting our innovation to the European teams. We presented early on the first day of the I4N competition and it turned out to be one of our smoothest run-throughs. We had prepared a physical 3D model, which we unveiled to an audible gasp, and once we had finished answering the questions at the end, we could relax for the rest of the conference!

How did you do?

We ended up fourth out of the 11 teams, just missing out on a podium position! The competition was fierce and the winning Italian team presented a novel idea for using targeted radiopharmaceuticals. Other notable mentions include the Serbian team, which presented an integrated system for classification of orphan sources; and the French team, with a nuclear reactor that could recycle ocean plastic into useful products via cross-linking. A massive thank you goes to the Nuclear Institute and the event sponsors for putting on the event, the UK YGN team for their support throughout the competition, and to our mentors, Assystem, for supporting our attendance.

What are the next steps for the mobile nuclear desalination vessel?

We are very passionate about our idea, but it's extremely challenging to move forward on such a large-scale project – even though we know the naval and nuclear industries are both expressing an interest. Another obstacle is simply the strong state of the UK nuclear energy sector. In the UK, we currently have so many other good projects to work on that there is less incentive for companies to risk time and effort on unproven technology. Currently, we don't think we can make much progress with this idea – although we invite anybody interested to take up the mantle!

There is a stereotype that the nuclear industry is overly risk-averse and, therefore, not open to innovation – what is your opinion?

I think innovation in nuclear faces unique challenges that other sectors may not face – as there is zero tolerance for safety risks that new technologies may bring – but I certainly do not think it is closed to innovation. At the ENYGF conference, we saw that innovation is happening all along the supply chain: nuclear scientists working on new fuels; nuclear companies developing new reactor designs; safety engineers exploring the use of AI; and strategy professionals expanding projects into new regions. Innovation is alive in nuclear – it may just progress at a different pace, because of the unique challenges that exist.



Building new nuclear in the UK at programme scale

By James Barker

Nuclear has built up an unfortunate reputation for poor project management: all too often we hear about construction delays, cost overruns and over-engineered solutions. At the same time, the UK has committed to building Sizewell C – a second gigawatt-scale reactor after Hinkley Point C – as well as SMRs and a commercially viable fusion power plant in the next 15 years. Delivering these as a coherent programme in that timescale would be substantially more than anything the industry has achieved in the past 30 years.

The recent World Nuclear Symposium – the 50th edition of the event – brought together more than 1,000 delegates from 56 nations and provided insight from leading global organisations and the nuclear supply chain on the need to move from one-off projects to a programme approach, in order to triple global nuclear capacity by 2050.

Agreed at COP28 by 25 nations, this target, while ambitious, will only maintain nuclear's position of providing 10% of global energy – with the addition of surging demand for electricity from data centres, the consumption of which will, next year, already be roughly equivalent to that of Japan. This is why we are seeing technology giants such as Microsoft actively engaging with nuclear energy as they look for firm, reliable, carbon-free power sources without waiting for governments to develop the grid.

It is, therefore, abundantly clear that project and programme delivery of nuclear projects has to improve to meet demand and agreed goals. Three key factors for programmatic success stand out: visibility, predictability and engagement. These apply to governments, financial institutions, the supply chain and workforce, combining to offer shared clarity of what will be built, how, where and when.

But where are the successes and how can the UK (and global) industry learn from them?

CANADA

The CANDU reactor life extension programme, being led by AtkinsRéalis in Canada, is a leading example of success. Currently working through a programme of life extensions to 22 CANDU reactors worldwide, 12 are in progress. The Darlington refurbishment project, the largest clean-energy project in Canada, is expected to be completed around five months ahead of schedule and within budget. Urgency in these projects is led by the growing need for energy security, following growing political tensions with the USA.

Canada is also leading the way in SMR delivery, with construction under way on the first of four 300 Mw reactors. This is expected to come online in 2030 and is being considered by the Ontario Power Generation company as the fifth unit in a programme, after the refurbishment of the Darlington reactors.

Compare this view with the UK, where we do not see AGR life extension and SMR construction as part of the same, integrated programme. By approaching these projects as an integrated programme, with AtkinsRéalis as the lead engineering supplier across all the projects, the desired learning and efficiency gains are being realised. Canada is already a net exporter of low carbon energy and its reactor technologies are deployed in several other nations.

UAE

Workforce development was crucial to the Barakah power plant's success, according to Mohamed Al-Hammadi, CEO of the Emirates Nuclear Energy Corporation (ENEC). As the country's first nuclear plant, Barakah needed to build technical expertise and develop its workforce. Under ENEC's 'one team, one goal' motto, there was relentless focus on the shared mission to unite everyone involved.

Al-Hammadi also cites a pragmatic project



approach as a driver of delivery, in reference to the financial and regulatory model used. As a first of a kind for UAE, ensuring a regulatory environment and financial model was vital to get the project up and running and avoid delays at the start of the project. Then, by using mature Korean reactor technology, in the form of APR-1400, four reactors were delivered between 2021 and 2024.

SOUTH KOREA

There are lessons to be learned from South Korea around maximising limited resources. Its nuclear supply chain has developed since the 1970s, when the country was a poor, non-industrialised nation with limited human resources and skills. Jumping ahead 50 years, Korea Hydro & Nuclear Power (KHNP), a subsidiary of the Korea Electric Power Corporation, now operates 23 reactors that provide around 30% of the country's electricity.

KHNP attributes this success to localised



Credit: EDF

sourcing of components, developing a pool of native technical experts and using joint partnerships to drive international growth. Most recently, and still bearing in mind limited human resources, Korea is focused on maximising the benefit of digital and AI technologies to support workers.

FROM PROJECTS TO PROGRAMMES

The UK has delivered a fleet of nuclear reactors before. The first generation of nuclear plants from the 1950s to the 1970s delivered 4.2 Gw without all the technological advantages we have today. In more recent times, gains have

been made between units 1 and 2 at Hinkley Point C, which must be realised further when transferred over to Sizewell C. Meanwhile, SMR construction by Rolls-Royce SMR is coming, but no sites have been allocated and announced to date, so, for the workforce and the supply chain, there is not yet any clear visibility of projects three, four and beyond.

Some excellent initiatives, such as the Nuclear Skills Plan, are now preparing and building capacity for 40,000 net new jobs by 2030 – but for the reality on the ground, people and businesses need to know where their jobs will be with certainty, which then sends positive

signals to government and investors that ambitions can be delivered.

The Nuclear Institute – through revisiting the nuclear roadmap consultation earlier this year – has urged the UK government to drive fleet build and enable schedule reductions through economies of scale and growing robust supply chains. This would lead to a clear programme that gives certainty to the industry and allows it to drive energy and national security for decades to come.

For more information visit: world-nuclear.org/our-association/publications/global-trends-reports/world-nuclear-performance-report

To support a commitment to advancing the understanding of nuclear science and technology, the NI runs a number of Special Interest Groups (SIGs) and sub-Groups, composed of leading experts and other interested parties, to focus on key topics in nuclear.

There are currently six SIGs covering **SMRs, Digital, Nuclear Security, Project Management, Radwaste and Requirements Management**. Any NI member can request to join a SIG by visiting the MyNI member area, going to the My Interests tab and selecting the relevant SIG.



Euan Hutton, CEO of Sellafield Ltd, on-site operations, security and the future of nuclear waste

Sellafield is home to 170 major nuclear facilities, including seven retired nuclear reactors, a collection of ageing silos and ponds, and the majority of the UK's nuclear waste. A vital site for supporting the civil and defence nuclear programmes, it has existed in one form or another since 1947, and continues to pioneer nuclear developments to this day.

At the start of the 1990s, when the site was about to enter the third phase of its life as one of the world's biggest nuclear fuel reprocessing facilities, a famous tabloid headline that read "UK to become nuclear dumping ground" reflected the negative feeling around the nuclear industry. At the same time, a young Euan Hutton had just finished his university course and, inspired by a family friend, had joined Sellafield as a trainee.

Now, 35 years later, that young trainee has become the CEO, and Sellafield is in a different position altogether. The site is the self-declared "largest environmental restoration project in Europe" and is now focused on cleaning up some of the most hazardous nuclear buildings in the UK. It continues to support the country's energy security needs and is custodian of the largest stockpile of civil plutonium in the world.

"We have every level of nuclear waste here on the site," Hutton states. "At the top

end, we have liquors – which concentrate the vast majority of the radioactivity, are heat generating, and need to be managed continually. We also store intermediate-level waste, mostly the by-products of reprocessing, and we have: low-level waste, which goes to the national Low Level Waste Repository; very low-level waste, which is disposed of at licensed waste disposal sites; and exempt waste, just like any other industrial site.

"We take in all the spent fuel from EDF Energy's operational and de-fuelling AGR nuclear power stations, size-reduce it to improve the packing fraction, and place it in our storage pond for interim storage before readying it prior to moving to a future Geological Disposal Facility (GDF). We also consolidate nuclear waste from other sites, such as Aldermaston and Harwell, because we have a range of treatment solutions that turn waste into a product that can go directly into a future GDF."

Hutton was about 15 when he first became interested in nuclear. Seeking a topic for his school physics project, he turned to family friend Ian Birse, who worked for the UK Atomic Energy Authority at Windscale. Hutton recalls: "My mum suggested I spoke to him, and I ended up doing my project about nuclear waste. That's what got me interested in the whole concept of nuclear."

IN PERSON
 "I'm really up for the challenge; there are so many incredibly interesting things that we have to do."

Magnox Swarf Storage Silo





High-level waste returns



After completing an applied physics degree, Hutton joined a group of graduates being recruited by British Nuclear Fuels Limited (BNFL) in 1991 to help operate the new Thermal Oxide Reprocessing Plant (THORP) at Sellafield. The plant, created to reprocess fuel from the post-Magnox reactors, had got the green light in 1978 after a 100-day public inquiry – and it was sized not only to process the UK’s spent nuclear fuel, but also spent fuel from other nations.

“Reprocessing was king at that time and BNFL was all about commercialisation,” recalls Hutton. “In its first 10 years, THORP paid a dividend back to the government of around £50 million a year. That was a lot back

then. Today, we are funded by a £2.8 billion grant, which is supplemented, across the Nuclear Decommissioning Authority (NDA), with revenue of around £700 million. That predominantly comes from those 1980s THORP contracts and the contract with EDF Energy to accept their spent nuclear fuel.”

Stretching over an incredible third of mile, and containing a pond the size of 20 Olympic swimming pools, THORP was one of the largest and most complex projects in Europe when construction began in 1981 – rivalled only by the Channel Tunnel and Disneyland Paris, which were both also under construction. It took receipt of its first batch of irradiated fuel in 1988 and began

reprocessing operations in 1994, three years after Hutton arrived.

“It was in the commissioning phase when I joined, and I trained to become a radiation protection advisor,” he says. “None of the plant was active – all the cells were still accessible, so you could go into them and get a really good understanding of it all. It was fascinating. I worked there for about six years, during the time it came into operation, then I got a job in executive support and started to learn more about the business as a whole.

“In 1998, I moved into a pre-operation role on a new facility we were building to take retrieved wastes, and it was there that I got bitten by the decommissioning bug. I moved



back into safety on the legacy ponds and silos – a job that was called ‘Waste Retrieval and Decommissioning’ at the time. That led to me heading up decommissioning in 2005, working on a wide portfolio of different decommissioning projects, focusing on the earliest facilities on the site.”

That work involved managing waste from all the UK’s nuclear eras, including some that had literally been ‘left for later’ by previous operators. As relatively small and niche projects, they often involved a lot of creative innovation – which Hutton found extremely exciting. However, the way the site was owned and managed changed in 2008, when site operations were handed



Compaction of low-level waste

“
Safety performance wasn’t where we wanted it to be at that point – and it was our role to work through that.”

over to a Parent Body Organisation (PBO) run by Nuclear Management Partners (NMP), putting Sellafield in the hands of a tri-nation consortium of British, French and US firms – Amec Foster Wheeler, Areva and URS – for an initial five years, with extension options to 17 years.

The new agreement gave them complete responsibility for operating and managing the assets, the workforce and the site, and it was around this time that Hutton left to gain experience working in different companies and sectors. He initially moved to Jordan Nuclear, a mechanical outfitting company that had worked at Sellafield, and ended up working on the Astute submarine programme

at Barrow. “I was looking after a specific contract delivering all of the coatings for the submarines,” he continues.

“We did the shot blasting, painting and all of the thermal and sound insulation that helped to make it the quietest-running submarine ever built. Submarines are so cool! The tech is amazing. I enjoyed the challenge, and it was really interesting working and learning in a different environment, having spent 17 years in one place, and getting to know how everything worked.”

After two years, Hutton decided to return to the decommissioning world and joined Serco, helping it win a contract for the European Commission (EC) Joint Research Centre (JRC) in Ispra, Northern Italy. The third-biggest EC site after Brussels and Luxembourg, it was established in 1960 as a nuclear research facility and had evolved into one of Europe’s leading research campuses.

Although Hutton never moved to Italy, the role gave him international experience working with international regulators. He ran an embedded team remotely from the UK and travelled over every other week. “Serco had an incredible set of capabilities,” he recalls. “We did finite element analysis on waste containers, and waste compaction, and I did a full reassessment of the site’s lifetime plan. So, it was fascinating work – and a very beautiful place.”

In 2012, however, Hutton decided to swap his frequent visits to that tranquil lakeside town in the foothills of the Alps for a permanent return to the equally picturesque – but sometimes a little less sunny – Cumbrian coastline. Sellafield was four years into its PBO period at that point, and his second stint on site began in Environmental Health, Safety and Quality (EHS&Q), where he worked as Programme Manager.

“Safety performance wasn’t where we wanted it to be at that point,” he admits. “And it was our role to work through that.” Hutton took on the role of EHS&Q Head of Decommissioning the following year, but it was a challenging time. The PBO structure was under scrutiny and, at the start of 2015, the NDA decided that, despite being on track to deliver key performance milestones, the site was too complex for private operation.

Sellafield Limited was made a subsidiary of the NDA, led by a team appointed and governed by a newly constituted board of the site licence company. “It was quite a change,” recalls Hutton. “We lost all of the senior leadership team and replaced them with people from within the organisation,

augmented with a few externals. Then we tried to get that refocus back onto the site.

“Fortunately, the PBO was a good leaver, really helpful and supportive in the transition. One of the things it had encouraged during its time was populating the layer down from executive level with Sellafield people – as opposed to people from their own organisations – so we were able to just step the people who were ‘exec minus one’ up into those roles, blended with some additions from outside.”

Hutton was asked to become the EHS&Q Director and, he says with satisfaction: “Safety performance really improved during that period. We drove hard on 10 areas, but when you cut through it all, it was about proving that the leadership was interested in safety, taking personal accountability and driving it. You get a double benefit from that – a focused senior leadership and a workforce that sees the leadership is looking out for them.”

That role led, two years later, to Hutton stepping into a newly created role of Chief Nuclear Officer (CNO) – which he describes as “the best job title in the nuclear industry”. Recognising that future Sellafield CEOs may not always have a nuclear background, the aim was to provide someone with nuclear experience alongside, to support the exploitation of innovation while maintaining a laser focus on nuclear safety.

“I had the independent authority to report to the board on any concerns related to the company’s operation,” explains Hutton. “I had a really close working relationship with the CEO and it allowed me to influence the direction of travel in terms of hazard and risk reduction. The creation of that role was a really powerful demonstration of the organisation’s commitment to nuclear safety.”

Hutton was twice plucked out of his CNO role to fill gaps left by retiring or departing staff, each time handing his position over to the current incumbent, Dr Paul Robson. He stepped in as Retrievals Value Stream Lead, which focused on starting the retrieval of waste in ponds and silos, and upping the rate. He was also interim Site Director, providing the support required to deliver infrastructure, analytics and asset care.

Shortly after returning to his CNO role in 2023, Hutton was asked to become CEO, taking over from the previous incumbent, Martin Chown, who had resigned after three years at the helm. For Hutton, it was the culmination of a journey from the bottom to the top, and he says: “I was incredibly proud to be asked. Humbled to be honest. I am really up

THE EVOLUTION OF SELLAFIELD

Sellafield has organically evolved in four phases to deliver on specific missions since the first spade in the ground in 1947. Hutton sees at least two more phases coming, and here he explains the site’s history and his vision for the future.

Phase 1 – Nuclear deterrent

“This phase was purely to produce the material required to support the UK’s development of a nuclear deterrent. It included the construction two graphite-moderated air-cooled pile reactors, an associated cooling pond, and chemical separation and conversion plants. The waste was put into silos or tanks to be worried about later. We are the later.”

Phase 2 – First-generation nuclear power stations

“This was the time when the clever scientists at Harwell created civil power generation. Instead of just blowing ‘waste’ heat from the development of nuclear deterrent material out the chimney, they recovered it to generate electricity. The deterrent programme required more material than the two pile reactors could create, which led to the construction of Calder Hall – with its four Magnox reactors – on the Sellafield site, along with a sibling station, Chapelcross, in the south of Scotland. Electricity was still a ‘by-product’, as the focus was mainly on creating more material for the deterrent.

“The new reactors used a different shape of fuel and had a different waste throughput requirement – so another cooling pond, reprocessing plant, and storage tanks and silos were created at Sellafield. The UK then extended Magnox generation to 12 nuclear power stations around the UK, which, apart from the first two, were all about electricity production. All 55,000-plus tonnes of spent fuel, from the day the Queen switched on the first plant in 1956 to when Wylfa came off the bars in 2015, was taken to Sellafield.”

Phase 3 – Oxide and international reprocessing

“This was all about Advanced Gas-cooled Reactors (AGRs), which were purely for electricity production and commercial reprocessing. The Windscale AGR prototype



(WAGR) was built on the Sellafield site and, once the technique was proven, the UK embarked on building a fleet of plants. Again, the fuel was different – pellets contained in either stainless steel or zirconium, rather than a uranium bar in magnesium alloy – and, in the late 1970s, there was a public inquiry into the building of another new reprocessing facility, the Thermal Oxide Reprocessing Plant (THORP).

“The decision was taken to make it twice as big as the UK needed for its fleet, and to sell the spare capacity to international customers. THORP was built and, with it, more waste treatment facilities, and much better liquid-effluent abatement was added to the site. The same six square kilometres also



contained buildings from the first two phases, all working side by side, some repurposing, some reusing, but all interconnected, increasing the complexity of the site. We stopped reprocessing in 2018 after all the contracts were completed. To continue, we would have needed a lot more contracts and significant refurbishment. In the end, THORP reprocessed 9,000 tonnes of spent fuel from around the world, generating an estimated £9 billion in revenue for the UK over two decades.”

Phase 4 (Today) – Waste management and UK mission support

“Reprocessing has concluded and we are now managing the things that were ‘left till later’ from Phase One and Phase Two. We’re

also creating space on site to conclude that mission and to be available to the UK for the next nationally important mission it wants to give us. That could include the expansion of civil nuclear, by receiving and storing spent fuel and treating it to go in the GDF.”

Phase 5 (Near future) – Plutonium processing

“I can see this as the next phase coming. In February, Government policy changed to put all of our plutonium beyond reach, so we are now developing the programme to do that. This will involve changing the form it’s in at the moment to one that means it is not usable in any way, then putting it in containers to, ultimately, go in the GDF.”

Phase 6 (Possible future) – GDF preparation

“Sellafield is not just cleaning up the past; we’re creating a nationally important asset for the UK looking into the future. Progress is being made on the GDF siting process and we continue to work closely with NWS to prepare waste packages for the facility. NWS is now engaged with two communities in Cumbria about what hosting a GDF could mean for them. The GDF programme is one of the largest environmental protection programmes in the UK, and ensures we remove the burden from future generations of having to keep the waste safe and secure in surface storage facilities for many thousands of years.”

for the challenge; there's so many incredibly interesting things that we have to do, and so many brilliant people doing them.

"Sellafield is an integral part of the NDA Group, and we work closely with our colleagues in its other three pillars: Nuclear Restoration Services (NRS), Nuclear Waste Services (NWS) and Nuclear Transport Solutions (NTS). The overall mission is the safe and efficient decommissioning of the legacy nuclear sites in the UK, and the best way to achieve this is through this close working and collaboration."

THE SELLAFIELD SEVEN

Hutton has identified seven major programmes of work that Sellafield must deliver on his watch: the management, size-reduction and storage of spent fuel from the current AGRs; support for the UK's submarine programme; vitrification of highly active waste; retrieval of legacy waste from previous nuclear phases; site remediation; plutonium storage; and, last but not least, maintaining all the buildings and infrastructure on site.

Sellafield's role managing spent fuel for the current AGRs means that the site still plays a very active supporting role in the production of the UK's electricity. Fittingly, that specific work takes Hutton right back to the place where he first started – because when the old THORP facility ceased reprocessing operations in 2018, its ponds were repurposed as long-term interim storage for the newly arriving spent fuel.

The biggest job, however, relates to waste that is far older – the highly radioactive remains from decades of reprocessing. "When you reprocess, you get four things," explains Hutton. "You get the uranium for re-use; you get plutonium; and you are also left with fuel cladding, Magnox swarf, zirconium or stainless steel, which is intermediate-level waste, as well as fission products in the form of a highly active liquor.

"The liquor is the most challenging type of waste, because of its very, very high radiation levels. It's a massive gamma emitter and it creates a huge amount of heat. Since we finished reprocessing, we're not creating any more, but we still have to deal with what we have. We have reduced the total volume so it can't heat itself up to the point where it can cause a significant problem, and now we are processing it for long-term storage.

"We have developed a process called vitrification, which concentrates the radiation source and converts it into glass, which we then pour into cylindrical stainless-steel

QUICK-FIRE QUESTIONS

Q: Who is, or has been, your professional mentor?

A: I would name two: Brian Watson, the former Sellafield MD, and John Clarke, the former Sellafield Production Director for BNFL/CEO of NDA.

Q: What has your nuclear career highlight been to date?

A: Being on shift when we started Finishing Line 6 in THORP and visiting the plant just before we produced the last can.

Q: If there's one thing you wish more people knew about nuclear, what would it be?

A: The incredible range of opportunities it presents for early careers and mid-career changers, and the respect that people with years of experience garner.

Q: What advice would you give to young people seeking a career in this field?

A: Join us, get good at things, try other things, and be part of an incredibly exciting mission.



containers. It still produces a lot of radiation, and it's still hot, but it's in a passively safe form. We place the containers in a store that uses natural convection to cool itself; you can stand on top of the storage vault, shielded from the radiation, and you can really feel the heat through the floor."

High radiation levels are not just a risk for humans – they can also degrade the machines. Off-the-shelf equipment is used where possible, but the more radioactive areas require specially developed machinery and, even then, the electronics struggle to cope. The cranes on the vitrification facility, for example, last only around two years – but while that is costly, it does have a flipside of enabling regular technology upgrades.

Some of this high-level waste is a legacy of reprocessing other nations' spent fuel, but all those contracts included an agreement to return waste to the country of origin. As a result, the UK sends a 'radiological equivalence' in glass back to its former customers. "Last year, we sent 196 containers

back to Germany, removing the hazard from the Sellafield site," explains Hutton. "We have more to return to Germany and have a significant number to return to Japan."

After more than six decades of reprocessing, it is no longer UK policy to do so – in contrast to France and Japan, which are both committed to the approach. That is good news when it comes to future waste, and Hutton explains: "The majority of the UK's waste was created through reprocessing, so with the new reactor fleet, because reprocessing isn't a policy, the spent fuel will simply be stored at the power station or reactor site, then packaged to go straight into a future GDF."

Sellafield continues to retrieve and treat waste from two sets of silos – one dry and one wet – and two outdoor ponds. Constructed in the early 1950s and '60s, the ponds contain radioactive material from the original pile reactors and early Magnox operations, including spent fuel that has broken down into radioactive sludge over time. New facilities were introduced in 1986

to manage the spent fuel from the Magnox reactors, and to provide storage and size-reduction capability for the AGR fleet.

The latest waste-retrieval work is being carried out on the Magnox Swarf Storage Silo (MSSS), another of the legacy storage facilities constructed between 1964 and 1983. Once described as one of the highest-hazard nuclear facilities in the UK, it has been updated to provide all of the equipment required to retrieve the stored waste. It is now the site team's job to extract and move the waste into modern stainless-steel containment, to be placed in a new store prior to ultimate disposal in the GDF.

A recent government report, published in June by the Committee of Public Accounts, stated that the MSSS is leaking contaminated water into the ground and that the waste contained in the silo is likely to represent an 'intolerable' risk until the late 2050s. Although the report acknowledged that there is no risk to workers or the public, and that Sellafield is working to a regulator-approved plan to retrieve the waste, it claimed the waste retrieval was too slow and that Sellafield had "optimistically assumed performance would improve 24-fold" over the next decade. Hutton, however, explains why there is a clear route to achieving that.

"It is quite a challenging job, because the original priority was storing the waste to support reprocessing and, hence, keep the Magnox fleet operating, not retrieving it, so it went in with no real plan of how to get it back out," he says. "The first thing we had to do is make sure the old building was modernised to cope with the operational duty upon it and be able to last long enough, which required a big refit. At the same time, we had to work out how to get the waste out.

"If the waste is in a sludge-type form, you can hydrate it and pump it; if it's more discernible items, you can use a grab to get it out. We use both techniques across our ponds and silos. To move waste, we have to design and manufacture new containers to put it in, and a store to put those containers in. With the MSSS, we developed a retrieval solution with three heavily shielded mobile caves containing grabs, sitting on rails about 15 inches square, and spent a lot preparing the building to take the extra weight.

"It's serious engineering and we now have one of those machines operating, with the second one installed for commissioning. At the start of any operational phase, you're in a slow build-up. We've achieved 50 units so far in just over two years, so how are we going to get

up to nearly 600 in a decade? Well, we will have three machines in operation, not just one. We will soon have a new store and import route available, and we are analysing every step of the operation to make it all run smoothly and efficiently. That's how it will ramp up."

The other challenge is that the items of waste are not all the same and the crane-operating team does not know exactly what the silo contains. Hutton continues: "The operators are in a cab on the side of the machine, with a big lead-glass window, so they can see directly in, but they're doing most of it with the cameras – we have to expect to find the unexpected, then find a way to deal with it.

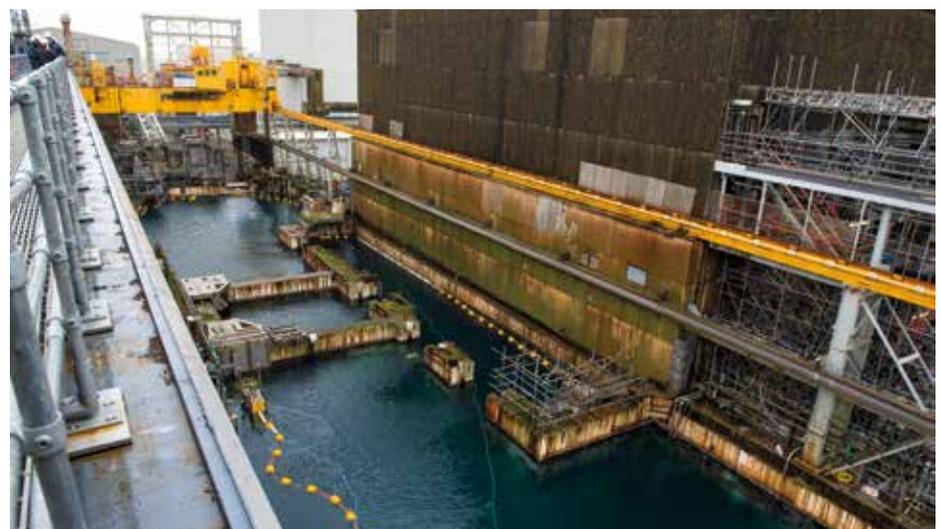
"When we started, we picked up a very heavy, lead-lined box and were nervous that, as we lowered into the waste container, it might deform the bottom. So we left it there and developed a special waste container that contained a shock absorber – a stainless steel, deformable egg-box-like structure in the bottom. When they went to pick it up, I thought they'd never be able to find it, but they picked it up first go, put it in the container and it worked perfectly."

MANAGING THE FUTURE

The planned construction of a GDF should, ultimately, see all of Sellafield's waste stores emptied and the waste siloed in tunnels up to a kilometre underground. The siting process is unique in that it is consent-based, and requires a suitable site and a willing community – so, if the community does not express support for the facility, it won't be built there. Nuclear Waste Services is currently working with two Community Partnerships, in Mid and South Copeland, and is making good progress.

Earlier this year, they identified areas of

“**We challenge and challenge ourselves [on security] and it's just not possible to create an unacceptable radiological consequence**”



First-generation Magnox storage pond

Nuclear power stations are really simple; they're just big kettles."

focus in these communities, where they are now doing more in-depth studies and investigations, such as environmental surveys, to guide where site characterisation work may be required. The next steps include a decision on the communities to take forward in the process, and the drilling of deep boreholes to enable more detailed investigations.

To prepare the waste for a GDF, Sellafield must empty old facilities and enable them to be demolished and cleared to make space for new ones, while also potentially expanding beyond the site's existing boundaries. Hutton explains: "We have a really supportive local community, a highly competent and motivated multigenerational workforce, and the capacity and capability to continue to support the UK, so we're working really hard to make sure we are available to whatever is required.

"We have a really detailed model that shows our physical space requirements, and our ability to decommission and demolish old facilities is built into that. I don't think we'll be able to fit it all inside the current fence line, but the NDA owns significant parcels of land next to the site, and we're working with local stakeholders on how to best use that space to deliver our mission and support the ambitions around clean energy development."

Sellafield is under constant improvement, which currently involves rewiring the site with a new 11kV ring main and substations. Hutton is also working on plans for future energy sources to support its steam processing – the energy for which, he embarrassedly admits, has been provided by a "relatively old gas-fired power station" ever since the closure of Calder Hall's electricity-generating nuclear reactors more than 20 years ago.

That former plant, in fact, is now in the process of being demolished to make way for new facilities and Hutton explains: "We have assessed every building on the site and put them into category levels based on how easy they are to knock down. With Calder Hall,

we have already knocked down the ancillary buildings and will be demolishing the two turbine halls soon. All this repurposing means the site is not becoming denser, but more of it is being used by nuclear buildings, as we are building the major new nuclear facilities on locations that didn't have nuclear facilities on them before.

"At some point, we may have to consider moving the site fence to use some of the land right next to the site for waste characterisation, segregation and interim storage while we await the GDF. The challenge is that there are different planning assumptions on when a GDF will be available, so we are having to plan carefully how we can use a smaller parcel of land in a much more efficient way, in a phased approach, depending on when that GDF becomes available.

"We'll have more than 5,000 tonnes of spent AGR fuel to condition for a GDF, and the new nuclear stations, when they are built, will have their own storage areas – in big casks made of concrete or steel – with enough capacity for waste from the entire lifetime of operation. It's not that big, maybe a football pitch size, and if we build a facility to condition for a GDF, we can make it versatile enough to manage all that spent fuel stored on other sites if we needed to."

The latest project, which will require a portion of the site to be repurposed, is the major programme on plutonium immobilisation. Announced in January this year, the work will involve putting the material – which is another legacy of reprocessing – into a form that reduces the long-term safety and security burden during storage and ensures it is suitable for disposal in a GDF. This will require a nuclear material processing plant and interim storage capability to be built at Sellafield – which Hutton describes as phase five of the site's evolution.

The UK's plutonium inventory is the largest civil stockpile in the world, consisting of around 32,000 packages. Hutton says the new construction project will be on a "similar scale" to the development of THORP half a century ago, and reveals that work on clearing the area where the sizeable new facility will be built is set to begin "within the next 18 months", with "multi-decades" set to pass before it completes its mission.

"Nuclear power stations are really simple; they're just big kettles," smiles Hutton. "I say that to my colleagues in EDF Energy all the time! This facility is not just a one of a kind, it's a first of a kind, and we're working really closely with the NDA, NWS, UK NNL, supply

chain partners, universities and colleagues on the technology for its development. Sellafield 'Phase Five' is going to be a combination of this, and available to deliver anything else the UK government and nuclear industry needs."

MODERN CHALLENGES

Given the site's significant stockpiles of radioactive material, Sellafield is one of the highest-security facilities in the country. Almost a billion pounds has been spent on developing the Sellafield Security Enhancement Programme and Hutton says that, since the 9-11 and 7-7 terrorist atrocities, every new building has been built to "take a direct hit from a fully laden passenger liner".

Over the past two years, the Office for Nuclear Regulation (ONR) has carried out a regular programme of enhanced inspections and interventions at Sellafield, in collaboration with the security and resilience team. More than 50 inspectors have regulated the site to ensure effective arrangements are in place against theft and sabotage of nuclear materials and, earlier this year, the site was returned to routine levels of attention.

Having spent much of his career in safety and security, Hutton has put priority importance on ensuring Sellafield has robust protection and says: "The site's physical security, I would suggest, is exemplary now. We have a new double-perimeter site fence with an additional security layer, an 'onion skin' approach, to more sensitive areas on the site. We also have physical protection, with all the tech on the fences for intruder detection.

"Everything is pulled together into a new main-site control facility, which is 78-hour black start, with sleeping bags, food, a big data hall with massive video walls and the site bridge, where you have the site shift manager, the police, fire brigade and all the support you need. It's really impressive, and all of those things came out of the requirements that were agreed with the authorities following the terrorist atrocities on 9/11 and 7/7.

"We also run a nuclear security committee, which involves independent members with physical security, military and cybersecurity backgrounds, and we're constantly reviewing our threat vectors and trying to think of potential things that could disrupt them. The regulator is brilliantly more devious than you can imagine in terms of the things it wants us to think about, so we're trying to stay one step ahead and to respond to global events."

Hutton says the site's experts, supported by independent specialists, run regular exercises on the systems to develop robust defences

against any potential attack, and he states: “We challenge and challenge ourselves, and it’s just not possible to create an unacceptable radiological consequence – which is the technical term. However, it’s a moving feast and you can never be complacent, so we work closely with the regulator to ensure we’re in a positive position.”

The cost of Sellafield’s ongoing clean-up is immense. The £2.8 billion of funding Hutton has for the next financial year is the site’s largest government grant to date, but is still not enough to complete its works as planned. Instead of making cuts, however, he is determined to use Sellafield’s spirit of innovation to overcome the shortfall.

“The teams we have here are amazing,” he says. “The skills involved, their enthusiasm – I’m constantly blown away by what they can do.

“My work is full of pressure, but when I go out on site and talk to people doing the work, I’m reinvigorated. We haven’t got enough money to do the things we needed to do in the way we planned to do them, so we will simply do them differently. That’s the challenge I’m giving to the organisation and I think we can take big chunks out of how we plan to do it, because that’s the nature of the people at Sellafield: they can rise to that challenge.”

As with most businesses, Sellafield is exploring innovations in AI, as well as robotics, to improve operations. Having been embedded in teams that have been innovating on the site for most of his career, Hutton believes his ability to lead from a position of technical competence puts the site in a unique place, with huge opportunities to drive forward future developments and improve the efficiency of operations.

“It gives confidence to people who are coming up with different ideas,” he says. “They know if they try new things, I’ll be supporting them, but also challenging them, making sure we’re keeping nuclear safety as a primary concern, but doing things differently.

“For example, we can now deploy Spot the robot dog from Westlakes, 10 miles away, through a highly secure cyber-resistant comms link, which means we are having to put fewer people on site, as they can re-train to deliver key work from off-site locations.

“Also, with the deployment of drones, we can do civil inspections on whole structures, roofs and chimneys, without putting anybody at risk. We’re also doing a lot with universities to develop a better understanding of site-specific challenges. Our wastes create

EUAN HUTTON CV

Hutton received a BSc in Applied Physics from Heriot-Watt University and joined Sellafield as a trainee. Since then, his two stints at the plant, and his experience from other industries, have taken him all the way up to the CEO role. These are the steps he took.

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| 1991 – 2008 | BNFL (Sellafield) Trainee in Commissioning, THORP (1991-96) Executive Support (1997-98) Waste Retrieval and Decommissioning (1998-2003) Safety Superintendent, Clean-up Directorate (2003-05) Head of Programme Delivery, Decommissioning (2005-08) |
| 2008 – 2010 | Project Director, Jordan Nuclear |
| 2010 – 2012 | Head of Decommissioning/Operations Manager Westlakes, Serco |
| 2012 – Present | Sellafield Limited Programme Manager, EHS&Q (2012-13) Head of EHS&Q Decommissioning (2013-16) EHS&Q Director (2016-18) Chief Nuclear Officer (2018-21 and 2022) Retrievals Value Stream Lead (2021-22) Site Director (2022-23) Chief Nuclear Officer (2023) Chief Executive Officer (2023 - present) |

hydrogen, for example, so we’re working with the University of Leeds to learn more about that, and we’re doing work on waste immobilisation with Sheffield Hallam, Sheffield University and Bristol.

“Innovative solutions are sometimes just the simplest thing, though, and I have been very keen to use AI in that way. I once went to an AI event where someone said ‘you don’t get AI to do the cool thing so you’ve got time to wash the dishes; you get AI to wash the dishes, so you’ve got time to do the cool thing.’ In that mindset, we’re now planning AI to do the boilerplate part of safety assessments, so our clever safety assessors can do the difficult bit.

“It’s about making the job easier so we can get more out of everybody’s hours at work. We’re also developing AI operator training, inputting the experiences of our longest-serving career people to provide insight on how a particular facility works. Then, when our new recruits arrive, they don’t just get access to the information – some of it is actually an avatar of a Sellafield worker telling them what to do. That’s going to be really helpful.”

The future of nuclear in the UK is exciting, with new gigawatt plants, SMRs, submarines and deterrents. Those coming into the industry could be forgiven for thinking Sellafield is just

all about the legacy of nuclear days gone by, not a hub of future innovation. That, however, could not be further from the truth. To manage the waste, new first-of-a-kind approaches are required all the time – and that, for Hutton, is the most exciting part.

“We’ve got so much to offer future graduates and people early in their career,” he explains. “If you play on the word significance, what is Sellafield? It’s doing many things of significance. It’s the biggest environmental remediation project in Europe, so if that is important to you, come and do it here; it’s all about sustainability and multigenerational impact, so if that’s what floats your boat, that’s us.

“If you’re interested in robotics, we’ve got some pretty cool robotic deployments, and we’re trying to expand AI; if you just like people, we’ve got 12,000 of them doing so many amazing things; and if you want to be part of the original mission as we move into this more dangerous world – and that was the thing that got me in – then we’re being asked to do a lot more things in that space.

“We’re not just about the end game – even though that is a long time. Sellafield is a nationally important asset, which means that we are delivering value to the UK today, and we will tomorrow. It’s exciting times, it really is.”