

The UK's National Nuclear Laboratory

This is NNL

Strategic Plan 2021

Nuclear Science to Benefit Society
#NewClearFuture

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1.1

CEO's Introduction

Thank you for taking the time to read our Strategic Plan which sets out how NNL, the UK's national laboratory for nuclear fission, is benefiting society through nuclear science.



Dr Paul Howarth

NNL Chief Executive Officer

In a sector that is characterised by its investment in infrastructure, it may appear incongruous that I begin by emphasising that the most important asset for our future success is our people.

At NNL we are fortunate to be gifted with some of the most creative and inspired scientific experts in our sector, in the world. Everyone in our workforce is here to deliver environmentally and financially sustainable solutions to some of the world's biggest challenges. We combine the decades of expertise of sector veterans, whose science has been at the forefront of nuclear technology over the past 30 years, with an emerging generation of talented and idealistic scientists, engineers and professionals.

This combination of hope and experience, and shared sense of purpose, provides us with the fortitude to maintain and build our distinct identity as the technical authority on nuclear fission; promoting UK skills and interests and solving global challenges.

Across NNL we take seriously our stewardship of a unique set of facilities and capabilities that enable ground-breaking nuclear research and development.

We are leveraging the UK's rich nuclear heritage to help solve global challenges in four strategic areas: Clean Energy, Health and Nuclear Medicine, Environmental Restoration, and Security and Non-Proliferation. These are the cornerstones of our ambitions, shaping what we deliver for our customers and for UK society, and how we invest in our future.

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At a time when society is waking up to acting on the environmental crisis our planet faces, it is impossible to overestimate the scale of the challenge ahead for the UK in reaching net zero by 2050.

Without nuclear, the UK will not meet this target on time. And without NNL's work, the UK nuclear sector cannot deliver what is required.

Throughout this plan you will find details of the scale of our necessary ambition and commitment to bringing the UK back to the forefront of global nuclear research and development. We recognise the call set down by the Government's Chief Scientific Adviser for all Public Sector Research Establishments to help drive growth and innovation across the UK; this responsibility is embedded within all we do.

Whether it is accelerating a UK demonstration programme for Advanced Modular Reactors or delivering our first indigenous supply of medical radioisotopes since the 1960s, NNL will be at the forefront of game-changing advances that will help to transform the environment and people's lives, now and into the future.

And it is our people here at NNL who will be driving this forward, supported by our customers and partners in government, academia and the private sector both in the UK and worldwide.

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The North West, which is where all four of our laboratories are located, has long ties to being the engine room of the UK's energy provision and our approach will bring new, high paid and high-skilled jobs to the area, as well as vast manufacturing and supply chain opportunities.

As we move to a clean energy system that combines renewables with nuclear, our region's historic achievement continues to shine as a beacon for new nuclear technologies and the hope of a carbon neutral economy to come.

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I hope that this document excites you – as it does all of us – about the potential and ambition we have at NNL. As the UK enters a new phase in all our lives – post-Brexit and, we hope, post-Covid-19 – we all need to believe, invest and trust in ourselves and our own abilities and expertise to deliver a better world.

At NNL we have all the evidence of why that trust in us is justified. We look forward to building on this and continuing to develop and promote the UK's capability as a global leader in the opportunities that nuclear presents.

The UK's National Nuclear Laboratory in numbers

£1.5 billion

the value of the nuclear facilities we manage



35

Organisations from around the UK have accessed our special facilities over the past six years, including innovative SMEs and startups, all focused on finding solutions to nationally important issues

4

World-leading laboratories in the heart of the north west:

In Seascale, Cumbria, at Sellafield

Central Laboratory

NNL's flagship, the most modern nuclear technology research facility in the world and an asset to UK and global nuclear research and development

Windscale Laboratory

Unique in the UK, and vital to the nuclear industry, it works with operators to ensure the continued safe running of our nation's nuclear reactors

In Workington, Cumbria

Workington Laboratory

A large and flexible industrial space for developing technology and skills for the UK's nuclear sector

In Preston, Lancashire

Preston Laboratory at Springfields, Lancashire

A centre of excellence for the next generation of nuclear fuels and clean energy technology

3

Other research sites at Risley in Cheshire, Stonehouse in Gloucestershire and Culham in Oxfordshire

Unique Expertise

400
scientists

150 PhDs
plus **100 PhDs** sponsored across
UK universities

10,000 years
combined years of expertise
in nuclear science

Nuclear Science to Benefit Society

4
Focus Areas

Clean Energy
Health and Nuclear Medicine
Environmental Restoration
Security and Non-Proliferation

Opportunity and Prosperity to Benefit the North West

1,000+ employees

including

600

in Cumbria

300

in Cheshire

130

in Lancashire

180

high-skilled jobs created in the North West in 2020/21

×2

we doubled our intake of apprentices and graduates between 2020 and 2021

£133 million

per year added to the local economy, with

1,740 jobs

supported in our supply chain, directly and indirectly

Global Leaders in Nuclear Science

In the UK



Anne-Marie Trevelyan
UK Energy Minister

“Nuclear power provides a reliable source of low-carbon electricity, which is why new and advanced nuclear are key parts of our Ten Point Plan for a Green Industrial Revolution. The National Nuclear Laboratory is at the forefront of pioneering innovation and remains a world leader in nuclear research and development. I am delighted that NNL is playing a critical role in developing next-generation nuclear fuels and fuel cycles, helping us build back greener and eliminating the UK’s contribution to climate change.”



Dr Tim Stone
Chair, Nuclear Industry Association and
Co-Chair, Nuclear Industry Council

“2050 is talked about as a tipping point in terms of climate change, but now is the tipping point if we’re going to do something about it, because without nuclear there will be no net zero. Period. There is a colossal task ahead to rebuild the UK’s entire primary energy supply system which will shape the lives of our grandchildren and beyond. The combination of NNL’s world-leading facilities and scientific expertise will strengthen the whole of the UK nuclear sector to achieve this.”

In the North West



Trudy Harrison MP

Member of Parliament for Copeland

“I’m proud that my constituency of Copeland is home to much of the fantastic work done by the National Nuclear Laboratory. NNL plays a vital role both in developing clean energy technology in support of the UK’s net zero commitment, and also in supporting high-quality skilled jobs both in Copeland and across the North West of England.”



Damian Waters

Regional Director, North West, CBI

“NNL have been long-standing supporters of CBI in the North West, and represent the kind of business I’d love to see more of in the region. Their work supports hundreds of high-value jobs, helps position the region as the focal point of Britain’s science superpower aspirations and underpins the role of the North West in delivering clean energy and achieving the UK’s commitment to net zero.”

Around the World



Kirsty Gogan

Co-founder, Energy for Humanity

“I’ve been pleased to work closely with NNL on our shared goal of ensuring that competitive, reliable and sustainable energy supplies are available across the globe – with nuclear energy as a key element of that future mix.”



Dr John Wagner

Lab Director, Idaho National Laboratory

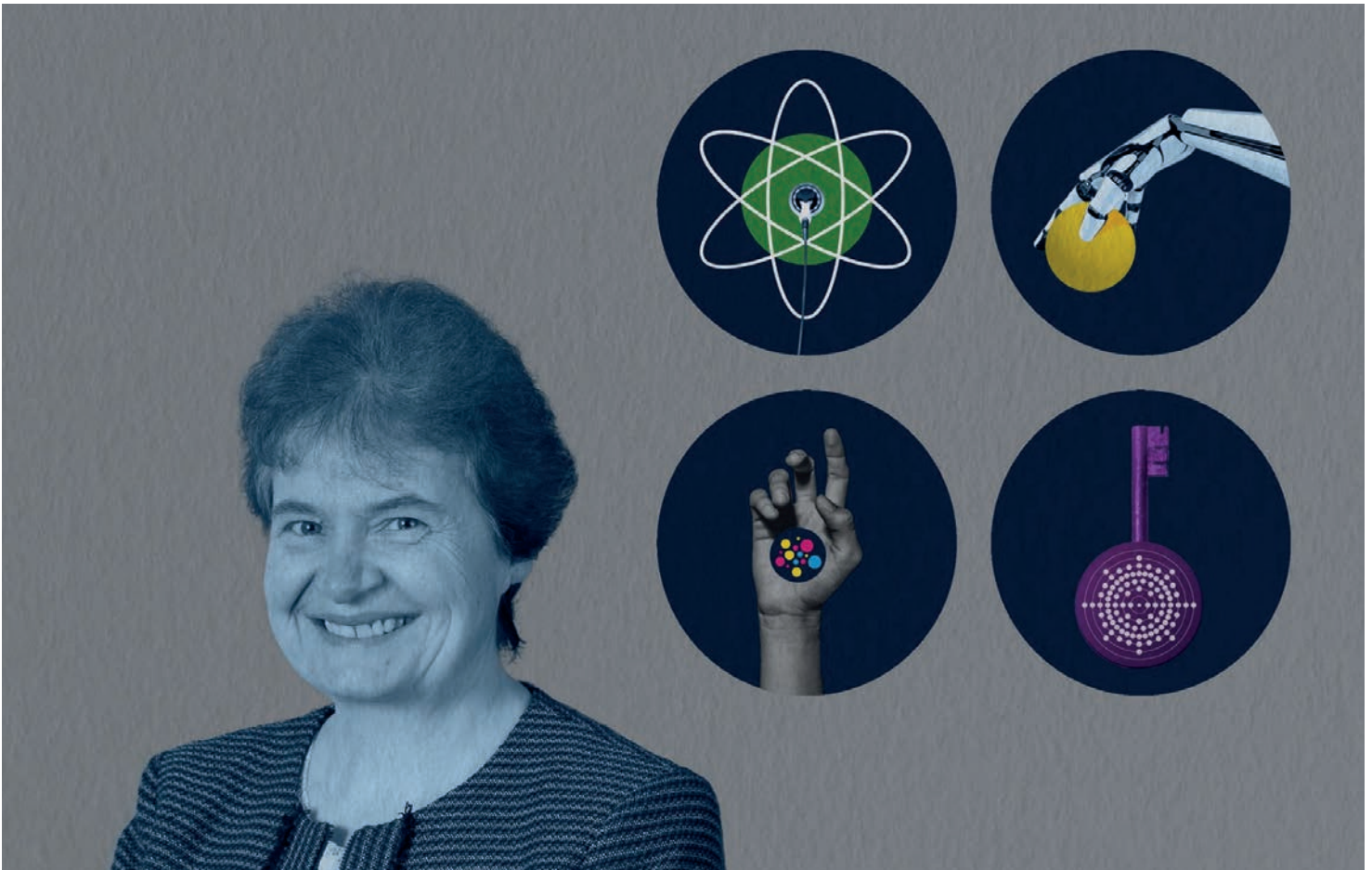
“The UK’s National Nuclear Laboratory is globally recognised for its combination of world-class facilities and subject matter experts. We look forward to working more closely with NNL in the future, benefitting from one another’s experience and insight, in our shared drive to deliver cleaner energy supplies for the world.”



Dr David Hall

Former UK Representative to IAEA and UK Governor to IAEA Board

“The UK National Nuclear Laboratory is recognised as one of the ‘crown jewels’ of the UK civil nuclear sector.”



1.4

Interview with our Chief Science and Technology Officer, Dr Fiona Rayment

1. The theme of NNL's strategy is nuclear science to benefit society. What does this mean to you?

Every so often in your lifetime, if you are lucky, you come across a window of opportunity where everything comes together at a single time and you feel you can really make a positive difference. I know this sector is going to help the country achieve so much of what it needs to do.

I don't just mean climate change, but the wider energy challenge too, the likes of which we have never seen before either nationally or internationally. The demand for electricity could double and even quadruple just as we are trying to reduce our carbon dioxide emissions to net zero.

To meet that target, we will need to completely and utterly transform the way we produce and consume energy; not just electricity but the totality of what we do as a nation both within our homes and industrially. I've been in this sector for 30 years and the reason I got interested in energy is because we could never take the supply for granted when I was a child - not only do I remember being sent home to study three days a week during the miners' strike because there wasn't enough heat for school buildings, I also remember in a separate year having to do my homework by candlelight because of power cuts.

By providing clean, affordable and reliable energy, nuclear new build projects and our advanced technologies will make a fundamentally important contribution to our future energy mix.

Coupled with that, there are some really significant opportunities to take what we know about nuclear science and apply it to other areas, not least in healthcare which is another great example of how our sector can directly improve people's lives.

There are space applications too and it was so exciting earlier this year to see NASA's Perseverance rover, which used a nuclear radioisotope for electricity and heat, landing on Mars.



2. NNL's work is going to be focused on four Focus Areas. Tell us about how and why these were chosen:

Our Focus Areas make perfect sense because they all have three qualities in common: they are all greatly needed by the UK, they are all areas we are working on now, and they all are areas where we have the capability – by which I mean the infrastructure and skills – to expand and work with the whole of the nuclear sector to successfully contribute.

Our first Focus Area is Environmental Restoration. Historically, a lot of NNL's focus has been on researching how we produce fuels and materials and how to recycle them once they have been used within a nuclear reactor. Because of this work, our experience and expertise in decommissioning and waste management is recognised throughout the world.

We have a distinctive heritage in Environmental Restoration, but our skills, knowledge and infrastructure play into all three of our other Focus Areas. Take our Clean Energy Focus Area, for example, which is very important to the UK, with the contribution of large, small and advanced nuclear plants featuring strongly in the government's Energy White Paper and its Ten Point Plan for a Green Industrial Revolution. We are applying our expertise in fuels, spent fuels and a whole range of other subjects such as materials chemistry to drive the Clean Energy agenda.

Our third Focus Area is around Health and Nuclear Medicine. It draws on the experience, expertise and credibility I have described and looks at how this can be applied to other societal needs. A lot of what we have done over the years includes the separation of radioisotopes to very high levels of purity so that they can be recycled for new purposes. Just as a radioisotope has been used by NASA in space, they are also used in healthcare. We are aiming to springboard the expertise we have to develop new capability for the future, focusing on supporting the medical community to diagnose and treat a range of debilitating health conditions from cancer to dementia.

Last, but by no means least, in order to do all of this you have to make sure the materials that are used are managed safely and securely, not just now but in the decades to come. This is why Security and Non-Proliferation, an area we already have significant capability in, is our fourth Focus Area.

3. Developing next generation reactors is part of the government's plan for a Green Industrial Revolution. What are the priorities for NNL in delivering this?

Advanced reactors offer the potential for the nuclear sector to help create not just the step change in the quantity of zero carbon electricity the UK needs, but also to replace fossil fuels much more widely by creating a new supply of green hydrogen, fuels and heat. Partly because of this, they offer other significant benefits including making the system work in terms of economics and finance.

This is why it is really important that the UK explores advanced reactors. Our priority is to enable the government to set the right roadmap for the sector to deliver on this technology, and to enable the sector to deliver what is needed by society.

But before we can have advanced reactors running in the UK, we need to run a demonstrator, which we want to do in partnership with other nuclear organisations in the UK. Because of the infrastructure we maintain within NNL, we can support the UK's understanding on the materials, fuels and waste management aspects of advanced reactors. We also have reactor physicists and engineers who understand the operations of reactor systems and will be able to look at how they operate, what their optimum safe envelopes are and also what the economics of each system are before they are brought to market.

Collaboration is key in the nuclear sector, because no single area of expertise resides in just one organisation. We would like to be in a

situation where we operate a user facility for our infrastructure, so that academia, other national labs and the entirety of the supply chain can all access it. It will be the nuclear industry that goes on to sell and utilise reactor technology but our role is to underpin what the technology does, so that it can be successfully deployed within the commercial marketplace.



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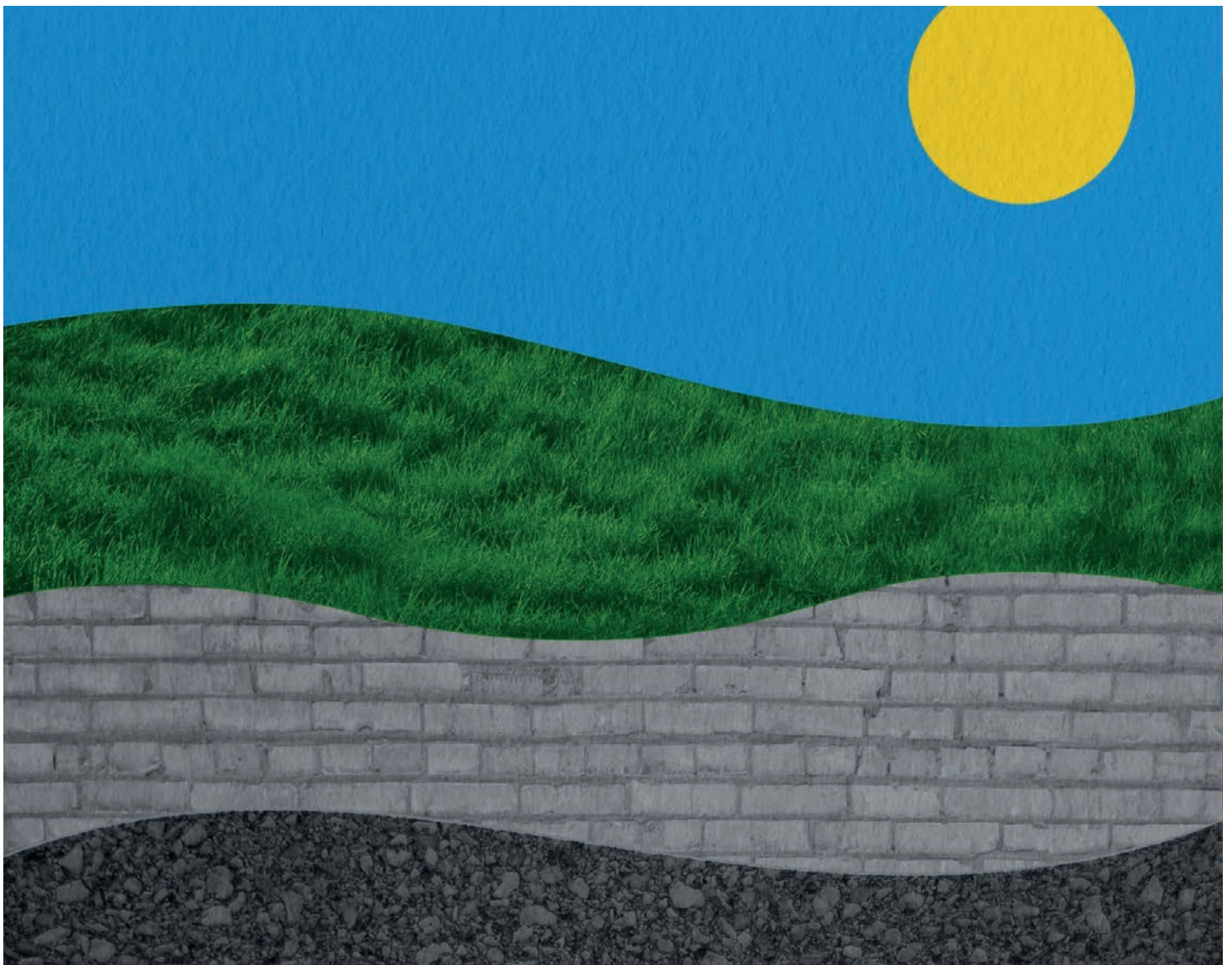
4. What do NNL's plans mean for the North West of England, and for the UK's post-pandemic recovery plan?

Not all of our sites are in the North West, but our four laboratories are. By creating these opportunities in the region, we will be bringing high-skilled jobs and economic stimulus to our communities. This dovetails completely with the government's agenda not just to unleash innovation, but also to level up regions including the North West and help our economy bounce back better from the coronavirus pandemic.

5. Later on in this Strategic Plan, we ask staff in the first few years of their career what they hope NNL will have achieved in 50 years' time. What's your answer to this question?

I hope that NNL has enabled the nuclear agenda to be back on track here in the UK, that our Focus Area of Environmental Restoration continues to move from strength to strength and we are reusing our decommissioned sites in the UK to better effect in the future; that a number of large, small and advanced nuclear reactors are operating in the UK, not just generating power but providing for the totality of the energy system that the UK requires; that NNL is generating radioisotopes to benefit medical diagnostics and treatments; that we are continuing to ensure the UK is an international thought leader in security and non-proliferation; and also for NNL to continue working with other sectors, including space and aerospace, to enable them to be successful.

People are the currency of the nuclear industry and as such I would like to see a diverse and innovative nuclear sector and NNL playing a pivotal role in establishing this.



2.1

Delivering for the New Nuclear Landscape

The nuclear landscape has changed.

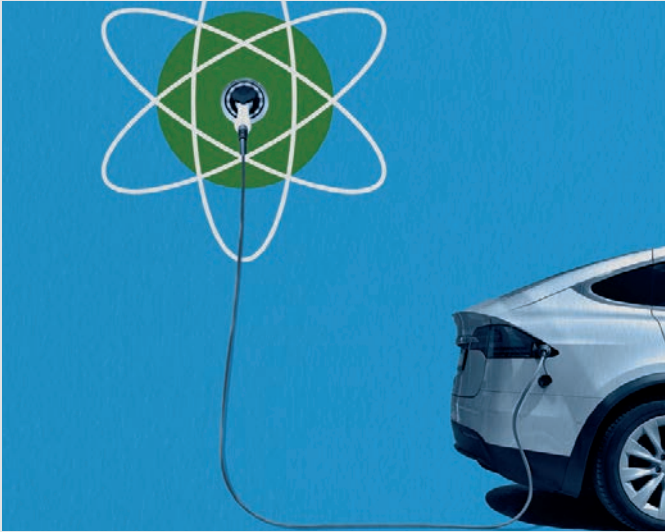
With a legally binding commitment in the UK to bring all greenhouse gas emissions to net zero by 2050, and more than 120 other countries moving towards the same target, existing and emerging nuclear technologies offer financially and environmentally affordable solutions to some of the world's biggest challenges.

Our strategy has evolved to meet the needs and opportunities of the new landscape, unleashing innovation across the whole of the UK's nuclear sector.

This programme of work will deliver on the government's agenda of making the UK a science superpower whilst bringing high-skilled jobs to the North West and helping the country's economy recover from the economic impact of the global pandemic.

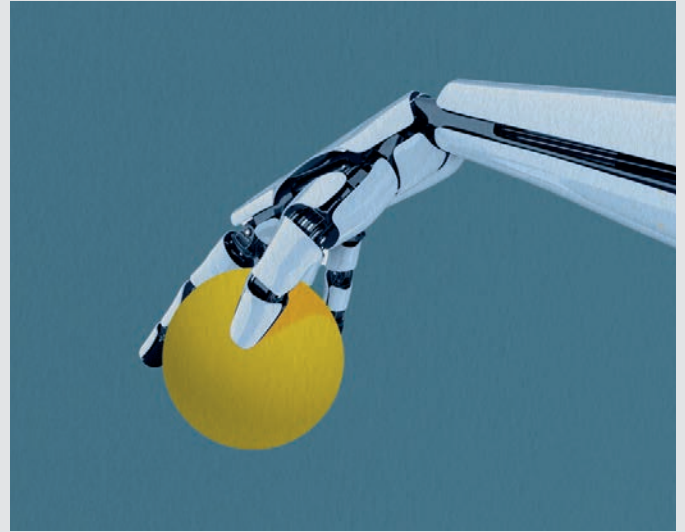
Focus Areas

We are building on the world-class solutions and successes we have already delivered to create a new agenda with four Focus Areas.



Clean Energy

Securing the UK's place as a global leader in the clean energies of the future by developing advanced nuclear technologies and leading their deployment



Environmental Restoration

Driving a step change in the way legacy and future wastes are processed by applying innovative science and breakthrough technologies



Health and Nuclear Medicine

Establishing an indigenous UK supply of vital medical radioisotopes

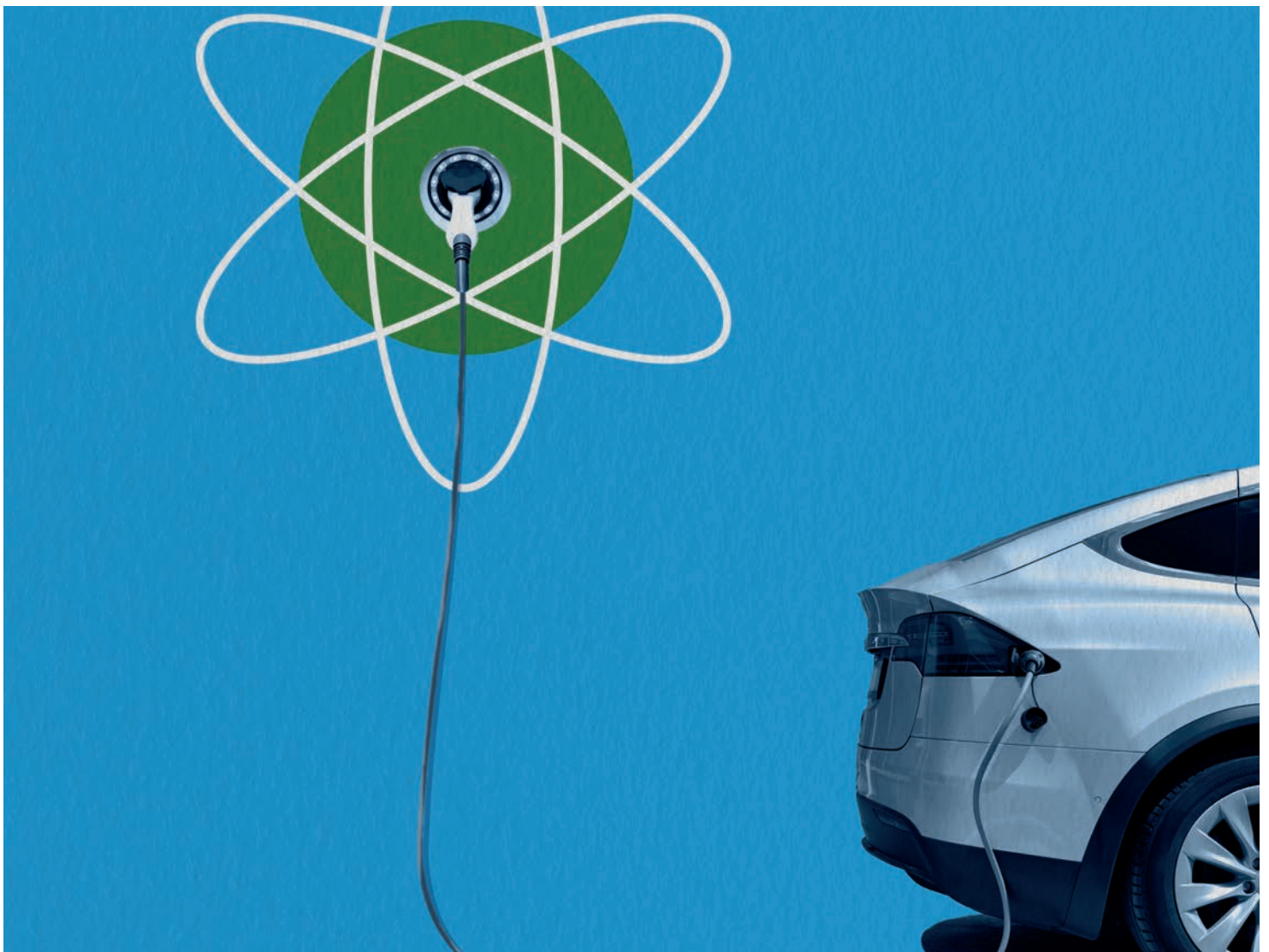


Security and Non-Proliferation

Facilitating the global deployment of new nuclear technologies by ensuring security and non-proliferation

This work is vital to the lives of people in the UK and around the world.

Whether it is contributing to the achievement of net zero or advancing nuclear science in the delivery of effective healthcare, the outcomes we achieve directly benefit us all. Over the next few years, our work in these areas will continue to grow in significance.



2.2.1

Clean Energy

A thriving nuclear power sector is an essential component of the UK's path to net zero.

All but one of the UK's nuclear power plants are scheduled to come offline within the next nine years. This means that nearly a fifth of our country's electricity supply will disappear, just as demand is forecast to rocket to enable the replacement of fossil fuels for powering our cars and heating our homes.

Current and new nuclear technologies have the potential to provide an affordable, clean and reliable source of power for the UK's future energy mix.

For NNL, embracing the challenges of net zero means building significant capability across the fuel cycle through initiatives such as our Advanced Fuel Cycle Programme – part of the Department for Business, Energy and Industrial Strategy's (BEIS) £505m Energy Innovation Programme; as well as working with the rest of our sector to provide the infrastructure it needs to be able to commercially deploy potentially transformative new nuclear technologies.

Large scale nuclear power will continue to play a significant role and we will continue to support the opportunities this offers, such as in hydrogen generation. But the government's backing of a new advanced modular approach – the Energy White Paper has called for operational Small Modular Reactors (SMRs) and a demonstrator Advanced Modular Reactor (AMR) by the early 2030s – means that the operating space for new nuclear technologies is stronger than ever.

The modular approach offers the opportunity to shift nuclear projects from construction sites to purpose built factories, with standardised components manufactured on a production line before being transported to site and assembled. This makes the infrastructure reliably replicable from one project to the next and much more attractive to invest in.

In other words, quicker to deploy and cheaper to finance.

At NNL, we are recognised for our research and development expertise in reactors, fuel cycles and clean energy applications, and have cultivated this experience with our core customer base. Our work provides the foundations that enable EDF's reactor fleet to provide electricity to around 17 million homes each year, and that help Rolls-Royce and the Ministry of Defence keep the UK's submarines at sea.

Now, with the urgent challenges ahead, we are using this grounding to assess the skills, capabilities and technologies required for nuclear to take its appropriate place in the nation's future energy portfolio.

Taking emerging technologies from concept to reality means evolving and building our sovereign capability to support the demonstration of an AMR by the early 2030s. Working with government and the UK nuclear sector, we will establish the pathway to demonstration and ensure NNL delivers the skills and facilities the industry needs to meet this ambition.

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We want to support the many facets of nuclear's potential within the clean energy space, not only in delivering reliable and affordable green electricity but as a critical component for decarbonising other energy vectors.

Whether in progressing avenues for synthetic fuels or green hydrogen production, we will support the development and maturity of these advanced systems and provide the backing needed for the UK industry to be able to commercially deploy new nuclear technologies over the coming decades.

Support for all technologies, large, small and advanced, is critical for the UK and our role in research, development and demonstration is crucial, as is building the right skills base. We will work with government to promote growth and investment in the UK's national nuclear capabilities to support the country's net zero goals.

In working with government and our industry partners, we want to continue to build the UK's global competitive advantage and secure its position as the most attractive place to develop these technologies in Europe, and around the world.

We will work with government to promote growth and investment in the UK's national nuclear capabilities to support the country's net zero goals.

An enabler for UK nuclear

NNL is supporting the wider UK nuclear sector to recognise and position itself to deliver the potential benefits of advanced nuclear technologies, including SMRs and AMRs:

- We are part of the UK SMR Consortium, led by Rolls-Royce, developing a UK concept for small modular reactors, putting the UK in prime position for the market in both SMRs and AMRs;
- In 2020, we led a review for government of how the UK's nuclear R&D sector and domestic supply chain should be developed in order to support the deployment of AMRs;
- We have provided early R&D support to vendors in the first round of the AMR programme, and have continued this in the second phase with our ongoing involvement in Westinghouse and U-Battery's reactor development projects. This has helped the sector to progress promising technological solutions and develop national capabilities.

Nuclear generated green hydrogen

To enable the deep decarbonisation that is required to meet net zero, it is clear that hydrogen will need to play an ever increasing role. Nuclear generated green hydrogen, alongside other clean energy routes, will enable a plentiful supply to fuel our future economy.

Alongside existing electrolysis methods, NNL is exploring new ways in which the high-grade heat generated by advanced reactors could be used to the same end. These techniques could unlock the decarbonisation of our large scale industry and transport systems by providing immense amounts of green hydrogen at much lower costs.

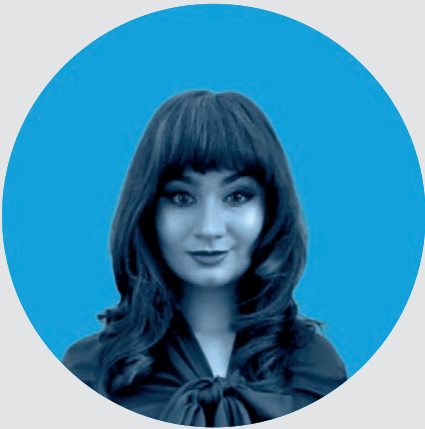
NNL is creating new cross sector partnerships to accelerate this work, support government decision-making and attract investor interest in nuclear generated hydrogen. This includes mapping out the evolution of potential nuclear hydrogen production technologies and the impact they could have on future energy scenarios.

By measuring the required target cost for hydrogen production against the most likely techniques for deployment, the aim is to find economically competitive solutions that maximise the contribution of nuclear to achieving net zero by 2050.



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NNL's Advanced Fuel Cycle Programme



“As a communicator and climate activist, I feel as though my values directly align with our cause – and that is an inspiring future to help create.”

Meredith Sherock
Communications Manager

Meredith Sherock manages communications for NNL's Advanced Fuel Cycle Programme (AFCP). A geologist by background, Meredith joined us in 2020 from the US National Renewable Energy Laboratory.

“AFCP is a multidisciplinary, collaborative innovation programme that is supporting the UK's transition to net zero by 2050. Led by NNL in partnership with BEIS, AFCP connects over 100 global organisations with the unified mission of providing affordable, sustainable clean energy options for the UK's evolving low-carbon landscape.

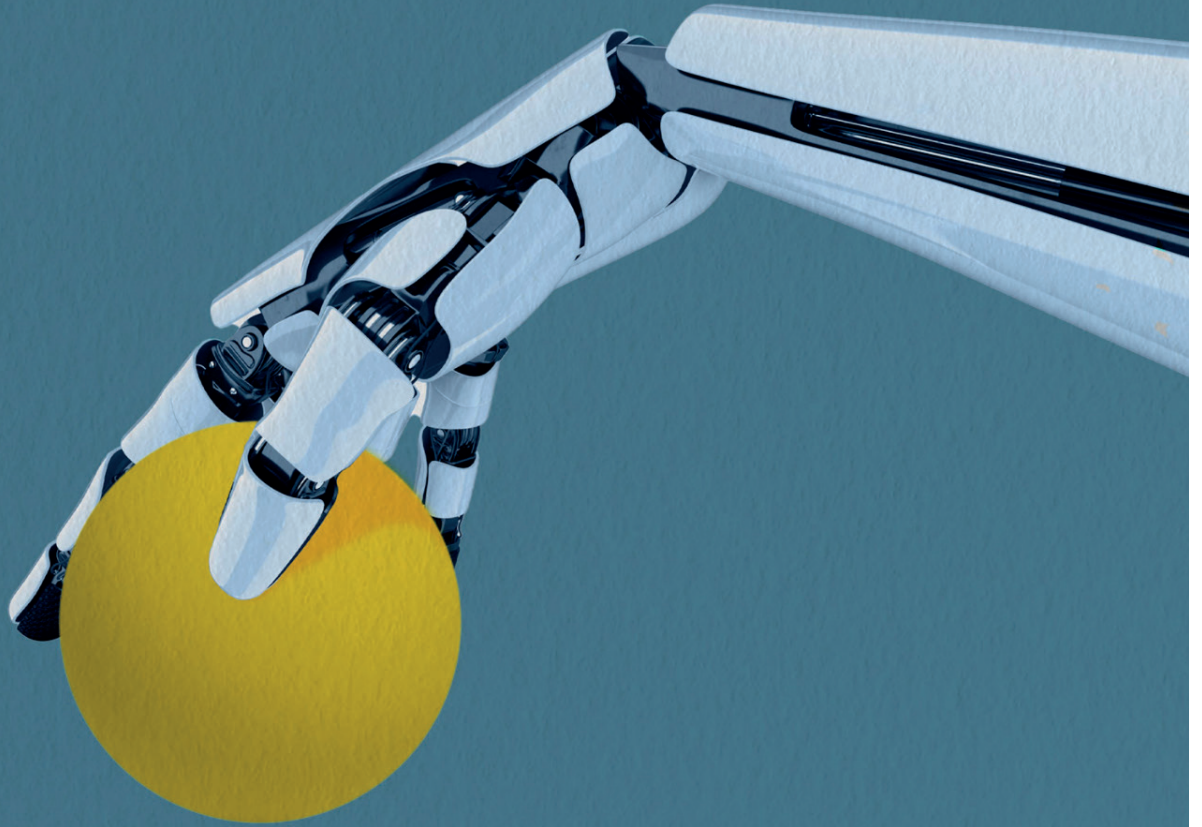
An advanced fuel cycle encompasses both nuclear fuels and recycling technologies, taking a holistic approach in order to maximise the potential of precious earth materials. We're not only addressing the nuclear legacy through sustainable fuel cycles, but we're also working to secure more accessible, equitable clean energy for people worldwide.

The programme therefore overlaps with many areas across NNL – Clean Energy, Environmental Restoration and more – to elevate our existing capability and demonstrate the lab's leadership in shaping the future of nuclear science in the UK.

As the Communications Manager for AFCP, I help give a voice to the programme. Having been previously external to nuclear, I think the programme is a perfect example of why old perceptions of the sector are misled. AFCP is modern, authentic, and human. It's future focused, considering the long-term environmental, social and economic impacts of nuclear energy.

Advanced fuel cycles are essential to sustainability – reducing waste, reusing materials, investing in opportunities to support future generations – and the programme reflects on what sustainable living means to us as individuals and to NNL as an organisation.

As a communicator and climate activist, I feel as though my values directly align with our cause – and that is an inspiring future to help create.”



2.2.2

Environmental Restoration

For 65 years, the UK's nuclear power stations have generated electricity, successfully providing nearly a fifth of our current overall power needs and two-fifths of our clean electricity.

As our ability to generate nuclear energy sustainably has developed, so has our ability to control, manage and remove the hazardous materials of the past in order to restore the environment for future generations.

In doing so, we are delivering a step change in environmental restoration; not just here, but around the world.

Our foundations as a national laboratory lie within this vitally important work, helping to leave the planet stronger and more sustainable for future generations. It has also been the proving ground for critical skills and experience which will enable nuclear science to benefit the UK, and globally, in other ways.

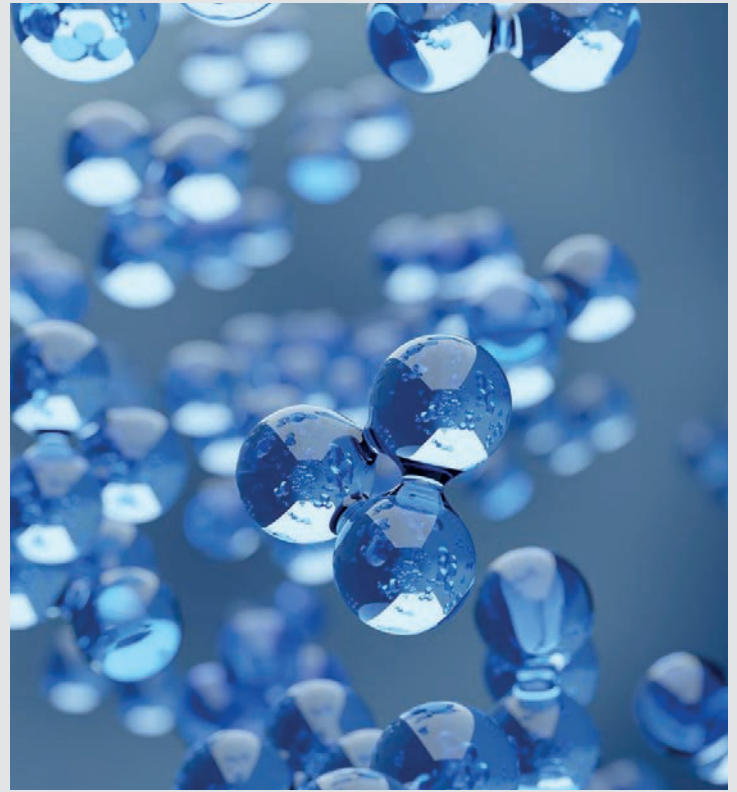
All three of our other Focus Areas build on the specialist capabilities first created in environmental restoration, whether in

our understanding of chemical behaviour to support clean energy technology, or in our ability to handle radioisotopes that can unlock life-changing healthcare solutions.

At the same time, we are helping to drive innovations in operations and the supply chain alongside our core customers and sector partners.

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NNL as a strategic partner: NDA and Sellafield Ltd

We work in partnership with the Nuclear Decommissioning Authority (NDA), which is accountable for nuclear clean-up in the UK, and its subsidiary, Sellafield Ltd, which is responsible for the Sellafield nuclear site.

NNL has a long and proud history of working with both organisations and a lifetime collaboration agreement with Sellafield Ltd. This includes a Technical Services Agreement (TSA), signed in 2017, which has put our joint working on a long-term footing, enabling us to realise significantly better outcomes and cost savings.

Doing more for less.

Since 2008, our collaboration has saved UK taxpayers over £7 billion with hundreds of millions of pounds in savings identified for the next few years. And, with the freedom to introduce new technologies for the long-term, we have worked with our partners to deliver a series of innovations that are helping to restore the environment better and faster.

A key area for collaboration with both Sellafield Ltd and the NDA is the Replacement Analytical Services Project (RAP). RAP is a £650 million investment in Central Laboratory and will create the biggest analytical nuclear laboratory in the UK, giving NNL a world class capability in nuclear analysis and nuclear forensics.

We and the NDA could multiply these benefits several times over if we replicate our partnership agreement with Sellafield Ltd across the remainder of its sites. The cost savings for taxpayers would be transformative, as would the outcomes for restoring the environment.

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But there is still much more we can do.

Introducing new technologies, skills and facilities



“Our relationship with Game Changers and ability to work with NNL has had a significant impact on our business, lending us credibility within the UK nuclear sector and the confidence to expand our market reach.

By helping us advance CellRail, our novel remote deployment technology, we hope to remove barriers to decommissioning activities and minimise the overall cost and environmental impact. Since being involved in Game Changers, we have been able to increase our workforce from one to nine and provide highly specialist jobs here in the North West.”

Andrew Ludar-Smith

Technical Director of Resolve Robotics

Examples of innovation achieved through our collaboration agreement with Sellafield Ltd:

- We have pioneered the use of thermal waste treatment, which mixes waste with glass or ceramic materials – rather than the traditional cement – which, once consolidated by heating at high temperatures, reduces the final volume of waste. This is cheaper to look after, more stable and therefore more resistant to proliferation, and safer as a result.
- We have collaborated with Sellafield Ltd to develop robots to remotely handle hazardous materials in radioactive environments. This is already delivering benefits and the project is potentially a game changer in terms of the NDA achieving its goal to have completely removed humans from this work by 2030.
- Game Changers programme, delivered in conjunction with innovation experts FIS360, has successfully incentivised over 100 other organisations, ranging from universities to pioneering Small and Medium Sized Enterprises (SMEs) in the supply chain to find ways to overcome some of the most complex challenges in the nuclear industry. One example of a successful project was with Resolve Robotics, a Cumbrian SME. It has received funding to develop its versatile and modular robotic deployment system CellRail, which will make it safer, easier and cheaper to carry out inspection and intervention processes in nuclear cells.



International collaboration to solve a global challenge

Environmental restoration is a global challenge shared with the UK's allies throughout the world.

NNL will continue to work with the global nuclear community, sharing best practice and expertise.

We are proud of our role in commercialising UK expertise and assets in order to support environmental challenges overseas but it is a win-win situation. Successful environmental restoration benefits the entire planet.

No one has the monopoly on good ideas. We all want the same outcome.

Vital restoration work in Japan

Since the great east-Japan earthquake and tsunami in 2011 caused significant damage to the Fukushima Daiichi power plant, NNL has provided ongoing support with clean-up operations, reflecting our position as a global expert in this area.

With experience built up over decades at Sellafield, we have been able to redeploy our skills and understanding to support our Japanese counterparts in their restoration work. This includes establishing a successful partnership with the Japan Atomic Energy Agency.

As a result, NNL sits at the centre of the UK's coordinated approach to nuclear collaboration with Japanese partners and customers. We have worked closely with UK organisations, large and small, to enable successful technology transfer to Japan and we will continue to explore other opportunities for future collaboration – for example, by combining our countries' experience in operating high temperature reactors.



“NNL has grown its reputation in Japan by providing support and sharing relevant UK experience to the challenging decommissioning and clean-up operation at Fukushima.

What has been impressive has been the way NNL has also been able to bring in other UK firms to support the clean-up effort. This has been achieved in partnership with other UK government organisations, closely supporting the work of the NDA and its subsidiary, International Nuclear Services Japan, and has demonstrated the value of government bodies and institutions working together for UK prosperity.”

Chris Heffer

Regional Director North-East Asia, Department for International Trade, British Embassy Tokyo



“The unrivalled energy density of nuclear power sources enables a whole range of missions that would be otherwise impossible.

This successful collaboration between the nuclear and space sectors has created a brand new capability for Europe, and opens the doors to a future of ambitious and exciting exploration of our solar system.”

Keith Stephenson

European Space Agency lead

Recycling used materials to develop a brand new capability for the European Space Agency

NNL led a pioneering team, working with the University of Leicester, which discovered that a rare element formed as used nuclear fuel decays was a viable alternative to the existing Radioisotope Power Systems (RPSs) used in space travel.

The breakthrough followed a call from the European Space Agency (ESA) to develop an alternative RPS to plutonium – specifically Plutonium-238, all of which is owned by the United States of America and Russia. This was to give the ESA the independence to control its own space missions and make space exploration more affordable by removing reliance on imported plutonium.

Nuclear fuel, through RPSs, remains the only way to power long-term, long distance missions. The new alternative developed as a result of the collaboration, Americium-241, is formed by recycling nuclear wastes. It has a half-life of around 430 years, compared to around 90 years for Plutonium-238, which means it is a lasting source of energy for longer space missions.

With NNL’s innovation providing the confidence the ESA needed, a lunar mission is planned to launch towards the end of the 2020s and the next generation of European moon landings are expected within the decade.

In 2020, Dr Stephanie Thornber, Senior Research Technologist at NNL, was winner of the European Nuclear Society’s prestigious High Scientific Council PhD award. Here, she describes her work at NNL:

“I joined NNL in 2018 after completing my PhD. I’ve been lucky enough to progress into a role that enables me to continue my PhD research, as one of a team of scientists and engineers working with the NDA to determine a long-term plan for improving how we safeguard the UK’s plutonium inventory.

Our team is leading the UK’s development of a heat-plus-pressure technology, known as Hot Isostatic Pressing (HIP), for processing plutonium oxide material into a ceramic form for long-term storage and disposal. Ceramic materials are superior hosts for plutonium, compared to glass and cement, both in terms of proliferation resistance and life-cycle costs as they lead to reduced volumes of packages requiring storage and disposal.

NNL has been researching ceramic wasteforms for more than 20 years, and are now leading the UK’s development of an active HIP facility that will increase the technology readiness level of this disposition option for treating the UK’s plutonium oxide inventory. Through the years we’ve collaborated with businesses including SMEs across our supply chain, as well as universities and other national laboratories.

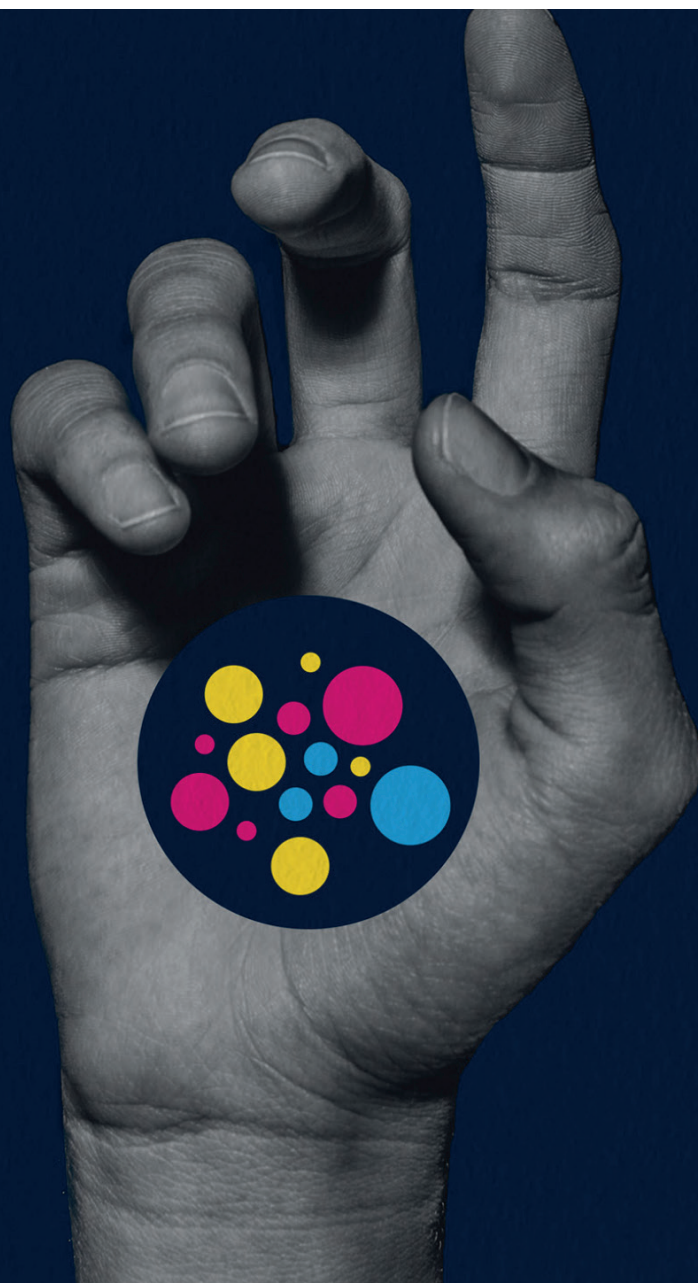
I am proud to be contributing to improvements in nuclear security and environmental restoration, in a stream of work that is tackling one of the most pressing challenges of the UK’s nuclear sector, as well as inspiring the next generation of nuclear materials scientists in the North West.”



“I am proud to be contributing to improvements in nuclear security and environmental restoration.”

Dr Stephanie Thornber

Senior Research Technologist



2.2.3

Health and Nuclear Medicine

Each year, thousands of NHS patients benefit from the advances of nuclear medicine in their treatment.

Trace amounts of radioisotopes are used to diagnose and treat health conditions including many types of cancer, heart disease and thyroid disease and for the early detection and assessment of brain disorders such as epilepsy, Alzheimer's disease and other forms of dementia.

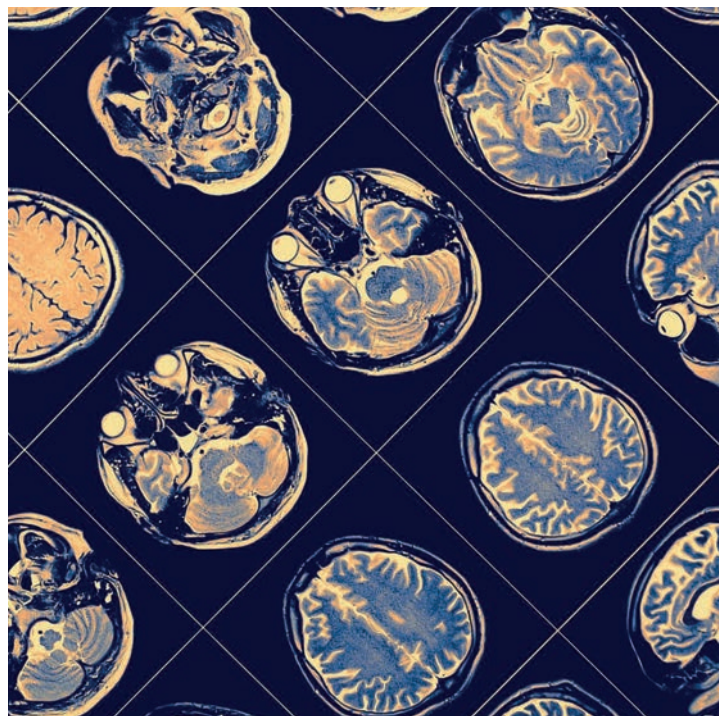
As medicine develops and breaks new frontiers, the use of radioisotopes will continue to be a significant component of this.

One in two UK citizens will be diagnosed with cancer in their lifetime and may well see their quality of life and the efficacy of their treatments enhanced as a result of nuclear medicine.

Each year, global demand for these treatments increases at a rate of up to five per cent. Every hospital in the UK uses them to help patients on a daily basis. Yet the supply of the radioisotopes required faces a global shortage.

Presently the UK has no home-grown supply for the vast majority of radioisotopes needed. We rely on imports from ageing European facilities.

In the 1950s and 1960s when such treatments began, we were global leaders in their production and medical use. We need to be again. And we can be.



Building on this heritage, and on NNL's world-leading capability in the area of complex chemical separation and purification of nuclear material with many years of experience, our objective is to develop production of the radioisotopes needed to develop new treatments. By co-locating a facility for this with space for academic and clinical medical work, we could directly enable engagement and access to materials for research and development.

Harvesting radioisotopes from existing nuclear material is a proven and beneficial approach to providing what is needed by medical clinicians and researchers. NNL has already developed a number of new radioisotope production routes and has begun the early development work to start building this as a capability for the UK. Our plan is to take this early work and progress it over the short term into a sustainable route to allow the regular provision of radioisotopes.

This is a significant new opportunity for NNL and core to our new purpose of nuclear science to benefit society. It would be transformative for healthcare in the UK and, given the global nature of the challenge, citizens of the other countries we supply.

And in developing a facility within one of our existing, nuclear-licensed laboratories, we would be creating new long-term and high-quality employment in the North West.

But harvesting medical radioisotopes requires the desired radioisotope to be present in the source material. Where this is not the case, a method to make the radioisotope is required, typically using an accelerator system or a nuclear reactor. Currently the UK does not have sovereign capabilities to do this except for a small number of specific radioisotopes. Addressing this missing infrastructure is core to our strategy and the surest way for the UK to create the indigenous supply it needs.

We are in dialogue with key stakeholders about the potential for a neutron accelerator system, known as STELLAR, to be installed within an existing nuclear facility. Combined with our existing capability in the form of hot cells and glove boxes, this would transform the UK's ability to produce a wide range of medical radioisotopes.

In addition to building our internal capability and expertise, we are also engaging with academia, industry and the medical profession. By bringing together these sectors, we are helping the UK establish a domestic supply of radioisotopes and compete in the global market, estimated to be worth £23 billion by 2024.

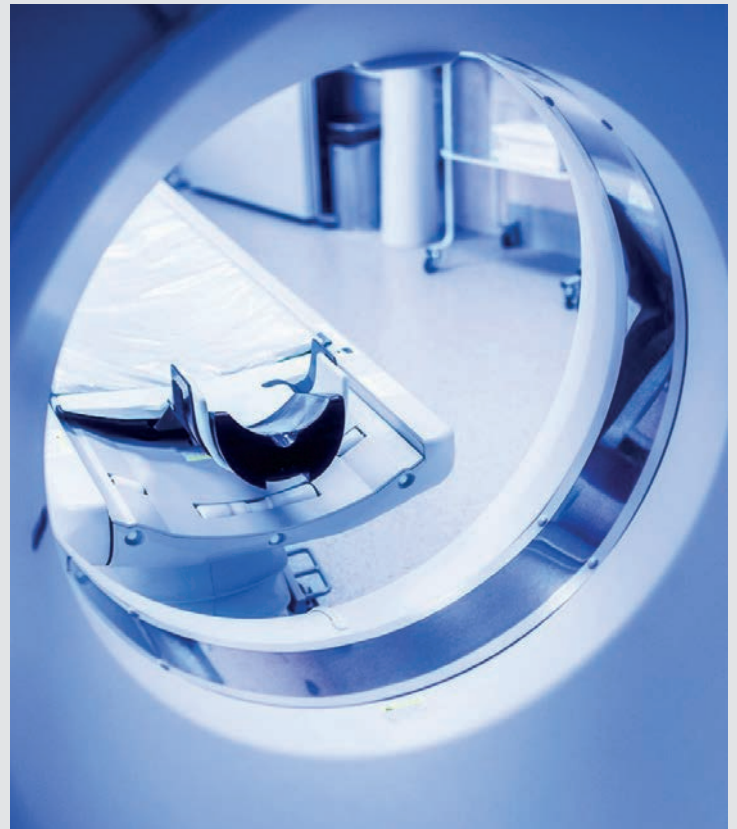
Access to material, understanding the pull from medical science and articulating the benefit to the UK are all important in achieving our objectives for this area. Investment in new critical infrastructure to enable the full ambition, such as neutron accelerator capability, requires a clear business case that has wide support.

This is a significant new opportunity for NNL and core to our new purpose of nuclear science to benefit society. It would be transformative for healthcare in the UK and, given the global nature of the challenge, citizens of the other countries we supply.

And in developing a facility within one of our existing, nuclear-licensed laboratories, we would be creating new long-term and high-quality employment in the North West.

How other countries are progressing this agenda

In the US, the Department of Energy has joined forces with Isotek Systems and TerraPower, the nuclear research venture founded by Bill Gates, to provide extremely rare and unique isotopes for cancer research and treatment. This public-private partnership uses thorium extracted from nuclear material stored as waste at Oak Ridge National Laboratory in Tennessee to support lifesaving radiation doses for cancer patients.



“One of the common things we get asked is, ‘How can I make this radioisotope?’. If we can find a way to do this, it might result in better medical treatment for somebody who is unwell.”

Allan Simpson

Nuclear and Reactor Physics Team

Allan Simpson joined our Graduate Scheme in 2016, and is now part of our Nuclear and Reactor Physics Team:

“As a team, we provide technical advice and input on a broad range of topics, from calculating the contents of used nuclear fuel to the development of advanced detector systems for monitoring waste.

One of the common things we get asked is, ‘How can I make this radioisotope?’.

If we can find a way to do this, it might result in better medical treatment for somebody who is unwell. However, the answer depends on thousands of different measurements within nuclear data libraries that allow us to calculate what happens at an isotopic level when materials are irradiated.

Until now, we have had to delve into the data and manually calculate how much of an isotope could potentially be made, but this year our team has been working on a project that is changing that. I had previously recognised that we could adapt our fuel inventory code to run the calculations needed, so after discussing with one of our team, our project this year is to develop the code.

Our code will allow us to quickly look at the production routes for some of the thousands of isotopes that have been identified. Using particle accelerators, we’d be able to transmute the contents of different streams – including waste streams that already exist on nuclear sites in the UK – to produce what is needed.

This means we could reduce the amount of overall waste that needs to be stored in the UK, whilst helping to reduce the suffering of people from diseases like cancer.”



2.2.4

Security and Non-Proliferation

It is clear that nuclear science holds the keys to advancing many areas of our lives and can help governments and industry to create a better planet for us all.

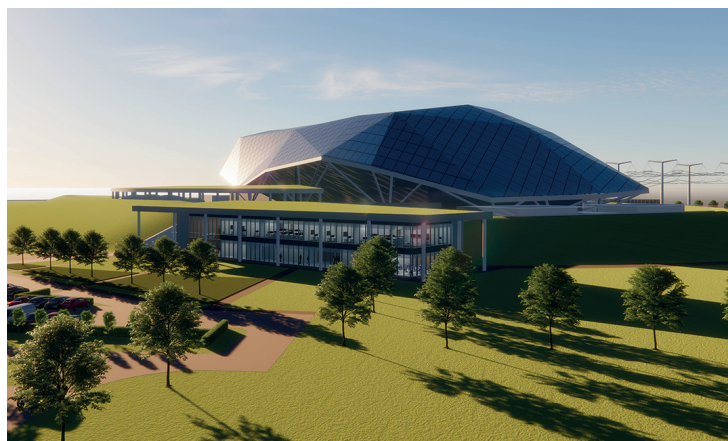
But it is not straightforward. The current and – importantly – future adoption of a greater breadth of advanced nuclear technologies presents challenges that must be addressed.

A critical component for benefiting from nuclear is our ability to ensure that the sector's sites, technologies and materials remain secure.

NNL already makes a considerable contribution to this, maintaining the security of complex nuclear sites and mitigating the risks of proliferation – both of materials and technologies.

Beyond our specialist expertise across the full fuel cycle, we have decades of experience in managing national infrastructure capable of handling some of the most challenging nuclear material in the world.

This combination of capabilities, which is unique to the world, enables us not just to ensure the security of our own infrastructure, it also means we are able to benefit the UK government and our intergovernmental partners.



By making the most of the UK's 70 years of expertise we enable the peaceful use of nuclear technologies, including the development and use of new small and advanced reactors. As their use increases globally, demand for our long established expertise will grow.

So it is in the national interest to build our capability to be at the global forefront of advice and best practice.

To support this, we will invest in our knowledge base and talent to ensure that the UK has the capabilities and people needed for existing and future nuclear programmes. This means working with government, UK nuclear and beyond the sector to identify challenges and opportunities and drive thought diversity.

In step with the government's Integrated Review of Security, Defence, Development and Foreign Policy, Global Britain in a Competitive Age, we are putting in place targeted investments in core science, innovation and cutting-edge research programmes to help sustain the UK's strategic advantage. Leading from the front, we will identify and respond to new and emerging threats, helping to meet challenges here and across the globe.

And in pushing the boundaries of our own capabilities here at NNL, we will establish key UK and international partnerships to help strengthen and influence essential safeguarding efforts worldwide.

Expert contribution on the global stage

The International Atomic Energy Agency (IAEA) is the world's centre for cooperation in the nuclear field, promoting the safe, secure and peaceful use of nuclear technology. Its independent verification work allows it to play an indispensable role in preventing the spread of nuclear weapons.

But the field of nuclear verification never stands still.

With rising global demand for nuclear technology for peaceful purposes, the number of facilities and quantity of material to be safeguarded continues to grow. And for the IAEA's work in this area to remain relevant, its safeguards need to remain at the forefront of emerging developments.

Leading the UK Support Programme

NNL leads a national team effort, on behalf of government, to provide a structured programme of voluntary support and expertise to the IAEA, in coordination with equivalent programmes from other Member States. Support provided ranges from enabling IAEA personnel to be trained at our unique, nuclear-licensed sites, through to analysis of samples taken during inspections, and access to our world-leading fuel cycle expertise.

Designated Collaborating Centre

In 2020, NNL was the first ever UK institution to be designated as a Collaborating Centre by the IAEA. The new Centre that has resulted now provides a global hub of expertise on the Advanced Fuel Cycle, a field of increasing importance as recognition grows of the vital role advanced nuclear technologies have to play in achieving deep decarbonisation of the energy system.

Safeguarding our vital physical assets: Central Laboratory

Among NNL's unique combination of facilities is our flagship Central Laboratory, housed within the Sellafield site. A state-of-the-art facility, it is the most advanced for nuclear research in the world.

Due to its significant capabilities, the laboratory is critical to the UK's plutonium stewardship programme. To permit these operations, the facility underwent a programme of security enhancements, and subsequently a Nuclear Site Security Plan submission to meet the Office for Nuclear Regulation's (ONR) new Security Assessment Principles (SyAPs). This framework represented a shift to an outcome-based regulation model, with greater reliance on site operators to internally assess and assure that they meet the required performance.

Through this comprehensive programme of work, our dedicated project team engaged with a broad range of stakeholders, including Sellafield Ltd, other duty holders, the Civil Nuclear Constabulary (CNC) and ONR, to successfully deliver and implement the new Nuclear Site Security Plans. The capability and knowledge we have gained from the process has added value to our long-term management of the laboratory and to the nationally strategic capability and programmes it enables. NNL has since shared our learnings and best practice with UK and international industry partners, so that others across the sector can also benefit.

As a lasting impact at Central Laboratory, we have been able to incorporate the experience into the engineering design phase of the Replacement Analytical Project (RAP) – a new facility that will see the laboratory become the home of essential analytical services towards the operation of Sellafield and delivery of its legacy waste management mission. This early integration will deliver against the principle of secure by design, a shift in approach which ensures security and regulatory requirements are built in from the start – saving time and money at future stages of the project.



“There’s a great sense of satisfaction at NNL that what you’re doing is making a difference. I didn’t know much about the nuclear sector before I joined it, but I was drawn to NNL’s sense of purpose and this has only grown with the extent of the climate crisis.”

Ismaeel Patel

Electrical Design Engineer

Ismaeel Patel, joined our Apprenticeship Scheme as an Electrical Design Engineer in 2014 and was seconded to our security team last year:

“When I look back at being 18 and joining NNL, I had just made the difficult decision between university and an apprenticeship. I’m so glad I took the route I did. It wasn’t as common at the time but it’s good to see more young people taking up a broader range of pathways to suit them.

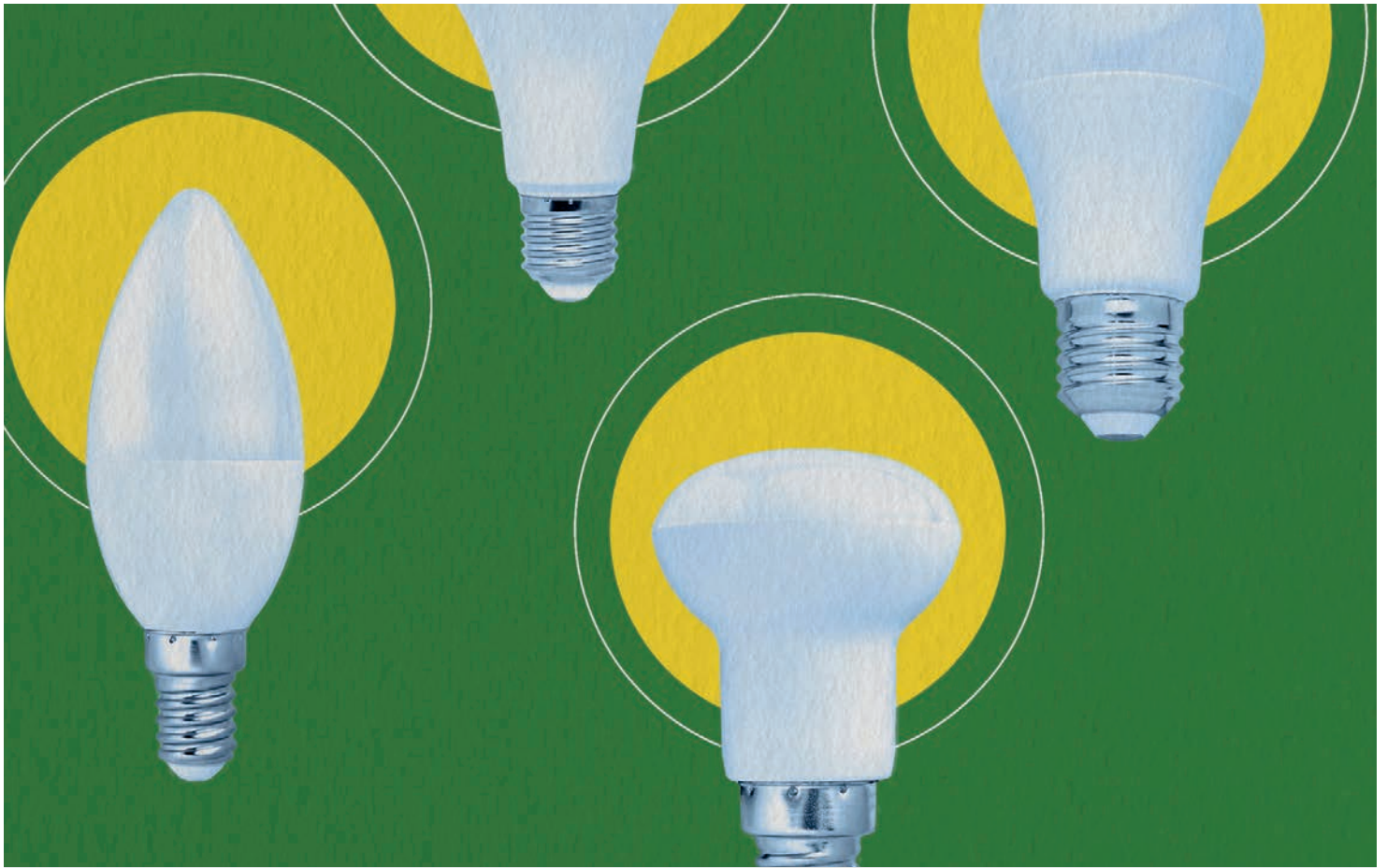
More recently, when an opportunity came up with the security team, I jumped at the chance. Security modelling was a new area of work for me, but you quickly understand that every project hinges on how safe and secure we can make these sites. I could see the difference my work was making. Whether for NNL’s own facilities, or for our customers, our vulnerability assessments are essential for minimising risk.

By applying scenario modelling and innovative thinking, we can also identify opportunities for potentially significant cost savings, which over the lifetime of a project can amount to tens of millions of pounds.

For new nuclear technologies, this takes on completely new dimensions. You have to consider something that doesn’t exist yet. As part of the Rolls-Royce led UK SMR consortium, our team has been looking at the concept of a small modular reactor facility and what protective arrangements would need to be in place. Doing this well will position UK SMR as a world-leading, competitively priced solution for the provision of safe and secure clean energy.

The wind is not always blowing and the sun’s not always shining; we need nuclear to be part of a renewable energy mix.

That’s why I’m so keen to work with schools and educate young people about the possibilities of a career in STEM, and in nuclear. I want to help more people like me see the opportunities there are for them – no matter your personality, there is a role for everyone. The most important thing is curiosity, and a mix of backgrounds and perspectives. At NNL and across the nuclear sector, we’re trying to solve some of the world’s biggest problems – if we’re going to be successful, we need people who can look at a problem from every angle.”



2.3

A New Agenda for Science and Technology

Science and technology is, and always has been, the beating heart of NNL.

Ongoing investment in research and knowledge ensures we retain our world-leading nuclear expertise, and that the UK has what it needs to underpin new and existing technologies.

In always seeking out innovation, we are able to reduce costs and risk whilst seizing on new opportunities and advancements. This has ranged from collaborating with Sellafield Ltd to successfully mitigate land contamination at their site, to influencing the operations of national and international reactors through our water radiolysis research.

With our new Purpose, nuclear science to benefit society, and new Focus Areas, we have refreshed our science and technology agenda to meet our aims.

Its three pillars are:

Core Science

12 areas of science that will support our Focus Areas, funded by reinvesting the earnings generated across NNL. In addition to three completely new areas of science, five of the 12 are heading to 'world-class' and four have already been independently peer reviewed as such. All will drive collaborations with universities and address current need within our sector and the UK as a whole.

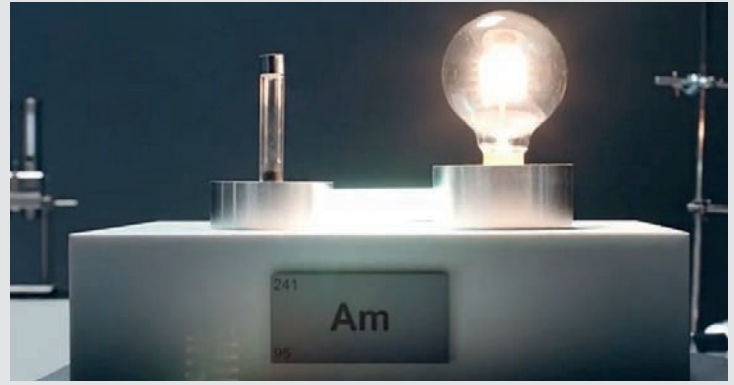
Strategic Research

Focused on developing our capability to meet the future requirements of the UK, we will work with our customers and other stakeholders to drive necessary new areas of technology to market.

Innovation

Developing new ways of doing things that will enable the sector to bring new ideas to market, plus working with our customers to address their innovation challenges through the application of science and technology, and partnering with SMEs in our supply chain to develop solutions for the future.

This is all supported by virtual collaboration centres, such as the one we have established with the IAEA to bring together key skills, infrastructure and financial resources needed for this agenda to be successful.



Our science and technology activity will:

- Enable successful delivery of customer programmes;
- Create global thought leadership;
- Provide intelligent customer capability for government that will shape the future nuclear agenda;

- Create new ideas, approaches and services that enable successful implementation of NNL's strategy;
- Deliver successful partnerships (nationally and internationally) with industry, national laboratories, academia and government for demonstration and selection of nuclear technologies;
- Make our custodianship of nuclear fission talent and critical national infrastructure deliver for the whole of the UK.

Maintaining our excellence for future benefit



“When it comes to science and technology it can take what feels like a long time for value to be realised. But in order to make sure essential developments do come to fruition, it is vital to keep pushing and innovating the Core Science now. That’s why we’re committed to investing in these areas – so that we can keep our people sharp and our facilities world-class.”

Dr Robin Taylor

Senior Fellow at NNL

Dr Robin Taylor is a Senior Fellow at NNL and internationally known for his contributions to Actinide Chemistry. Here, he describes the work of Advanced Recycle and Isotope Separations (ARIS) – one of our world-leading Core Science areas:

“Separation chemistry underpins a broad range of activities, from fuel recycle to isotope recovery to treatment of waste. ARIS was therefore chosen as a Core Science theme as it is an area in which NNL has historically been very strong and in which there are significant emerging opportunities. It will be supporting elements of each of our four Focus Areas in some way.

Over the years, ARIS has been a key component of retaining and developing the skills, facilities and knowledge base we are proud to offer here at NNL, enabling us to contribute to highly valuable national and international projects. For us as scientists, being involved in state-of-the-art research that is both interesting and relevant goes a long way.

If it hadn't been for the investment in ARIS over the last decade, it's unlikely we would have had the expertise and the facilities we needed to deliver the Advanced Fuel Cycle Programme (AFCP) for government; we wouldn't have been able to collaborate with the European Space Agency on a new power source for space travel; and we wouldn't be involved in a lot of the essential Plutonium storage work we're doing with Sellafield Ltd.

One of the things we try and do across our Core Science areas is to look ahead – how do we build our reputation and capabilities now to address future needs, both in the UK and globally? We are currently doing this in ARIS by branching out into other isotopes to see how other materials can be recovered and for what purpose. Exciting and potentially ground-breaking opportunities lie in how they could be used for medical application, which feeds into our Health and Nuclear Medicine Focus Area. ARIS is now enabling us to not only look for these opportunities but also to develop the next generation of experts who will be needed to make them happen.

When it comes to science and technology it can take what feels like a long time for value to be realised. But in order to make sure essential developments do come to fruition, it is vital to keep pushing and innovating the Core Science now. That's why we're committed to investing in these areas – so that we can keep our people sharp and our facilities world-class.”



2.4

A Thriving and Ambitious Workforce

Beyond our unique set of specialist facilities, it is the skills, knowledge and energy of our people that drives our work and fuels our purpose.

From award winning graduates to internationally acclaimed subject matter experts, we are fortunate to have some of the sector's best minds within our midst.

Meeting the aims of our Focus Areas means continuing to grow this thriving, ambitious and expert workforce and ensuring we are able to develop and retain the complex mix of capabilities we require.

We are building a culture where everybody feels valued and can flourish, and a reputation as a home for stimulating, rewarding careers.

With the urgency of the climate crisis, there is growing public consciousness about the role each and every one of us can play towards net zero. Across NNL, all our employees can be confident that they are making a positive difference to society, within their daily roles.

This potential will only grow with the people we retain and recruit.



By developing our use of people analytics, we are making better use of data and ensuring we can anticipate the future requirements of our workforce and undertake the strategic planning needed for NNL to fulfil its aims.

Not only have we expanded our programme for graduates and apprentices, but we are also successfully bringing in talented individuals from other sectors and industries. This cross-pollination of good ideas and effective practices is building our strength as an organisation and keeping us at the cutting-edge.

Hand in hand with our science and technology agenda is the continued personal and professional development of our people. Each year, we invest appropriately in their skills and training.

As we grow, the processes we use to improve employee experiences also evolve and develop. We aim to act on suggestions for improvement to meet our people's needs and promote their health and wellbeing so that everybody can deliver their best work.

By moving to a hybrid working model, for example, we are providing greater flexibility for our teams and responding to the needs of our people, whilst retaining the highest standards for how we deliver.

Complementing all of this, we have strong and productive relationships with our Trade Unions, GMB, Prospect and Unite. All parties have worked hard to build trust and ensure a smooth and productive way of working.

Nurturing the next generation of scientists and innovators

NNL prides itself on giving brilliant individuals the chance to develop their careers and expertise in an environment of encouragement, support and scientific curiosity underpinned by decades of expertise in nuclear science.



“I was encouraged to lead, to think independently and most importantly to challenge the world around me. It is incredibly rewarding to know the work I did and continue to do is helping to ensure the nuclear sector has a progressive future and can continue to find solutions for some of the key challenges society faces.”

Dr Hayley Green

Post-doctoral Researcher in Special Nuclear Materials

Dr Hayley Green, describes the science she was involved at NNL as a Post-doctoral Researcher in Special Nuclear Materials:

“I have a PhD in Chemistry and during my studies I had the opportunity to do a summer placement at NNL and from there my passion for nuclear science was confirmed.

During my two years at the lab, I was lucky enough to work collaboratively across the technical teams at both NNL and Sellafield Ltd. The programmes I've worked on have provided me with a solid foundation in the challenges the industry has and will face and, more importantly, a clear understanding of where our focuses need to lie going forward.

This included the Alpha Resilience Capability (ARC) programme, which is all about ensuring the nuclear sector has the skills, capabilities, and robust scientific understanding needed for decades to come. I was able to collaborate with colleagues from the breadth of the sector and I am proud of the role I could play in helping ensure that vital skills are being retained and generated for the future.

Through my time at NNL, I was encouraged to lead, to think independently and most importantly to challenge the world around me. It is incredibly rewarding to know the work I did and continue to do is helping to ensure the nuclear sector has a progressive future and can continue to find solutions for some of the key challenges society faces.”



2.5

Embedding Diversity and Inclusion, Providing Meaningful Work for All



“I’m delighted that NNL are the current Industrial Sponsor for Women in Nuclear, UK – demonstrating the leading role NNL play in driving the equality and diversity agenda across the sector. It’s vital that the major companies like NNL lead from the front on this important issue – and NNL have certainly done that!”

Lynsey Valentine

President, Women in Nuclear UK

We are strongly committed to delivering a fairer and more just and inclusive society. This begins at home with how we actively encourage women and others from social, economic or ethnic backgrounds underrepresented in science into the amazing opportunities that a career here could hold; and how we ensure that they thrive once they get here by creating the conditions for them to succeed in.

Historically, the scientific community has lacked diversity and inclusion has been limited. It is time to change that, not least because we now have a strong evidence base that diverse teams outperform homogenous ones: groupthink has no place in our future and our team should reflect the society we serve.



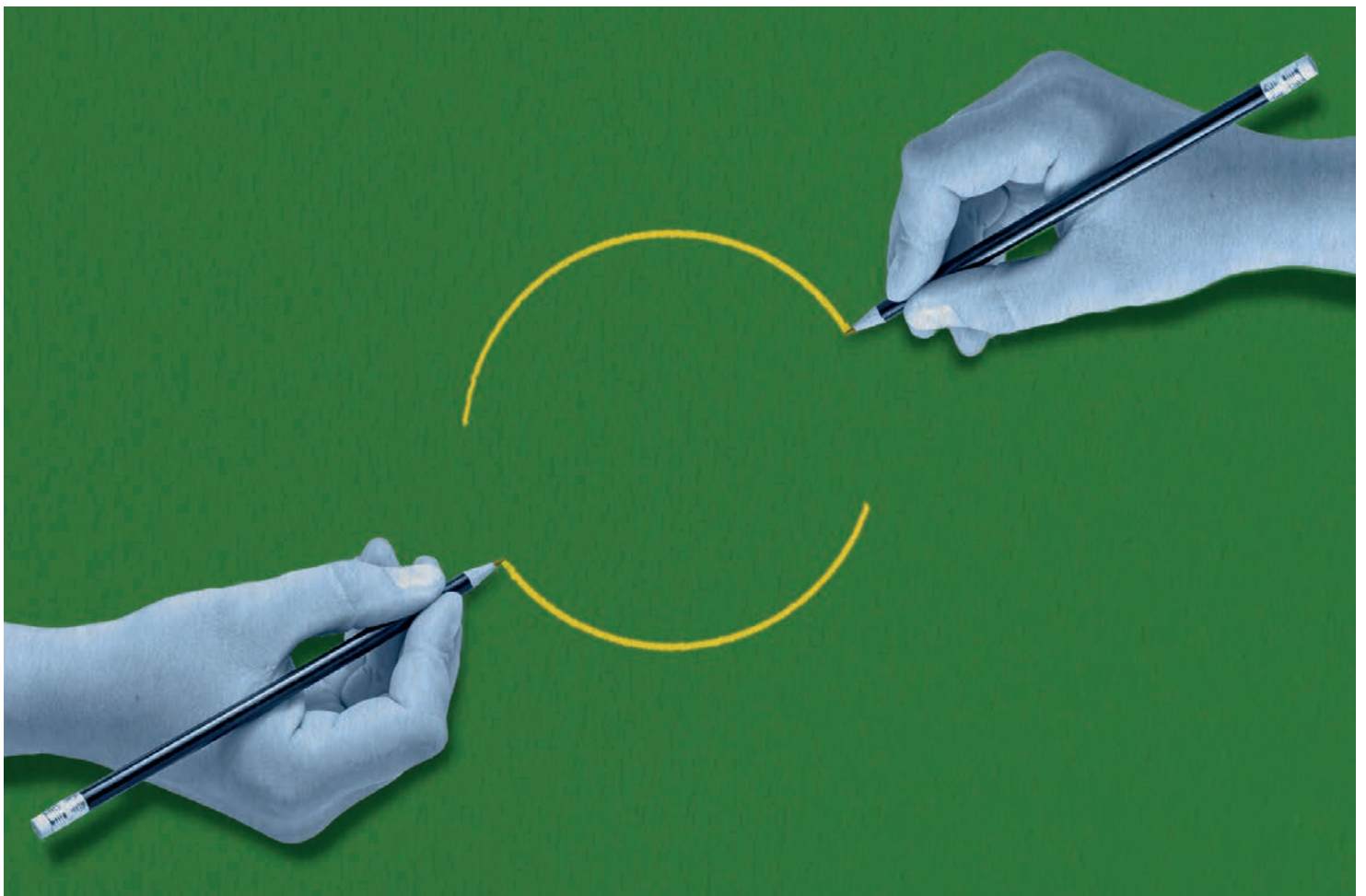
Historically, the scientific community has lacked diversity and inclusion has been limited. It is time to change that.

As well as paying full attention to the more visible aspects of equality, diversity and inclusion through a strategy that focuses our approach around Attraction, Belonging and Career Support, we go well beyond compliance. We ensure that our commitments to both protected and unprotected characteristics are clear and that we stretch ourselves to make measurable progress and contributions. Earlier in 2021, we achieved the National Equality Standard, a benchmark for equality, diversity and inclusion, which involved an independent and highly rigorous assessment of our approach and practices.

Our aim is to provide meaningful work for all, and for our people to have stimulating, rewarding careers.

Covid-19 has exacerbated social inequalities and, in some cases, impacted the access and aspirations of a generation of potential STEM and other careers candidates. We are responding to this by growing our direct outreach. In addition to supporting direct tutoring programmes, we are providing financial support for essential equipment such as scientific calculators, laptops and textbooks.

Through our work and our commitment to measuring what we believe matters and raising the bar on what 'good' looks like, we are widening the pool of knowledge and experiences from which we can harness ideas as well as ensuring we provide a great place to work.



2.6

Quality Partnerships with our Customers and Suppliers

In tackling some of the biggest challenges facing society today and in the future, we need to be prepared on all fronts to deliver what is required.

As an organisation, this means striving for excellence in our operational capacity, execution and delivery so that we can meet the aims of our Focus Areas, and the needs of our customers.

Being agile and efficient. Safe and reliable.

With the new nuclear landscape, we have been creating a culture change in the way we serve our customers and engage our supply chain.

Our Delivering Excellence programme has introduced a new way of thinking and a new approach, helping us create the right environment for sustained success and consistent delivery. This is intrinsic to our purpose – putting value first and maximising our capabilities as a national laboratory for the benefit of all.

For customers, this means moving towards long-lasting partnerships that generate far better outcomes. We have already built the model for this with Sellafield Ltd, with whom we have a lifetime collaboration agreement that has helped us to deliver more, for less, saving taxpayers billions of pounds. We also have a similar

arrangement in place with EDF through the Lifetime Enterprise Agreement which was signed in 2017.

With the new nuclear landscape, we have been creating a culture change in the way we serve our customers and engage our supply chain.

By identifying earlier and more accurately the needs of our customers, we will ensure we have the skills, infrastructure capabilities and processes to meet their needs both now and in the future. This includes our commercial and procurement functions as well as programme and project management.

The culture change we have delivered, and are continuing to seek, for customers is driving substantial improvements for our supply chain, helping prepare it for the opportunities and challenges ahead. In particular, by putting our relationships with customers on a longer-term footing, we can do the same for our suppliers, which comprise a significant proportion of SMEs, giving them the certainty they need to grow their businesses whilst driving better quality and value for our customers.

Significant investment over recent years has enhanced the quality of our offer and made us a more efficient, more flexible partner to work with – and this is ongoing. The programmes that we will be delivering in the future are increasing in scale and complexity; our ability to deliver in terms of time, quality and cost will need to be developed accordingly, whilst maintaining our strong track record in safety and security.



Creating Opportunities for UK Businesses

A third

of our work is outsourced to suppliers

£125 million

of our work has been contracted out to industry over the past three financial years

Investing in small businesses: AFCP as a catalyst for expansion and innovation

As delivery lead for AFCP, we have provided a platform for UK manufacturing and engineering businesses to expand and innovate – with more than half of total industry investment from the programme benefiting SMEs.

AFCP's backing has been transformative for a significant number of businesses. It has helped them innovate to secure their places in future energy markets worldwide, whilst protecting and creating high-skilled jobs around the UK.

Among the SMEs that have benefited is Teer Coatings Ltd in Droitwich, Worcestershire, which despite being heavily involved in UK Research & Development (R&D) over the past decade had struggled to make the shift to production, due to the risks associated with technology scale-up for a business of its size. AFCP provided this crucial springboard – allowing the business to advance its own design and manufacture capability, and use the experience gained through the programme to supply and sell novel machines into new markets.



“Being a supplier to AFCP enabled us to rethink our design and build our manufacturing capability in ways we otherwise wouldn’t have been able to achieve. This opened up new markets to us, both domestically and internationally, and has strengthened our growth as a company.”

Wayne Southall
Sales Director



“We have pioneered the development of flash sintering technology in a number of sectors. However, it took the involvement of AFCP to enable the first ever application of flash sintering to nuclear fuels. In doing so, we have grown as a business and been able to sustain even more high-value jobs here in Staffordshire.”

Tim Abbott
Business Manager

Stoke-on-Trent based SME Lucideon Ltd has also brought world-leading materials technology expertise to AFCP. Through collaboration with NNL and the University of Manchester, Lucideon has deployed its unique flash sintering technology on advanced fuel formulations. This support has enabled it to expand its offerings and target new international markets, with confidence that this will lead to future deployment and manufacture.

Strategic advice, technical services and expert support

Our lifetime collaboration agreement with Sellafield Ltd has put our relationship on a new footing, creating a step change in how we work together. It has allowed us to move from a transactional, project-by-project approach to one where we can take a step back and plan work strategically together over the medium and long-term. This benefits everyone, including the UK taxpayer, by driving cost savings, greater efficiency and exciting innovation.

Given the importance of underpinning science to the whole nuclear sector, committing to a long-term working framework has clear benefits for technical services. But beyond this, our people are also able to build diversity of thought by cross-collaboration and through increased staff secondments between NNL and Sellafield Ltd.

Perhaps the single biggest impact of this approach is on skills and capabilities. Together, we are working to address the immense workforce challenge for environmental restoration over the coming generations. There is an urgent, national imperative to grow these specialist skills and our partnership with Sellafield Ltd allows us to jointly tackle this.



“Having a long-term partnership set up with NNL means a long-term commitment to jobs, skills and capabilities, ensuring that the UK is ‘match fit’ for the ongoing environmental restoration work we need to achieve our purpose of creating a clean and safe environment for future generations. Programmes like ARC and Game Changers are just two examples of the added benefits this one-team approach can bring for the UK nuclear sector and supply chain.”

Duncan Steel
Chief Technology Officer, Sellafield Ltd

We have close and established relationships with our customers, including:

Sellafield Ltd

We work in partnership with Sellafield to develop innovative new capabilities, helping them to find safer, quicker and more cost-effective ways to restore the site environment.

EDF

EDF operates the UK's civil nuclear reactor fleet and our work for them supports the continued operation of their reactors.

Rolls-Royce and the Ministry of Defence

We provide capability to support the UK's submarine operations.

Nuclear Decommissioning Authority

We provide a range of services, with particular emphasis on the disposition of fuels and special nuclear materials.

BEIS

We have delivered a number of significant programmes with BEIS, including AFCP.

The other businesses and organisations we work with in the UK include Dounreay Site Restoration Ltd, Westinghouse UK and Urenco UK Ltd. Globally we have customers in the USA, Japan and Europe, and we work with overseas governments and utilities as well as other national laboratories.



**10,000
YEARS**

2.7

Driving Innovation Through Partnership

Translating the potential of nuclear science into viable technologies and transferable knowledge requires strategic partnerships across both the public and private sectors.

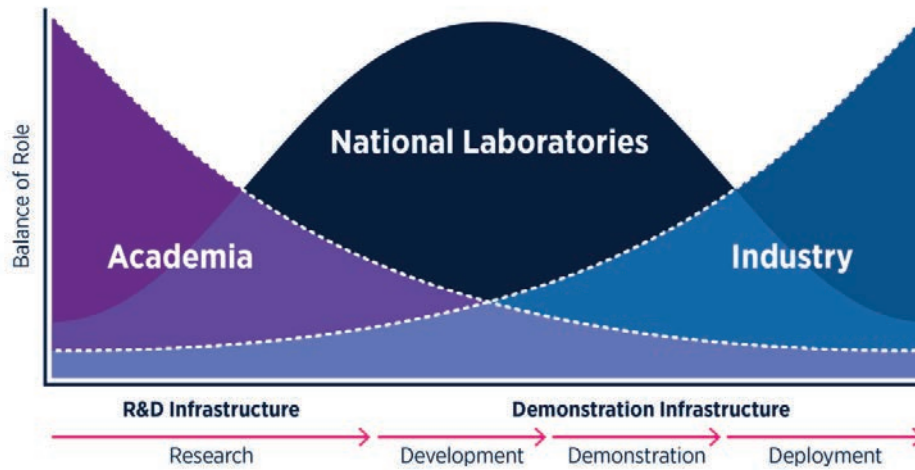
As the UK's national laboratory, we embrace our responsibility to help cultivate the conditions needed for successful new development and to catalyse collaboration across academia, research bodies, government and industry.

We want to ensure the UK has the capabilities it needs – whether in physical infrastructure, or in the skills and knowledge of our people – to underpin innovation and secure the technologies of the future.

At the heart of this is establishing the necessary relationships across the full spectrum of technology readiness levels (TRLs), which describe the development pathway of new applications, techniques and technologies, to bridge any gaps that exist.

From research in its earliest forms, through to deploying a commercial product that meets regulatory requirements, each TRL is as significant as the next. The stronger the interface between them, the sooner emerging technologies can start to make a difference.

We want to ensure the UK has the capabilities it needs – whether in physical infrastructure, or in the skills and knowledge of our people – to underpin innovation and secure the technologies of the future.



For NNL as an enabler, this means working in partnership with universities, maximising the groundswell of new ideas and concepts, and nurturing upcoming scientists and researchers. We are using our 10,000 combined person years of expertise to help PhD candidates and post-doctoral researchers undertake cutting-edge research, whether through our university-based academia partnerships or in-house vocational research collaborations.

Towards the higher end of the TRL scale, how we support and engage with our customers and partners within industry is also crucial. We want to support and provide the R&D infrastructure and capabilities that will unlock routes to market.

From helping to keep existing reactors operating successfully, to supporting a strong and effective UK supply chain, we will continue to build relationships and programmes that support the entire nuclear sector.

Identifying what is needed. Ensuring the UK has what it takes. Working with others to get there.

From helping to keep existing reactors operating successfully, to supporting a strong and effective UK supply chain, we will continue to build relationships and programmes that support the entire nuclear sector.

Supporting academic endeavour and growing UK expertise

Nurturing knowledge and understanding

Currently, NNL provides industrial co-supervision for around 100 PhD students at universities across the UK. We provide significant industrial funding towards these from our Core Science Programmes, whilst also facilitating access to our unique active facilities, in order to support our purpose of nuclear science to benefit society.

We also facilitate the NDA's dedicated PhD bursary scheme, through which we industrially supervise candidates. This enables them to engage not only with our own teams and facilities but with our wider customers and partners.

By working in collaboration with academia at these early stages, and in many cases co-writing scientific papers, we can enable cross-fertilisation of knowledge and ensure work at the initial TRL stages can be more successfully progressed.

Deploying our people

NNL staff hold a range of visiting or honorary professorships and teaching appointments, including several visiting professorships, through which we co-lead or contribute to national and international academic research and innovation programmes. This is directly leading to a wider and more effective network for NNL and the translation of research into application within the nuclear sector.

Introducing vocational PhD pathways

In 2017, NNL established the Centre for Innovative Nuclear Decommissioning (CINDe), which represents a successful collaboration with Sellafield Ltd, the University of Manchester, Lancaster University, the University of Liverpool and the University of Cumbria. Based at our Workington Laboratory, CINDe provides an industrially-based platform for vocational PhDs aimed at supporting environmental restoration efforts and building the skills pipeline within West Cumbria.



“Having the opportunity to work directly on site with scientists and professionals at NNL was invaluable for my PhD programme as I was able to draw on their significant expertise to understand the challenges my work could help solve, and connect the dots between theoretical development and industrial application. Now, as an NNL-funded post-doctoral researcher, I am continuing to work on aspects of sustainability and environmental restoration including further investigating aerial radiation mapping of nuclear sites with a view to minimising environmental impact.”

Dean Connor

PDRA, University of Bristol

Facilitating the R&D capabilities the UK needs

In the true spirit of a national laboratory, NNL's unique set of skills, capabilities and facilities positions us at the centre of the TRL scale – helping to test and demonstrate new and advanced nuclear technologies.

This sees us play both a crucial enabling role, for example as part of the Rolls-Royce led UK SMR consortium, and taking the lead on delivery, as with AFCP. For the latter, the ability to convene such a broad range of different partners and stakeholders in business and academia has been a core success factor, and these links will create a lasting legacy.

Across the global nuclear community, we have strong relationships with other UK and international laboratories. It is important that we can seize opportunities for regular collaboration and shared learnings

– climate change and energy security are challenges that don't stop at borders.

And, here in the UK, we continue to work closely with the UKAEA, our counterparts for nuclear fusion, to develop critical UK infrastructure and capabilities that will benefit both fission and fusion programmes.

Underpinning all these collaborations is our relationship with the UK government. We will continue to work closely with our owner BEIS and with other key governmental departments, aligning with domestic objectives and helping to realise the UK nuclear sector's ability to support a green recovery.

Through the Nuclear Innovation and Research Office (NIRO), a division of NNL operated on an independent, arm's-length basis and staffed by experts from across the nuclear industry, we advise government on nuclear research and innovation to support policy.

Supporting technical delivery and enabling the UK supply chain

Our specialist capabilities and facilities are assets for nuclear research and development, but they are also an essential component for supporting technical delivery within the UK sector.

Through our key customer work and across all four of our Focus Areas, we are continually identifying opportunities for disruptive innovation, cross-sector collaboration and growth of our UK supply chain.

Translating technology from other sectors: Rawwater and Molten Metal Manipulation (M3)

Cheshire based Rawwater is a well established SME in the oil and gas sector, where its work of over 20 years includes the development of novel alloy-based plugs for reservoirs deep under the ocean.

The Game Changers programme – a partnership in itself between NNL, Sellafield Ltd and FIS360 – introduced Rawwater to the nuclear sector for the first time and provided the opportunity for the adaptation of its alloy-based Molten Metal Manipulation (M3) leak-sealing capabilities for nuclear decommissioning activities.

Working in association with NNL, Rawwater is developing specialist alloy seals for use in nuclear decommissioning. These alloys and application techniques offer exciting opportunities for the rapid, emergency repair of civil structures, seals and pipelines, as well as planned preventive maintenance. By stopping the leakage of liquids and gases from contained systems, Rawwater's technologies also have a positive environmental impact.

Based on the success of this collaboration, Rawwater is developing three new emerging technologies to further improve decommissioning activities: sealing around pipes and flanges, manually spraying alloy seals and remotely spraying alloy seals.

NNL's nuclear expertise has complemented Rawwater's technical and engineering skills significantly, and has enabled the SME not only to provide innovative solutions within UK nuclear but to expand into other sectors and markets.



“We’re delighted that NNL sees the considerable potential of our innovative Molten Metal Manipulation (M3) leak-sealing capabilities for nuclear decommissioning activities. NNL’s unrivalled insight into the requirements of the nuclear industry, combined with its significant technical expertise, has assisted us considerably.”

Working in collaboration with NNL has allowed Rawwater to access potential nuclear decommissioning markets both in the UK and internationally. Perhaps most importantly, it has enabled open communication between NNL, Rawwater and end customers – something that has enhanced our understanding of the challenges faced by the nuclear sector immeasurably.”

Kat Lennox

Managing Director, Rawwater Applied Technology

The Role of NNL

What we don't do

Compete with our supply chain

Sell for commercial gain

Work in isolation

What we do

We focus on the work our skills and capabilities are specifically required for, with around a third of our workload currently outsourced to businesses around the UK.

We provide the technical skills, capabilities and advice that government needs from its national laboratory – now and for the future. So when it comes to emerging nuclear technologies, our role is to kickstart the growth of a UK advanced nuclear industry by demonstrating that the technology is viable and cost effective – and thus, investable.

We are setting up virtual collaboration centres across our science and technology centres and our aim is to operate our infrastructure as a user centre so it can be accessed by academia, other national labs and the entirety of the supply chain.



3.1

Making a Difference to the Next Generation

We asked some of the engineers and scientists in their first few years of a career with us what difference they hope NNL will make to the lives of UK citizens over the next 50 years. Here's what they said.



“Over the next 50 years I see NNL playing an important role in helping the UK become a cleaner, healthier country, both in terms of its people and its places. NNL is perfectly placed to support the development of low-carbon energy technologies, expand the country’s capability in nuclear medicine and improve nuclear waste management – all of which help achieve these aims.”

Lucy Platts
Plant Chemist



“I was an environmentalist before I was a nuclear physicist so mitigating climate change is something that really drives me. My problem-solving tendency is what led me to study physics and through that I realised the energy density of nuclear offered the best solution to climate change. My hope is therefore that NNL’s work will help make the world more sustainable and further our progress in solving our world’s largest environmental challenge.”

Henry Preston

Scientist in Fuels, Reactors and Reprocessing Business Area

“Looking ahead, I hope that NNL will improve the lives of UK citizens from both an energy production and an environmental restoration standpoint. By continuing to develop more efficient and safer energy production methods, NNL can help future generations live without the use of fossil fuels. Alongside this, I think that NNL will continue to support advances in nuclear decommissioning and environmental remediation, for example by leading research in nuclear material behaviours and developing new practices to aid in the storage, decontamination, processing and disposal of waste.”

Jennifer Smart

Analytical and Project Delivery Lead



“The thing that really stands out to me about nuclear is the role it can play in reducing air pollution and greenhouse gas emissions. I think that NNL will therefore play a key part in helping to protect our environment for the future, particularly the Gulf Stream, and reversing some of the effects of climate change. I also hope that NNL can help change the perception of nuclear amongst the general public, taking it from being an area that might feel inaccessible and unknown to something that is cutting-edge and very much on the cultural pulse of society.”

Emin Veron

Fuel Performance Scientist, Nuclear and Reactor Physics Team

“NNL’s benefit to society is very tangible and real and it’s a huge part of why I choose to work here. Looking forward, I really do think that our skills and expertise in nuclear medicine, along with the human compassion of our scientists at NNL, is going to help transform the lives of families across the UK suffering with cancer.”

Sophie Zienkiewicz

Insight Advisor

