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International Nuclear Manufacturing Summit

Industry leaders set out the supply chain opportunities in the UK and beyond

University of Sheffield

CATAPULT
High Value Manufacturing

International Nuclear Manufacturing Summit 2022

The Nuclear Manufacturing Summit returned in November 2022 with expanded coverage of opportunities for the UK supply chain in the global nuclear market, a new venue, and enhanced networking activities.

Hosted by the Nuclear AMRC at Rotherham's Magna Science Adventure Centre, the International Nuclear Manufacturing Summit showcased opportunities in all the major programmes and explored how suppliers can win work now and over the next 30 years.

The Summit drew more than 300 delegates from along the supply chain for two days of intensive knowledge-sharing and networking – including more than 150 one-to-one meetings between suppliers and buyers to explore potential collaboration, and 45 companies showcasing their products and services in the exhibition space.

The first day featured senior speakers from all the major UK nuclear programmes, discussing their latest developments and supply opportunities. The second day, organised in partnership with the Department for International Trade and the Energy Industries Council, widened the event to cover export and collaboration opportunities in eight key overseas markets.

Both days were compèred by Rosa Wilkinson, head of policy for the High Value Manufacturing Catapult, and stage-managed by nuclear event specialists Marick.

This special edition of *Nuclear AMRC News* details the key messages for the supply chain from all the speakers, as a reminder for all the nuclear manufacturers who attended, and a resource for those who couldn't.

Great British Nuclear to provide market confidence

A long-term programme of nuclear new build projects is essential to delivering the UK's commitments to decarbonisation and energy security, according to a senior government advisor.

This is an incredibly important time for the UK nuclear sector, Declan Burke, director of the nuclear projects and development team at BEIS, told the Summit in his keynote speech. With around 80 per cent of the UK's total energy still coming from fossil fuels, the UK urgently needs to transition to a resilient and affordable mix of low-carbon energy sources.

BEIS believes that the most affordable solution features a mix of renewables and nuclear, with nuclear expected to provide around a quarter of the UK's power by 2050.

"We really see nuclear as the bedrock on which we can build a resilient power system," Burke said. "We're going to have a lot of renewables on the system, but nuclear is an existing strength of the UK, and I think now is a great time for the UK nuclear sector. To get that right, it'll be ever more important for government to work hand in glove with industry."

With total electricity demand expected to almost double by 2050 thanks to the decarbonisation of transport and heating, the optimum energy mix will include around 25GW of nuclear capacity with a mix of gigawatt-scale reactors such as the EPRs currently being built at Hinkley Point C and new designs of small modular reactor (SMR).

Delivering that in less than three decades will require a sustained programme of new build projects. "It needs to be a programme, it needs to give the sector the confidence to invest," Burke emphasised. "If we get it right, we'll see nuclear go on the same journey offshore wind did. You'll get into a virtuous circle of more deployment giving the sector confidence, leading to more investment and young people joining the sector. It's that long-term programme we're very keen to see."

In March 2022, the government's energy security strategy announced the creation of a new arm's-length body called Great British Nuclear to create a pipeline of new build projects and give confidence to investors and developers.

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Hinkley Point delivery: the final liner ring for the first reactor building was installed in December.

Essential programme:
Declan Burke, senior advisor at BEIS.

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"We think it's going to be really important that government is working really closely with industry, and that we're effectively tackling the barriers that have led maybe to a stop-start approach to nuclear new build in the UK," Burke said. "Having something at the centre of government, closely working with industry to attack those barriers, we think is going to be really really important."

Delivering a programme

Simon Bowen, formerly chief executive of Babcock International's nuclear business, was appointed by BEIS in May to lead the development of Great British Nuclear. Speaking to the conference by video link, Bowen emphasised that the nuclear sector first needs to deal with its reputation for failing to deliver to schedule, as well as the historic lack of trust between industry and government.

"The one thing we have got to sort is the pace at which we deliver, and we've got to do what we've said we'll do," he said. "The essence of us developing a successful nuclear programme is that we have to deliver on our promises."

Following a 100-day sprint of work with industry leaders to prepare proposals for action, Bowen's team submitted a detailed report to government in late summer. Two weeks after the summit, the government confirmed that it would go ahead with establishing Great British Nuclear, with a full response expected in early 2023.

An arm's-length body is essential to running a successful programme, Bowen argued. "Unless we can get a drumbeat of projects, we don't have an investible industry," he said. "This stop-start environment we've been involved in and the developer-led model that we've had previously have simply, in my opinion, failed. You have to develop a programme which has predictable numbers of projects to create certainty for the industry and for the investors."

The programme will require substantial government investment at the front end to create certainty for both gigawatt-scale and small reactors, and to provide support for industry in areas such as skills development.

"It's got to be government and industry – government to provide some of the seed funding to get the apprenticeship programmes and graduate programmes in place, then industry to have the courage to recruit and employ those people and give them really meaningful training," Bowen said. "If government is investing, we have to play our part. We have to create a vibrant innovative supply chain, and convince the government and ourselves that we can deliver to time and budget."

"If we are to maximise UK content, if we are to generate opportunities internationally, we need to grab the programmes and the contracts as they come through."

Andrew Storer, Nuclear AMRC.

Supply chain support

The Great British Nuclear report includes some 25 recommendations for action, with 11 coming from the supply chain, skills and capacity group led by Andrew Storer, CEO of the Nuclear AMRC.

The proposals aim to tackle gaps in the UK supply chain, where the total demand from new build and other nuclear programmes could easily overwhelm capacity in product classes such as valves or pipes. Demand could also easily outstrip capacity in equipment qualification and testing, materials and skills.

Proposed measures include a single approved vendor list for buyers across the sector to help companies access new market opportunities, and new internationally-recognised test facilities for product qualification.

"If we are to maximise UK content, if we are to generate opportunities internationally, we need to grab the programmes and the contracts as they come through," Storer said. "The opportunity comes from looking at all the demands – whether it's pumps, pipes, valves or vessels – and creating centres of excellence, so that if you're a company working in those sorts of products we can say to the customers work with this group of people."

While there have been a lot of supply chain interventions over the past 10–20 years, industry organisations need to get better at working together, he added.

"Great British Nuclear will be a fantastic intervention," Storer told the audience of manufacturers. "My hope for it is that we cluster a lot of the interventions that exist today together, to get a demand model that you guys can all see and get ready for."

New build

The UK is aiming for at least 24GW of nuclear capacity by 2050, with potential investment totalling hundreds of billions of pounds across a variety of large, small and advanced reactor technologies.

Leaders from the key programmes came to the Summit to discuss the latest developments and the opportunities for the supply chain.

EDF

EDF is successfully improving its fabrication and construction processes in its current new build project at Hinkley Point C, and will continue to drive efficiency gains at Sizewell C.

Paul Spence, director of strategy and corporate affairs for EDF, highlighted the efficiency improvements between the first and second units at the twin-EPR project in Somerset.

"I think everyone here knows that if you do something and you practice doing it, you get better each time – that is what we are already seeing happening at Hinkley Point," he told the Summit.

EDF has cut the time needed for several key construction steps by around 30 per cent, with digital twin technology helping drive the improvements.

Pouring the concrete for the turbine hall base slab was streamlined from 12 pours over 10 months for the first unit, to 10 pours over seven months for the second. Average time to install each tonne of steel was cut from 25 hours to 16. And welding time for the containment liner was reduced from 57 days to 39.

"We are showing for real, time after time, that if we have a programme and if we are purposeful about doing that, then nuclear can do what the other industries have shown that they can do," Spence said. "We can bring the cost down and the delivery certainty up."

Hinkley Point C is making good progress despite the challenges of Covid and Brexit, Spence noted, and EDF is still aiming to have the first 1.6GWe unit operating in 2027.

On track for 2027: the reactor pressure vessel for the first unit at Hinkley Point C was completed in December.

The French group is investing at least £18 billion in the UK – around 64 per cent of the construction spend for Hinkley Point – with some 3,600 companies already engaged across the country. If Sizewell C goes ahead (see p22), the portion of UK spend will be even higher. EDF and its key suppliers will also extend the lessons from Hinkley Point to further drive efficiencies at what it's calling units three and four of the UK new build programme.

"The time is now, the opportunity is now, the companies in this room are the companies that will deliver that," Spence concluded.

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New build

Westinghouse

Westinghouse and Bechtel's proposal to build at least two AP1000 reactors at Wylfa could be the UK's next new nuclear project after Sizewell C.

Wylfa is a tremendous site from a geological perspective, argued Mike Waite, director for new plant market development at Westinghouse, and would deliver significant economic benefits to North Wales.

The AP1000 differs from other gigawatt-scale reactor technologies because of the simplified design allowed by its passive safety systems, Waite noted. Its reactor island base requires about a quarter of the concrete used in other designs, and can be poured in less than 48 hours. The 1.1GWe reactor is also more flexible, and can change its output at 1MW per second to help balance varying grid loads.

Having completed the generic design assessment in 2017, the AP1000 is approved for UK new build. Four units are already in operation in the US and China, with another two nearing completion and others in the pipeline. Westinghouse is currently seeing strong demand across Europe, Waite noted.

"It's a proven reactor, it's breaking operational records in the four operational units, the start-up times have been extremely quick," Waite said. "We very much hope that there is a UK project, and the UK supply chain can first of all deliver those UK projects, but also participate in the rest of the European fleet."

Westinghouse also has a number of other reactor designs in development, including a 225MWe SMR, the 5MWe eVinci micro reactor, and a high-temperature lead-cooled fast reactor.

Advanced reactors

Advanced high-temperature reactors will present significant opportunities for the UK supply chain, but the technology developers are still seeking market clarity.

Several advanced modular reactors (AMRs) are under development for the UK market, with government support focusing on high-temperature designs which can be used in industrial decarbonisation, hydrogen production and other applications. Key figures came together to discuss the challenges in a panel led by Saralyn Thomas, chair of the Nuclear Institute's Young Generation Network.

"Looking at the UK supply chain, I think there is a huge opportunity for all manufacturers to get in on the advanced nuclear technology train," said Michael Drury, managing director of Terrestrial Energy UK, who is looking to deploy a molten salt reactor for grid and industrial use. "The market is clearly there, but what we need is the confidence to invest and deploy our technology. We need to have confirmation that the customer is there."

James Ewence of Cavendish Nuclear, who is working with US-based X-energy on its high-temperature gas-cooled reactor, said he is already talking to UK suppliers for major components such as pressure vessels. "We see it as a very real near-to-market technology, where the UK has got some great opportunities to bring in its supply chain with its gas reactor technology heritage," he noted.

Advanced expertise: Ewence, Rogers, Landon, Drury and Thomas (L-R).

Phil Rogers, technology lead at NNL, is working with a number of developers supported by the government AMR programme, and with Japanese partners on a potential UK demonstrator. Getting involved at an early point of development is key to delivering UK content in any reactor programme, he noted.

Material qualification capabilities for high-temperature reactors will be a major challenge, the panel agreed, as will the supply of specialist fuels.

Developing a skilled workforce will also be challenging, emphasised David Landon, CEO of MoltexFlex, who is planning to triple his workforce in the next few years to bring the firm's molten salt technology to market.

Rolls-Royce SMR

Supplier engagement is underway for Rolls-Royce SMR's ambitious plans to build a new generation of compact power station.

The company is now working through the design maturity process for its factory-built 470MWe reactor, with the aim of standardising the product for bulk production and deployment.

"When we look at our nuclear reactor and when we look at the build, it's the same thing time and time again," David White, chief operating officer, told the Summit. "It's not one unit we want to build, it's up to 100 units over a number of years."

The modular approach is intended to shorten the assembly process, taking lessons learned from the automotive and aerospace sectors, and using digital twin technology to manage the build process and ensure delivery to schedule.

With plans to build its first power plant in the early 2030s and rapidly ramp up to as many as four units a year, Rolls-Royce SMR sees a secure supply chain as key to delivery. "We want to build the large vessels, and we want to make sure the UK supply chain assurance is there and make sure we have UK jobs and skills," White said. "We can't do this on our own – we do need partners, we do need the supply chain to be with us at the beginning of this journey. It's a perfect time for anybody to speak to us."

In full production, the company aims to have up to 16 units in various stages of manufacture, with some three million components in each.

"That is an amazing opportunity for an amazing supply chain," said Alan Hartley, head of procurement and supply chain strategy. "We will be packaging it up into the right kind of systems, scopes and modules that make sense to us to enable us to build effectively and efficiently, but also into packages, systems and modules that are attractive to the supply chain."

Rolls-Royce SMR estimates an initial cost per unit of £2 billion, but is aiming to work with the supply chain to drive that down to £1.3 billion. Depending on value for money, repeatability, capacity and resilience, up to 80 per cent by value should go to UK companies once the programme is mature.

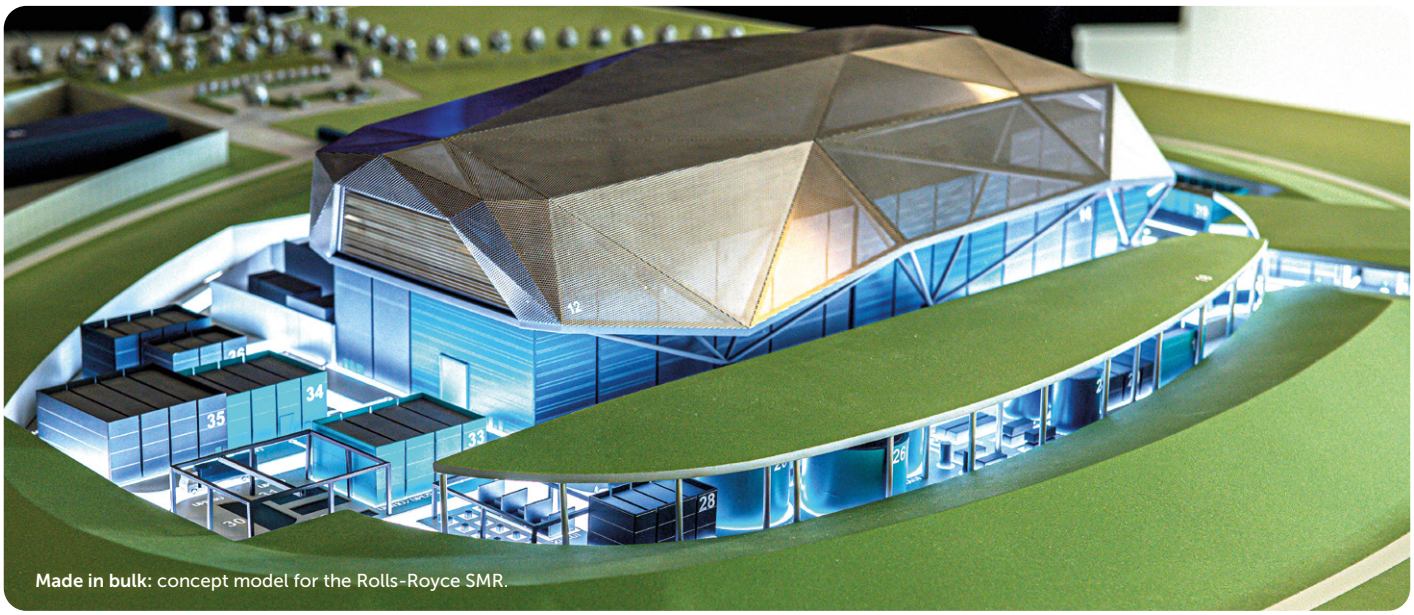
"For us to be successful, we need a supply chain with a difference," Hartley emphasised. "We need a supply chain that isn't just based on people coming from the nuclear environment – we need real diversity within our supply chain. To do that, we need a supply chain that's absolutely committed to meet our standards and the quality standards that we'll be looking for – and not just committed to achieving them, but delivering on a repeatable basis.

Amazing opportunities: Alan Hartley, head of procurement.

"We need a supply chain that is absolutely committed to a collaborative environment – not just vertically with us, but horizontally across the supply chain because we need to do this in a seamless manner."

Rolls-Royce SMR will host a series of supply chain conferences and market engagement events in 2023, and is preparing to launch a dedicated supply chain portal.

In December, the company announced the final shortlist for its first factory, with potential sites in Sunderland, Teesside and Deeside. A final decision is expected in early 2023.



Made in bulk: concept model for the Rolls-Royce SMR.

Defence

The UK is preparing for a major increase in supply chain requirements for nuclear submarines and other defence applications.

Mike Robinson, submarine strategy director at Babcock, highlighted the opportunities as he introduced a defence industry panel at the Summit.

Nuclear submarines are some of the most complicated machines that mankind has ever built and operated, he emphasised. "That is a phenomenal operational challenge, but I would argue that the engineering, the project and programme management, and the supply chain to enable that to occur is even more challenging," he said.

The UK sector is currently focused on delivering the Dreadnought submarine programme, and gearing up to replace the current Astute-class fleet. At the same time, 32 submarines are entering decommissioning.

Dreadnought's PWR3 reactor technology is a big evolution over previous designs, noted Simon Barnes, chief engineer for the project at Rolls-Royce. "It's significantly simpler, safer, more capable and more available than the reactors that are currently in service," he said.

Rolls-Royce took a three-phase approach to the reactor, starting with a capability-building programme including dozens of development projects with Rolls-Royce's network of manufacturing R&D centres. After first-of-a-kind manufacture and delivery for the first boat, the business is now in the third phase of leaner and more accelerated delivery, and is aiming to increase throughput.

"Our drumbeat is increasing – we're looking to broadly double the throughput compared to today, which is a significant ramp-up in effort," Barnes said. "We need the supply chain to respond to that."

Matthew Goodwin of Goodwin International, an established supplier to the submarine programme, brought the manufacturer's perspective to the panel. "We can see that there's going to be a massive increase in demand and capacity that's going to be required, whether that be machines, skilled labour and everything else to do that," he said. Suppliers will need a strategic lead on what orders will be available over the long term, he emphasised.

The UK is also preparing to replace its nuclear warheads. That programme will be on a scale not seen since the 1950s, said Gary Picking, AWE's chief manufacturing engineer. In the first pre-production phase, AWE will invest around £8 billion in new infrastructure.

Space

The UK supply chain can apply its nuclear expertise to new applications in outer space, Rolls-Royce's head of manufacturing innovation told the Summit.

Rolls-Royce is looking at a range of nuclear technologies to launch and propel spacecraft, as well as micro-reactors to provide heat and electricity for manned bases on the moon and beyond.

"Heat and electricity are really valuable commodities in space, and nuclear really hits both of those," said Professor Gary Jones. "We can't do it alone – we need supply chain, manufacturing support and technology centres to help us do that as a team."

Jones' team have spent 18 months studying UK capabilities for space nuclear and identifying clusters of expertise, and are looking to add more SMEs to the map. "The sky is no longer the limit – the galaxy is the limit," he concluded.

Galactic ambitions: Gary Jones, Rolls-Royce.

Decommissioning

With major programmes including the Geological Disposal Facility in the pipeline, the Nuclear Decommissioning Authority (NDA) is aiming to improve the way it works with suppliers.

The NDA spends around half of its annual £3.5 billion budget in the supply chain, noted Corhyn Parr, chief executive of Nuclear Waste Services (NWS), as she introduced a panel of decommissioning chiefs.

"We know that we've not always been really easy to work with as a supplier, especially when you get into manufactured products," Parr said. "We are really keen to hear about your thoughts on how we operate and what you can offer us from your organisations."

Following a strategic streamlining across the UK decommissioning estate, NWS is now one of NDA's four core subsidiaries, combining the former Low Level Waste Repository and Radioactive Waste Management businesses. It is responsible for delivering the Geological Disposal Facility (GDF), a permanent home for the UK's nuclear waste, at an expected cost of £30–50 billion.

The GDF will shortly enter its design and site suitability phase, with around £2 billion procurement planned in areas including design and engineering. The programme will look to draw on manufacturing expertise from the supply chain, as well as experience from other sectors such as mining.

NWS is also looking for outside assistance to improve its integrated waste management programme. "We looked across the whole of the £25 billion spend in this area, and we think we can save about 10 per cent by working differently with the supply chain and bringing in innovation," Parr said. NWS will hold its own supply chain conference in March 2023.

As one of world's largest and most challenging decom sites, Sellafield remains the biggest NDA subsidiary, with an annual spend of £2.5 billion. Around 64 per cent of that is spent with the supply chain, with about a third going to SMEs.

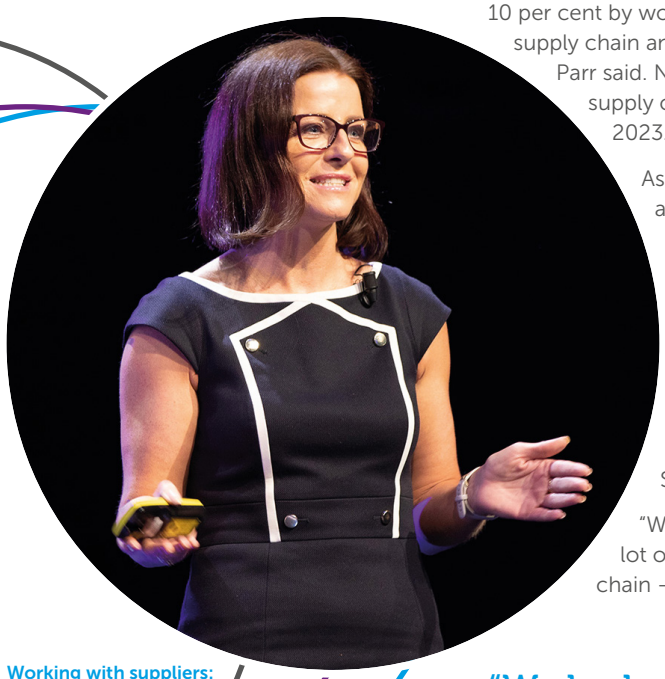
"We do recognise we do a lot of business in the supply chain – we are a complex company, and there are real opportunities out there," said Glen McCracken, head of remediation at Sellafield Ltd. "There's a lot of money being spent in the here and now on manufacturing and new technology to support the decommissioning programme."

Sellafield has introduced a new system of technology and innovation frameworks with key suppliers, and is preparing for a new tranche of 15-year decommissioning framework contracts worth some £4 billion total.

Current requirements include up to 15,000 $3m^3$ boxes for intermediate level waste, and up to 600 storage racks for spent fuel from the AGR fleet. Sellafield is also preparing various new build projects, including waste processing plants and plutonium repackaging facilities.

The NDA is meanwhile combining Dounreay with the Magnox estate to form another of its core subsidiaries (the fourth is Nuclear Transport Solutions). Dounreay is currently reworking its lifetime decommissioning plan to better identify priority hazards and opportunities, managing director Mark Rouse told the Summit, and has introduced a new innovation team to help suppliers connect with opportunities.

"They've been looking at what technologies and what problems we've got right through the site," Rouse said. "Previously, you'd have had to go through all our 90-odd projects to find out what was going on."



Working with suppliers: Corhyn Parr, NWS.

"We looked across the whole of the £25 billion spend in this area, and we think we can save about 10 per cent by working differently with the supply chain and bringing in innovation."

Fusion

The UK is a world leader in the rapidly maturing fusion market, with increasing opportunities for suppliers in a host of areas.

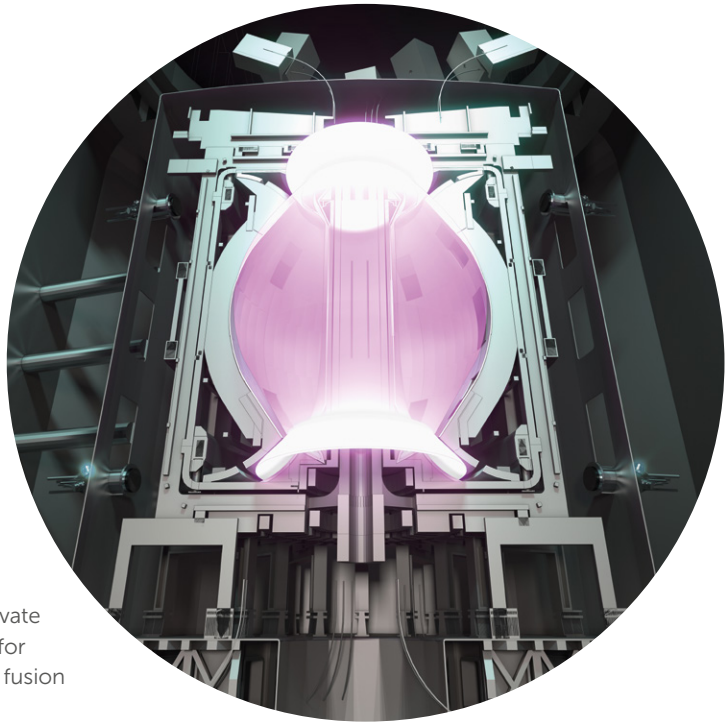
A maturing field: Ian Chapman, UKAEA.

"This is an opportune time to get involved with fusion," said Ian Chapman, chief executive of UKAEA, as he introduced a panel of fusion developers. "We're seeing more and more collaboration between the private sector and the public sector, and there are lots of pretty big opportunities coming in the near term."

Some of the biggest opportunities will come from UKAEA's own STEP programme, which aims to build a prototype power plant in Nottinghamshire by the early 2040s. Once the concept design phase finishes in spring 2024, the programme will enter six to eight years of detailed engineering design, including the start of procurement for long-lead items and test rigs.

Subject to government approval, UKAEA plans to set up a subsidiary to lead STEP development and partner with engineering and construction consortiums on the prototype plant.

Fusion company numbers and total investment are growing exponentially, Chapman noted. Around a third of fusion start-ups are based in the UK, and overseas developers are moving here to tap into the research base.



Prototype plans: engineering design for STEP will start from 2024.

Canadian company General Fusion came to UKAEA's home of Culham to build a pioneering public-private demonstration plant for its magnetised target fusion technology.

Norman Harrison, chair of General Fusion's UK arm, explained how the project is already generating opportunities for the UK supply chain. Sheffield Forgemasters has cast the first of 11 42-tonne rings for the fusion vessel, and General Fusion is looking for UK capability and capacity to supply the machine build and balance of plant.

Tokamak Energy, a spin-out from the Culham Centre, is meanwhile developing a series of increasingly sophisticated spherical tokamaks. The firm recently achieved temperatures of 100 million degrees, the threshold for commercial fusion power, in its ST40 test chamber.

Tokamak Energy is now working on its ST80 tokamak, which will be twice the size of the ST40. "We're going to need partners to help us scale up and manufacture the device," business development manager Tom Anderson told the Summit.

ST80 will be a stepping stone to an even larger grid-ready device called ST-E1. "We're looking for design and manufacturing partners who can go on that journey with us," Anderson said. "We want to try and accrue and retain the value of knowledge transfer from our next device, and onwards to ST-E1, the first of a kind, and hopefully the start of a nascent commercial supply chain."

Other companies have been created to address niche opportunities in fusion technology. "I think this is a sign of a maturing field," Chapman noted. "You've not just got people claiming to be vendors, you've got people thinking about how do you partner with the energy industry, how do you partner with nuclear companies?"

Kyoto Fusioneering is a UK-Japanese venture focusing on selected power core and plant technologies, and is working with a number of major UK engineering groups.

Commercial fusion power will require intensive material development and innovation, noted co-founder Richard Pearson. Kyoto is looking at silicon carbide composites for high-temperate neutron-resistant components, which will take a decade to get ready for use in a reactor. "Because of those long lead times, we're starting now," he said. "What's changed in fusion is we've moved from pure R&D into product development and manufacturing."

First Light Fusion focuses on high-velocity projectiles to create fusion conditions, and is currently designing the science facilities needed to develop the technology. "This is a technically diverse landscape," noted Dr Jamie Darling, lead engineer. "But where suppliers increasingly work in both fission and fusion, I feel that will help to solve common challenges and achieve better alignment."

International opportunities

The global push for energy security and decarbonisation is creating new export opportunities for the UK nuclear industry.

Energy security: Daniel Mosley, Lord Ravensdale.

In partnership with the Department for International Trade (DIT) and the Energy Industries Council, the second day of the Summit focused on eight key nuclear markets around the world. Speakers from industry and government discussed their major national programmes in new build, life extension, technology development and decommissioning, and outlined opportunities for UK companies to provide their expertise and products.

The day was introduced by Daniel Mosley, Lord Ravensdale, who as a principal engineer with Atkins is the only member of the UK Parliament working in the nuclear engineering sector.

Energy security is now at the top of every national policymaker's list, he emphasised. "We've realised what should have been obvious all along – we don't get security by relying on fossil fuels, we get insecurity," he said. "Nuclear is the ultimate in secure, homegrown, reliable energy, and energy security will be a huge factor in accelerating nuclear right across the world."

France

The UK and France are closely aligned in terms of nuclear policy, noted Pierre-Yves Cordier, nuclear advisor to the French Embassy in the UK. Both are committed to nuclear playing a large part in the net-zero energy mix by 2050, with EDF taking a lead role in new build.

France has long been a major user of nuclear power, and the government is now developing plans for between 13 and 27GWe of new capacity including gigawatt reactors and SMRs. EDF is proposing to build six of its EPR2 reactors, which incorporate improvements from EPR projects in the UK and other territories, with the first online around 2035.

"France is now back to really promoting nuclear energy and building new nuclear plant," Cordier said. "For the combined French and British supply chain, it's almost a 20-year visibility for new build just for this programme. This is already a tremendous opportunity for companies on both sides of the channel to work together, and I think this visibility is very important."

GIFEN, the French nuclear trade association, is now working with the UK's NIA to improve collaboration and develop a new supply chain platform to promote opportunities and tackle skills shortages.

"It's better if we think about it globally, than separately in the UK and France," Cordier concluded.

Central Europe

Energy security is also driving new nuclear programmes across central Europe. The EU's eastern states are currently home to almost a quarter of the total number of reactors across the bloc, and most are planning new large reactors or exploring SMRs.

There are many opportunities but also challenges for UK suppliers, said Luiza Craciun, lead for DIT's central Europe civil nuclear campaign.

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Preparing for decommissioning: VVER reactor hall at Paks, Hungary.

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"The scale of the opportunity that the Europe central region offers the British company is vast, but so is the effort that is being done by the competition," she said. "Although the UK is grasping these opportunities, it still lags behind the US and France here."

National programmes and ambitions vary between countries. For example, Poland has no current reactors but is planning 6–9GWe of new capacity, and signed an agreement for its first Westinghouse AP1000 in December.

Romania is meanwhile preparing to build two new Candu reactors, and is working with NuScale to deploy six of its 77MWe modules on the site of a former coal power station. That could be the first SMR project in Europe, pointed out Stella Ciulcov, head of purchasing at Romanian power company Nuclearelectrica.

Some countries with Soviet-era plant are now looking at decommissioning, and keen to learn from experienced UK companies. Hungary operates four VVER reactors which are due to enter decommissioning in the 2030s, but is also considering further life extension. "We are preparing ourselves for decommissioning, and we are keen to learn from you," said Dr Balázs Molnár, senior advisor at Hungarian power company MVM.

China

The world's largest nuclear new build programme is in China, where 54 current reactors are generating 52GWe but supplying just five per cent of the country's total consumption. Another 22 are under construction, and China aims to increase capacity in the near term to 70GWe by building six to eight reactors a year until 2025.

The country has an established supply chain covering the entire life cycle, but Zakir Chaudhry, deputy head of civil nuclear at DIT, told the Summit that UK suppliers with specialist expertise are winning work. There are opportunities in niche areas of valves, cables, instrumentation and control systems, as well as fuel handling and disposal equipment.

China is also investing heavily in SMR and advanced nuclear technologies, including high-temperature gas reactors and offshore floating plant.

And while there's no decommissioning planned in the near term, the authorities are already preparing for plant closures in 20–30 years' time.

"China has limited experience or capability in decommissioning, while the UK has extensive experience," Chaudry noted. "There appears to be interest in gaining benefit from foreign support for the decommissioning programme, and potential collaboration could cover areas such as specialist equipment, and cutting and dismantling technology."

United Arab Emirates

Chaudry also discussed opportunities with the UK's largest trading partner in the Middle East. The UAE has ambitious decarbonisation plans, with the last of its four new Korean APR1400 reactors at Barakah due to connect to the grid in 2023.

International collaboration: one of four new APR1400s at Barakah, UAE.

There will be potential opportunities for the UK supply chain to support operations and further build, but manufacturers will generally have to set up production in the UAE to deliver in-country value.

"The UAE will be looking for companies which can work harmoniously or in partnership with local companies to deliver this, particularly where the product and maintenance will be localised," Chaudry said. "For example, a valve manufacturer willing to site a facility in the UAE can win work."

Advanced plans: Isabella van Rooyen, US Department of Energy.

United States

The US is focusing on advanced reactor development to provide grid flexibility and industrial decarbonisation, and help drive domestic manufacturing and job creation. That means there's limited opportunities for overseas manufacturers, although there are opportunities for partnership in manufacturing and materials development.

Isabella van Rooyen, technical lead for the Department of Energy's nuclear energy enabling technologies programme, discussed work on technology demonstration and risk reduction for the near term, and reactor concept development for demonstration in the 2030s. "We are looking at advanced reactors from design to deployment," she said. "And it's not even just to deployment, it is from cradle to grave."

The national R&D programme covers advanced fuels, modelling, sensors, and advanced materials and manufacturing, with a focus on rapid qualification capabilities. "In all our interactions with industry, we hear one thing repeatedly – 'I

am not going to use your new advanced manufacturing techniques or your new materials because it is difficult to qualify,'" van Rooyen said.

UK organisations are supporting several of these projects, including the collaboration led by EPRI and involving Sheffield Forgemasters and the Nuclear AMRC to reduce production time for SMR pressure vessels (see p18).

There are opportunities for collaboration in areas such as quality standards for high-temperature materials, performance data in extreme environments, and qualification for heavy manufacturing. The DOE needs to involve suppliers more than it has done previously, van Rooyen acknowledged.

"We would like to invite both suppliers and developers to give us a showcase that we can work with you to prove our methodologies, and then scale up for manufacturing," she concluded.

Team sport: Karen Fritz, Ontario Power Generation.

Canada

Canadian power companies are also focusing on new flexible reactor technologies, with a significant potential market for industrial applications and off-grid supply.

Ontario Power Generation (OPG) is working with GE Hitachi to deploy four BWRX-300 SMRs at Darlington near Toronto – currently Canada's only licenced site for new build – and is talking to other SMR and AMR developers.

With OPG also engaged in a major refurbishment and life extension of its four Candu units at Darlington, chief supply officer Karen Fritz explained that the company is facing capacity issues. International collaboration and sharing of lessons will be vital to building an SMR supply chain and delivering a range of programmes.

"Demand will be high, and we really do need to work together," she said. "The energy transition is really a team sport."

Germany

Nuclear markets in other territories are meanwhile focused on decommissioning and waste management.

Germany, having taken a political decision in 2011 to end its nuclear programme, now has at least 15 reactors entering decommissioning. Simon Webb, executive director of Nichols Group, told the summit that there are significant opportunities for experienced UK suppliers to win a slice of the €22 billion national pot for decommissioning.

As well as reactor closures, Germany faces major challenges in waste management and storage. Alexander Vogel, head of sales for nuclear applications at Bilfinger, outlined the challenges at the Asse geological facility in Lower Saxony, where some 120,000 drums of intermediate-level waste were dumped in a former salt mine in the 1960s.

"They have geological problems – the mine is not stable enough, so they have problems with water coming in," he noted. Bilfinger is now leading work to develop innovative retrieval technologies, and is also supporting development of the new Schacht Konrad repository which will take up to 303,000m^3 of waste from 2027.

Japan

Japan is also entering a major decommissioning programme, after mothballing its 54-strong reactor fleet in the wake of the Fukushima disaster. Part of the fleet is now restarting to meet national energy security demands, but at least 24 reactors are set to enter decommissioning.

Japan is a challenging market for overseas suppliers, said Thomas Cross, nuclear counsellor at the British Embassy in Tokyo. Historically, the big three engineering companies – Hitachi, Mitsubishi Heavy Industries and Toshiba – have led nuclear programmes and directly managed supply chains made up of trusted partners and long-established suppliers.

"The flipside of that is that if you are the trusted partner, you are the person they go to. They will keep coming back to you," Cross said.

Decommissioning opportunities tend to be in niche capabilities. One example is a long robot arm used for fuel debris removal at Fukushima, which was manufactured in the UK based on technology developed for the fusion programme.

"If you have a capability that doesn't exist in Japan, it is worth exploring, but you will want to have a Japanese partner," Cross noted.

With a continuing moratorium on new build, the Japanese nuclear industry is looking overseas for growth opportunities, particularly in SMRs and AMRs. Companies are willing to work with local partners to support qualification to global standards, Cross said. And, as in the automotive sector, some companies may be interested in using the UK as a manufacturing base for Europe and other markets.

"There is the opportunity to interact on a more direct peer-to-peer basis at tier one, and also at tier two and tier three, and make collaborations happen," he concluded.

Executive **view**

The year to drive new build

Happy new year to you – I hope you all had a relaxing break over the holiday period.

It's a great time to reflect on things and look back at what we have achieved, but also to focus on the challenges and opportunities for 2023.

In previous articles, I have mentioned the urgency we need to build new nuclear, and the huge challenge to acquire the supply chain capability and capacity and the skills across Britain to ensure we can deliver and maximise the benefit to our economy.

I have mentioned my time spent in BEIS working to establish Great British Nuclear (GBN) as the vehicle for bringing together nuclear new build projects to achieve 24GW by 2050. At the Nuclear AMRC, we continue to develop specific interventions for the supply chain, and to help develop academies to address some of the skills gaps.

We all assumed GBN would launch in the autumn of 2022 but, at the time of writing in January, it has still not been launched. This lack of urgency and focus is not unusual, and has plagued the nuclear sector for well over a decade. The supply chain cannot hang around waiting, so the longer we wait the harder it will be to gather the capability and capacity to deliver.

On a more positive note, UKAEA is progressing well with its fusion programme and has selected the West Burton site for the STEP reactor. Being so close to our Rotherham and Derby facilities, this is a great boost for us. I was also really pleased that my colleague and friend Ian Chapman, CEO of UKAEA, was knighted in the 2023 new year honours list – congratulations to Sir Ian.

Further progress is being made in the defence sector, with more submarine reactors required for the UK and perhaps for the Australian programme. There is also a lot of progress being made with space reactors by Rolls-Royce, and we are working closely to see how we can help.

All of this plays back to the skills agenda and the capability/capacity to deliver across the sector. I am really pleased that the Nuclear Skills Academy we played a part in developing, which opened in September 2022, is going well with 200 young people having started their apprenticeships. Rolls-Royce is keen to expand this, and we are in discussions with them and others in the sector about another academy in Derby.

While we await GBN and hopefully more progress on small and advanced modular reactors, we also anticipate the outcome of the Future Nuclear Enabling Fund and Nuclear Fuel Fund – hopefully with GBN will come further interventions.

This year we intend to hold another Nuclear Manufacturing Summit to build on the hugely successful event in November. It totally beat all our expectations, so thank you to those that attended and supported us. I hope you will support us again this year.

The High Value Manufacturing Catapult has performed really well on the current grant, and looks in really good shape for its next five years' grant beyond 2024. That will ensure the Nuclear AMRC has the funding to invest and grow further capability.

With all the positive activity across the sector and potential for far more, I have appointed three new directors in my team: Tom Purnell as the Business Development Director, Chris Pook as our Government Policy Director, and Liz Gregory as our Supply Chain Director. I am really excited to have them on board at such an exciting time. We have also appointed Charles Carpenter as interim CTO, as Professor Steve Jones will focus on his role as professor of joining technologies for the Nuclear AMRC, the Catapult and the University of Sheffield.

Finally, the senior leadership team at the Nuclear AMRC have decided we would like to focus more on our corporate social responsibility. We are going to set ourselves some challenging targets for 2023 to raise money for charity, focused mainly on Macmillan Cancer Support for this year, and also helping local communities as much as possible. One major event for this year will be a team entry to the Keswick to Barrow 40 mile run/walk – watch out for more on this on our social media.

Hopefully 2023 will be the year for the sector to pick up new build and drive forward, as we all know is needed. This requires government to focus and commit, and I hope the work of GBN will be the catalyst for decisions.

Andrew Storer, CEO

Nuclear AMRC Midlands hits construction milestone

The new Nuclear AMRC Midlands facility is on track to open in spring, at the end of an intensive 10-month construction schedule.

Senior figures from the Nuclear AMRC and partners visited the site at Infinity Park Derby in early November to mark the topping out of the £20 million building. The team broke ground on the site in April 2022.

The new Nuclear AMRC Midlands facility will provide a permanent base in Derby for the Nuclear AMRC, and a new home for the University of Derby's Institute for Innovation in Sustainable Engineering (IISE).

"It's fantastic to see the progress that's been made on our new facility, especially when the UN climate change conference in Egypt is again highlighting the urgency of reducing emissions from all parts of the global economy," said Andrew Storer, CEO of the Nuclear AMRC. "As a nation, we need to build a new generation of low-carbon power plant, and we need to move industry to more sustainable manufacturing and engineering practices.

"The research that will be carried out in this facility will help tackle both of those challenges, and support manufacturers in Derby and beyond to seize the opportunities of the energy transition. I look forward to working with local industry, academic and government partners to deliver sustainable growth in the Midlands for generations to come."

The pilot Nuclear AMRC Midlands opened in 2019 within the iHub building on Infinity Park – now the home of the Nuclear Skills Academy led by Rolls-Royce and the University of Derby.

"Our pilot centre at iHub was a great success, and has helped start the snowball effect of creating a real community for industry and innovation at Infinity Park," Storer noted. "Along with our role in securing the Nuclear Skills Academy on the park, I am really proud of the role the Nuclear AMRC is playing to develop long-lasting support for the supply chain in the Midlands."

Topping out: Nuclear AMRC staff and construction partners visit the site in November.

The new 4,300m² facility will expand the centre's capabilities to better help UK manufacturers win work in the nuclear supply chain. While the Nuclear AMRC's original facility in South Yorkshire focuses on mechanical manufacturing processes for power plant components, Nuclear AMRC Midlands specialises in emerging technology areas including digital engineering, control and instrumentation systems, and additive manufacturing.

The new building, designed by Stephen George + Partners and built by Stepnell, is based around a large open-plan workshop which will host a flexible range of state-of-the-art manufacturing and research equipment, with ten metre ceilings and 50 tonne cranes to allow work on large fabrications and assemblies.

The Nuclear AMRC Midlands building is supported by Derby City Council, and part-funded by the D2N2 local enterprise partnership.

"It's great that we've been able to visit the site of the new Nuclear AMRC to mark this key milestone," said Councillor Steve Hassall, cabinet member for regeneration at Derby City Council. "This state-of-the-art facility is a great example of partnership working in action, and will offer a huge boost to our local economy and reaffirm our place as a national leader for innovation, manufacturing and world-class research and development."

"Along with our role in securing the Nuclear Skills Academy on the park, I am really proud of the role the Nuclear AMRC is playing to develop long-lasting support for the supply chain in the Midlands."

Andrew Storer, CEO of the Nuclear AMRC

New directors pledge increased support for manufacturers

Three nuclear industry leaders have joined the Nuclear AMRC's executive team to help more UK manufacturers win work in the sector, and ensure that the nuclear supply chain can play its full part in sustainable energy security and economic growth.

Liz Gregory has been appointed to the new role of Supply Chain Director following a key role in delivering the nuclear sector deal. Chris Pook joins as Government Policy Director after decades at the heart of UK science and technology policy. And Tom Purnell is the centre's new Business Development Director, joining from Frazer-Nash Consultancy.

Nuclear AMRC News asked the three to introduce themselves.

Liz Gregory

I am passionate about the nuclear industry and its success, having spent over 25 years working across the sector, spanning both the defence and civil programmes.

I have worked with UK and international customers, in business development, account management, project management, supply chain and equipment quality. More recently, I was seconded into UK government as director of the programme management office for the Nuclear Sector Deal. That led to work on the Great British Nuclear initiative, supporting the UK manufacturing supply chain workstream.

This experience has given me a lot of ideas to develop with the Nuclear AMRC to support and promote the UK supply chain, and position it to support the UK and global programmes in the best possible way.

My new role covers both supply chain and skills issues. I am keen to see the UK supply chain maximise its content in the UK nuclear new build programme, and I believe that innovation and collaboration will be key to seeing this opportunity realised. It's about identifying the opportunities for UK suppliers, signposting them, and making it easier for new entrants to have a clear route through.

We'll look to build on the good work we're already doing, but take on feedback from the companies we work with. A lot of feedback I've heard is about what's next – where are the opportunities, how do we get involved, how do we become a supplier to the tier twos or threes? We have huge programmes in new build, decommissioning and defence – how do we work differently to deliver those opportunities through innovation and collaboration?

On the skills side, it's all about supporting delivery to close the skills gaps that we've identified in the sector, and building on the work we've done with the Rolls-Royce Nuclear Skills Academy to support other organisations.

Having supported the development of Great British Nuclear, I understand the pinch points we've got as a sector, and how they need to be addressed. There's a lot of capability in this centre to do what's needed to address those gaps. The Nuclear AMRC is front and centre of a lot of what's going on in the sector, and we're ideally placed to really make a difference.

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Chris Pook

I am delighted to be joining the Nuclear AMRC at a time of great opportunity for the industry. As Government Policy Director, I focus on ensuring that the government understands the needs of the sector and the challenges faced by the UK supply chain, and the role of the Nuclear AMRC in addressing them.

Despite the political turmoil of 2022, it has been encouraging to see all administrations maintaining their support for nuclear and R&D. My job is to ensure that this support is maintained and that government at all levels is aware of the capabilities that exist in the Nuclear AMRC – a critical national asset for the UK.

I have been working for governments of all colours since 1993, most recently at the Government Office for Science with responsibility for science capability, systems, science and innovation. Part of this was to ensure that R&D funding was increased and used effectively across government, and that departments and agencies had access to the skills and capabilities required to deliver the vision of the UK as a science superpower.

I helped establish the Technology Strategy Board, the predecessor to Innovate UK, and represented UK science, innovation and industry in overseas postings in the US, Japan and Singapore. The insight gained from this will help me to understand how best to position the Nuclear AMRC to meet the opportunities and challenges of the future, and to understand what business needs from government.

I am very pleased to be moving back into a role focused on nuclear and the energy industry. Under the coalition government, I led development of the industrial strategies for nuclear and offshore wind, which included for the first time a legal requirement for offshore developers to state how they would support supply chain development, skills and innovation. Previously, I worked on a review of nuclear decommissioning and waste management, visiting all the major nuclear research sites. The review led to the creation of the Nuclear Decommissioning Authority, and focused UKAEA on fusion research.

In my new role, I will be working closely with Tom, Liz and the rest of the team to secure the future of the Nuclear AMRC as an essential part of the UK's industrial landscape. There will be a lot to learn, and a lot has changed since my first visit to Rotherham in 2012, but I am very much looking forward to the challenge.

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Tom Purnell

At the Nuclear AMRC, I am responsible for how we face the market, our relationships, membership and winning business – all of which are critical at a time of great change and opportunity within our sector.

My principal background is working for Frazer-Nash Consultancy and Rolls-Royce – in both the civil nuclear and SMR business – always in technically-biased business development and strategic roles. These have enabled me to gather a wealth of experience within the sector at senior levels, delivering key outcomes such as negotiating the formation of the Rolls-Royce SMR consortium, programme-managing international divestments, and leading consultancy services to key clients including BEIS and many nuclear vendors.

I have collaborated with and overseen delivery of projects with the Nuclear AMRC in my previous roles, and took Frazer-Nash through tier two membership. This has given me a good understanding of how the Nuclear AMRC works with our stakeholders, and how to provide best value through collaboration.

My inspection and services background allowed me to see so much of industry which really helps me understand the needs of the manufacturing sector, and I can apply my nuclear experience and track record for growth to support the industry.

In my new role, I want to drive the greatest impact and realise the much-needed new build aspirations for nuclear alongside key developments in the broader decommissioning, defence and energy markets. This will be achieved in part by winning work and delivering collaborative commercial and R&D projects, alongside developing the rights skills and capabilities with Liz in partnership with key bodies within the sector and the supply chain.

One of the main challenges facing manufacturers wanting to win work in nuclear is making sense of the developing opportunities, and where to target their effort and capability development to yield results. That is not easy, and will be a core focus of mine in our engagements with our collaborators and manufacturers.

I see the Nuclear AMRC as being a critical enabler within the sector, being a natural partner for many organisations. I am pleased to be its ambassador.

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New route to defect-free **pressure vessel welds**

The Nuclear AMRC has demonstrated a new way to prevent defects during the electron beam welding of circular sections of pressure vessel steel.

The research is part of the centre's ongoing collaboration with EPRI, with funding from the US Department of Energy, to develop industry-ready techniques for using electron beam welding to join thick-walled nuclear components.

Electron beam welding allows multiple arc welded passes to be replaced by a single deep-penetration weld. It could reduce welding costs for large fabrications such as pressure vessels by 40 per cent, and also provide material benefits.

However, circumferential welds of thick-walled cylindrical sections are particularly challenging, due to the risk of defects at the start and finish of each join.

On linear joins, the weld is typically started and finished on sacrificial sections, so potentially defective areas can be easily machined off. But if you're joining cylindrical sections to fabricate pressure vessels, there's no room for error.

The Nuclear AMRC team have now demonstrated a "slope out" technique which carefully controls the weld parameters and positioning of the electron beam at the start and end of each weld, minimising the risk of defects.

The team successfully achieved defect-free welds in SA508 steel sections of 80-90mm thickness, including a demonstration run on a mock-up pressure vessel assembly of 1810mm diameter. The results were validated against the ASME code requirements using non-destructive testing.

"Before this research, there was no published methodology to help an engineer to achieve such a defect-free weld," says welding engineer Thomas Dutilleul. "To obtain industry approval of the electron beam process, we need to provide enough confidence in it. This is a step toward this goal. We hope this will help other engineers to produce good welds and data, which will be important for fabricators and regulators."

Defect-free: the demonstration pressure vessel used in the welding trials.

Dutilleul presented the project at ASME's 2022 pressure vessels and piping conference in Las Vegas. The paper has now been published in the conference proceedings.

doi.org/10.1115/PVP2022-85478

Research for the **final frontier**

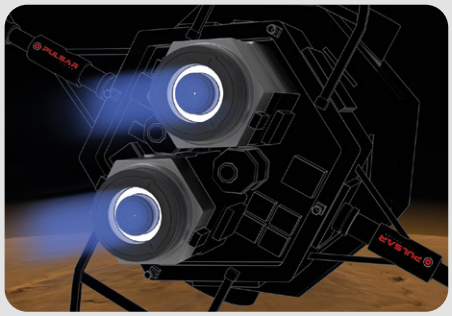
The Nuclear AMRC is working with a UK rocket company to develop energy-efficient spacecraft engines powered by nuclear fission.

Pulsar Fusion, based at Bletchley in Buckinghamshire, manufactures advanced rocket engines including Europe's largest and most powerful electric spacecraft engine. The firm focuses on plasma technology which promises to be significantly more energy efficient than conventional engines.

Pulsar's current engines are Hall-effect thrusters, which use an electric field to accelerate the propellant. The basic technology has been used in satellites since the 1970s, but the firm's ultimate aim is to develop hyper-speed engines powered by nuclear fusion.

Pulsar has now secured funding from the UK Space Agency (UKSA) to develop integrated nuclear fission-based power systems to provide the electric power for the thrusters.

"Combining this part of our propulsion portfolio with nuclear fission reactor technology is perfectly suited to the company's skillsets, and I am delighted that this has been recognised by the UKSA," says Dr James Lambert, the company's head of operations. "The project will help us to build relationships and gather important data that will contribute towards our longer-term ambitions for nuclear fusion propulsion."



During the two-year study, Pulsar will work with astronautic researchers at the University of Southampton, micro-reactor specialists at Cambridge University, and the Nuclear AMRC.

If the initial technology development is a success, the next phase could involve the production of a demonstration prototype of the engine.

pulsarfusion.com

30 companies enter hydrogen & carbon capture programme

Thirty manufacturing companies from across the UK are starting a new programme to test and develop their capabilities to supply the growing markets for hydrogen production and carbon capture.

F4H2 Fit For Hydrogen

F4CCUS Fit For Carbon Capture, Usage & Storage

In the year-long pilot programme for the Zero Carbon Humber Partnership, the companies will work towards the Fit For Hydrogen (F4H2) and Fit For Carbon Capture, Usage and Storage (F4CCUS) standards.

Zero Carbon Humber is a major collaboration of 14 partners with a shared vision to decarbonise the UK's most carbon intensive region, and transform the Humber into the world's first net-zero industrial region by 2040.

The pilot phase will see 30 companies progress through F4H2 and F4CCUS, beginning in November 2022 and running until December 2023. The programme, based on the proven Fit For Nuclear model, combines assessment against a variety of business excellence measures with sector-specific assessment and development activities.

The companies were selected from more than 90 companies which registered their interest in joining the pilot over the summer.

"Hydrogen offers a low carbon, scalable fuel source that has the potential to decarbonise major industrial clusters, such as the Humber," commented Ian Livingston from Zero Carbon Humber. "We are delighted to see steps being taken to test and develop the capabilities of UK companies to supply the growing hydrogen and carbon capture markets. Building these capabilities has never been more important."

F4H2 and F4CCUS are managed by the Nuclear AMRC, and the centre's regionally-based industrial advisors will work closely with the companies to help them close any gaps in their capabilities or performance.

"Our Fit For model of supply chain development has proven its value in helping companies develop their capabilities to win work in demanding energy sectors, and we're delighted to adapt it to help UK manufacturers rise to new opportunities in industrial decarbonisation," said Stephen Kinsey, supply chain programme manager at the Nuclear AMRC.

"As with other quality-critical sectors, it's vital that companies wanting to enter the supply chain for hydrogen and carbon capture understand the specific requirements of their potential customers and can demonstrate high standards of quality management and performance across their business. These new programmes will help UK companies take a first step into these emerging markets which will be essential for meeting our national commitment to net zero emissions by 2050."

The F4H2 and F4CCUS pilot kicked off in early November with a virtual meeting for all 30 participating companies and Zero Carbon Humber partners. The companies are now working through a common business excellence assessment and development programme, with an in-person meeting hosted by the Nuclear AMRC in the spring to begin the sector-specific development and discuss progress.

If they can demonstrate that they meet all the requirements, the companies will be awarded granted status in December 2023.

The 30 participating companies are:

Amarinth
BEL Valves
Capula
CMP Products
EFAB
Fan Systems
Goodwin International
Graham Hart (Process Technology)
Halifax Fan
Hayward Tyler
Honeywell Analytics
HSP Valves Group
Hydrobolt
KGD Enterprises
Laker Vent Engineering
Langfields
LBBC Beechwood
Ledwood Mechanical Engineering
Parker Hannifin Manufacturing
Porvair Filtration Group
Powertherm Contract Services
Proeon Systems
Rockford Components
Score Europe
SL Engineering
Solartron ISA
Sterling Thermal Technology
Swagelok Manchester
Tei Ltd
Woodcock & Wilson

F4N
Fit For Nuclear

New advisor brings industry experience to the north west

Industry veteran Andy Hinton is the latest recruit to the Nuclear AMRC's team of regionally-based industrial advisors helping companies develop their capabilities for nuclear and other low-carbon sectors. *Nuclear AMRC News* asked him to introduce himself.

I am a physicist by degree and an industrial engineer by experience, and have aided hundreds of enterprises across all industry sectors. I am committed to helping companies grow.

I was involved for many years with the Manufacturing Advisory Service and business innovation organisations, and understand the real issues facing manufacturers. I have delivered international consultancy on process development and improvement, and worked for companies such as Pirelli, Corning and Ocular Sciences.

I began my journey into the nuclear sector some 36 years ago at the Atomic Weapons Establishment and Admiralty Research Establishment, and have supported various companies in the nuclear supply chain during my manufacturing career.

One of my first roles as an engineer in industry was supplying cables to Sizewell B, so I understand the issues that nuclear suppliers face in developing products, processes and the associated paperwork.

As a Fit For Nuclear industrial advisor, I work with companies across north-west England. There is an established nuclear supply chain here, but it is going to struggle in the future when all the opportunities come through – there's not enough companies at present that can deliver work at the safety, quality and good management required.

I am looking for companies where I can help them understand the process. I see a lot of value in the small companies which are new to the game, but the ones that we can really help are the mid-sized companies that need a bit of guidance in professional ways of doing proven methods and engaging employees. The most important thing is that they are open to suggestion and willing to follow advice, treating us as part of the team.

As well as F4N, I am helping deliver the pilot Fit For Hydrogen programme. I have experience in working with hydrogen from a supply and use point of view, and understand what the industry needs and how careful they have to be in practice and storage.

The difference from the manufacturing point of view is the longevity of components, depending on where the parts are going. Working with hydrogen, the safety aspects are around tolerances and leaks, and the ageing it causes in materials like the embrittlement of steels. The nuclear side can be more complex, but the fundamentals of business excellence are the same.

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Congratulations to the latest companies to be granted Fit For Nuclear

Amarinth designs and manufactures centrifugal pumps and associated equipment for offshore, energy and other markets.
www.amarinth.com

Certex offers a full solution for lifting products and services for the industrial, oil & gas, renewable and elevator markets.
www.certex.co.uk

Chirton Engineering manufactures precision CNC-machined solutions for sectors including nuclear, oil & gas and renewables.
www.chirtonengineering.co.uk

Kloeckner Metals (Dudley) is one of the largest mill independent multi-metal stockholders and distributors in the UK.
www.kloecknermetalsuk.com

Michell Bearings designs and manufactures hydrodynamic bearings to the industrial, commercial marine and naval markets.
www.michellbearings.com

Score Europe (Brighouse) manufactures valves and fuel systems for markets including nuclear, defence, aerospace, utilities and energy.
score-group.com

Congratulations also to **Abbey Forged Products, Amazon Filters, Fan Systems, HV Wooding, Rhyal Engineering, Severfield Nuclear & Infrastructure** and **TSP Engineering** on being regranted F4N.

Michell Bearings puts safety culture first

Michell Bearings, a long-established supplier to the nuclear industry, has taken its safety culture to a higher level with help from the Fit For Nuclear programme.

Based in South Shields, Michell Bearings designs and manufactures hydrodynamic bearings for the industrial, commercial marine and naval markets. Founded in 1920 by AGM Michell, the inventor of the tilting pad bearing, the company is now part of the British Engines Group.

Michell Bearings has a long history of supplying into the nuclear market, says quality manager Jeff Hall, but did not hold any formal recognition of its capabilities for the sector. "The F4N programme was identified as an ideal way of helping us demonstrate to both customers and OEMs that Michell Bearings understand the unique requirements of the nuclear sector, and its commitment to delivering high quality nuclear products and services in accordance with the principles of a nuclear safety culture," he says.

The business already had a mature and robust business management system certified to ISO9001, ISO14001 and ISO45001, but the initial F4N assessment identified some areas for improvement around people and process excellence. These then formed the basis for the company's improvement plans.

"Although we were initially daunted by the journey, the whole process was easily managed through the excellent F4N portal which allowed us to benchmark the business and create action plans to improve in the required areas," Hall notes.

The action plans focused on rolling out nuclear safety culture training across the business, with the company using its new learning management system to engage the whole team. The firm also provided 6S training for shopfloor personnel, as part of a factory-wide programme to improve workplace organisation.

Embedded safety culture: inside Michell Bearings' South Shields factory

"To further improve our people excellence score, all non-managerial employees were asked to complete a safety climate questionnaire to gather views on health and safety in the business," Hall says. "This survey tool had been developed by the Health and Safety Executive, and was totally anonymous to allow individuals to express their thoughts on our strengths and weaknesses. The information gathered helped us look at what we do well, and which areas we need to improve on."

An increasing awareness across the business of the importance and criticality of nuclear-related work was one of the biggest benefits of the F4N journey, Hall notes. "By rolling out nuclear safety culture training, employees now have a better understanding on the importance of compliance to ensure that products and processes continue to meet the stringent and unique requirements in this sector," he says.

Michell Bearings was granted F4N in October 2022, becoming the third company in the British Engines Group, after CMP Products and Tyne Pressure Testing, to secure the hallmark.

"F4N status gives the business formal recognition of its capabilities," Hall says. "The business has already identified and targeted a number of UK and overseas nuclear projects which offer new opportunities for our bearings.

"Overall, we found the F4N process both enlightening and rewarding as it has enabled us to identify potential areas for improvement, and to improve awareness throughout the business on the safety-critical nature of this sector."

www.michellbearings.com

UK government to invest in **Sizewell C**

The UK government has confirmed it will directly invest in the development of EDF's nuclear new build project at Sizewell in Suffolk.

As part of a package of energy security measures announced in late November, the government will spend £679 million to take a 50 per cent stake in Sizewell C during its development phase. This will be the first direct UK government investment in a new nuclear power project since Sizewell B was approved for construction in 1987.

EDF is proposing to build two Framatome EPRs at Sizewell C, in a near-replica of its current project at Hinkley Point C. The French group is expected to make a final investment decision in 2023.

If Sizewell C goes ahead, EDF will provide additional investment to match the government's stake in the project, and both parties will work together to attract new third-party investment to help finance the project's construction and operation.

Sizewell C will be the first UK nuclear project to use the regulated asset base (RAB) investment model. RAB is designed to provide a more attractive investment profile for major infrastructure projects by reducing project risk for the investor and providing an income stream during construction, and has been used for other major infrastructure projects in the UK including the Thames Tideway Tunnel and London Heathrow Terminal 5.

By cutting the cost of nuclear project finance, RAB is intended to reduce the costs of electricity to consumers, with estimated lifetime savings of at least £30 billion compared with the contracts for difference model used at Hinkley Point C.

The government investment also allows for the exit of China General Nuclear (CGN) from the project. CGN held a 20 per cent investment share in Sizewell C, and retains a 33.5 per cent share in Hinkley Point C.

"This is a big vote of confidence in Sizewell C and we are very excited the government is partnering with us to prepare the project for further investment," commented Simone Rossi, CEO for EDF in the UK. "Sizewell C will build on the achievements of Hinkley Point C, and replicating its design will provide more certainty over schedule and costs. It will deliver another big boost to jobs and skills in the nuclear industry and provide huge new opportunities for communities in Suffolk. New nuclear will protect Britain from volatile global gas markets and help keep bills under control for the country's homes and businesses."

New dawn: government and EDF teams meet at Sizewell.

If approved, Sizewell C is expected to create 10,000 highly skilled jobs and provide reliable low-carbon power to the equivalent of 6 million homes for over 50 years. EDF expects to place 70 per cent of the value of the project's construction and operations contracts with the UK supply chain.

In December, EDF and the UK government announced an initial agreement with Framatome for the construction of Sizewell C. The framework agreement covers manufacturing the nuclear steam supply systems, managing obsolescence of instrumentation and control systems, and early engineering and procurement activities including preparation for long-lead forging components. Final contracts will be signed following EDF's final investment decision.

www.edfenergy.com/energy/nuclear-new-build-projects/sizewell-c

SMR developers apply for UK approval

The government is considering a string of applications from small modular reactor developers to enter the UK's generic design assessment (GDA) process.

Distributed power: concept design for Holtec's SMR-160.

The GDA allows the Office for Nuclear Regulation and Environment Agency to assess the safety, security and environmental protection of nuclear power plant designs. It is intended to support the construction of a number of new power stations by approving a standard reactor design which can be deployed in different locations.

GE Hitachi submitted its BWRX-300 boiling water reactor in December. The BWRX-300 is a 300MWe water-cooled, natural circulation SMR, with passive safety systems adapted from the US-licenced ESBWR. GE Hitachi says it has been designed to achieve construction and operating costs which are substantially lower than traditional nuclear technologies, and could be deployed as early as 2028.

"We believe the BWRX-300 is the ideal technology to help the UK meet its decarbonisation and energy security goals," said Sean Sexstone, executive vice president for advanced nuclear. "Through the GDA process we look forward to engaging UK regulators and enabling collaboration with their global counterparts."

The US-Japanese company's submission is supported by Jacobs UK.

US-based **Holtec** has submitted its SMR-160 design, a 160MWe pressurised water reactor developed in collaboration with Mitsubishi Electric of Japan and Hyundai Engineering and Construction of Korea.

Holtec proposes to deploy 32 of the reactors by 2050, to provide distributed baseload power as part of a diverse energy mix.

"I believe we will need multiple, complementary nuclear power plant designs based on proven PWR reactor technology already in the United Kingdom to assure carbon-free energy security ten years from now, and we have to start now," says Dr Richard Springman, senior vice president at Holtec Britain.

Holtec Britain also announced a joint memorandum of understanding with Balfour Beatty and Hyundai on construction planning, for potential sites at Trawsfynydd, Heysham and Oldbury.

Other applications have come from new developers.

US-based **X-energy** is working with Cavendish Nuclear to deploy its high-temperature gas reactor in the UK. The reactor is aimed at industrial decarbonisation as well as electricity generation. X-energy says its first units will be deployed in the US from 2027, with the UK to follow.

UK Atomics, a subsidiary of Danish-based start-up Copenhagen Atomics, is developing a containerised thorium molten salt reactor. The firm says it has already constructed a prototype reactor, and is aiming for first deployment in 2028.

UK-Italian start-up **Newcleo** focuses on lead-cooled fast reactors. The company is aiming to develop a 30MWe micro-reactor by 2030, followed by a 200MWe reactor fuelled by waste from existing nuclear plant.

And **GMET**, a Cumbrian engineering group which last year acquired established nuclear supplier TSP Engineering, says it is developing a small reactor called NuCell for production at TSP's Workington facility.

So far, Rolls-Royce SMR is the only SMR developer to formally begin GDA. The firm submitted its 470MWe design in November 2021, with the regulators starting the first stage of assessment in April 2022.

For the latest on SMR developments in the UK: **namrc.co.uk/intelligence/smr**

Energy security: GE Hitachi's BWRX-300.

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