CUMBRIA: NUCLEAR PROSPECTUS

Energising the Energy Coast

Published August 2020

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FOREWORD

Energising the Energy Coast

This Prospectus has been produced on behalf of the Clean Energy Sector Panel of the Cumbria Local Enterprise Partnership (CLEP), a partnership body that is committed to developing clean energy opportunities to meet the UK's commitment to achieve Net Zero by 2050.

The Prospectus sets out an ambition for the growth of a Cumbrian energy cluster, with nuclear as the key component of a low carbon, clean growth economy: a cluster of regional and national significance; driving the best possible outcomes for climate change and the environment; creating long-term regional prosperity; and forging a strong Clean Energy identity for Cumbria and the North.

This Prospectus presents an ambitious yet pragmatic proposal for the formation of a Clean Energy Park, underpinned by the credibility of our existing industrial cluster, building on our strengths to grow opportunities for diversification and export, and developing strategic opportunities for new low-carbon energy generation, exploring synergies with offshore wind, hydrogen and synthetic fuels as those new markets grow.

Nuclear and clean energy are a core part of Cumbria's polycentric economy and, alongside green tourism, sustainable food, agriculture and natural capital, are central to the Local Industrial Strategy.

Sellafield has been the backbone of West Cumbria's economy for 70 years. In 2018, Oxford Economics demonstrated the significance of Sellafield's contribution to the UK economy and the positive socio-economic impacts felt locally and nationally, but also highlighted risks around local economic diversity and resilience. Similarly, BAE Systems- could be described as the backbone of the South Cumbrian economy.

Yet it is our inherent capability across industry, supply chain and academia, within a supportive community that offers opportunity to deliver existing missions more effectively, to make more of existing investment and to create greater value for the UK economy. It is this same supportive ecosystem that makes this an attractive place for inward investment in new energy developments.

To realise this opportunity, we must move from dependence on Sellafield to a more diverse economic future. We will work alongside our communities to ensure their views and needs are understood. Paramount in the debate about our clean energy future is the voice of the younger generation and one route to bring in fresh views is via Cumbria Future Leaders, in which Cumbria LEP's Futures Forum and the Nuclear Institute Young Generation Network take part along with other groups.

Cumbria's rural industrial economy relies heavily on infrastructure, both physical and increasingly digital, to ensure greater access for all members of society. Enhancements to our towns, leisure offer, digital connectivity and education provision are already underway, and our clean growth ambition can ensure we decarbonise heat, power and transport, supporting climate goals and inclusive economic recovery.

Cumbria can make a significant contribution to a number of government priorities:

- Clean Energy Generation: developing a low-carbon energy hub around the Moorside site, capable of generating in excess of 5GW of clean energy, including important baseload capacity;
- Economic Recovery: 23% of Cumbria's overall GVA comes from the advanced manufacturing and engineering sectors, which have the skills and expertise to quickly pivot to respond to new supply chain opportunities to accelerate recovery;
- Levelling Up: investment in new nuclear will provide a further catalyst to the levelling up agenda, creating new and sustainable employment in rural communities. Our commitment and actions to inclusive growth will ensure that nobody is left behind.

The Clean Energy Sector Panel is committed to providing the necessary support to government and investors so that the nuclear opportunity can be brought to life, here in Cumbria.

Dr Rebecca Weston
Cumbria Local Enterprise Partnership Board Member,
Chair of the Clean Energy Sector Panel

A ROADMAP TO NET ZERO

Cumbria is the original home of nuclear energy. This document sets out a pathway for Cumbria to become the Northern "Living Lab" for clean energy: decarbonising heat, power and transport, and driving Clean Growth as we head towards Net Zero by 2050.

Centred around the vision of a Cumbria Clean Energy Park, the proposals in this document draw upon Cumbria's capability across industry, supply chain and academia within a supportive community, applying these strengths to the development of a major clean energy platform for the North.

Cumbria will be the trailblazer for the UK's decarbonised energy system – a blend of Nuclear New Build and Advanced Nuclear Technologies, providing heat and power for local use or distribution via the National Grid, and producing low carbon synthetic fuels, with links into wider renewable energy networks in the North West.

These proposals include the delivery of ongoing missions more effectively in a way that drives wider social and environmental benefit, and the acceleration of significant clean energy infrastructure projects, which will reboot and level up the economy, by creating green collar jobs and securing regional prosperity for decades to come.

The five themes of the vision cut across UK government policy and delivery areas, demonstrating the need for a joined-up approach to Cumbria's future economic strategy.

Cumbria is globally recognised as a place of opportunity to innovate, to improve efficiency and effectiveness, to increase potential return on government investment and to improve attractiveness of new nuclear developments to private investors. The ongoing delivery of full lifecycle nuclear projects in Cumbria continues to stimulate a vibrant and skilled supply chain and workforce, with world-leading capability in nuclear operations, nuclear safety and security, construction management, robotics and AI, and environmental protection.

Cumbria offers a one-stop shop for nuclear missions, with the centre of excellence in decommissioning and environmental remediation around Sellafield in close proximity to professional services and manufacturing hubs on the West Coast. The Cumbria Clean Energy Park can be delivered in partnership with low-carbon energy developments across Lancashire, Cheshire and North Wales, to grow the UK contribution of the North West Nuclear Arc.

Investment in Cumbria's nuclear future will enable us to build on our heritage to deliver the UK's Industrial Strategy, driving sustainable growth and de-risking investment.

Cumbria has the pioneering heritage, innovation culture, visionary leadership, collective ambition and global reach to develop and deploy the UK's future energy systems.

CUMBRIA CLEAN ENERGY PARK
A vision for the Cumbria Clean Energy Park is set out on page 11

- Page 12 — 3GW+ New Build at Moorside
- Page 13 — Energy Coast Hydrogen Network
- Page 12/13 — Small Modular Reactor
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20% Legacy Cost Reduction by 2030

- Page 19 — Safer, Sooner, Higher Value
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- Page 20 — Long Term Management Solution

2020 → 2030 → 2040

INVESTING IN OUR NUCLEAR FUTURE

Cumbria is a Centre of Nuclear Excellence: decarbonising heat, power and transport, and driving Clean Growth as we head towards Net Zero by 2050. Investment in Cumbria's nuclear future will enable us to build on our heritage to deliver the UK's Industrial Strategy.

The Importance of Nuclear

The UK is undergoing an energy revolution: simultaneous electrification and decarbonisation to reduce emissions and achieve Net Zero by 2050; decentralised energy generation from renewable sources for heat, power and transport; and digitalisation of the national grid to manage and balance supply against demand. Most of the UK's existing nuclear fleet, which supplies approximately 20% of the UK's electricity, will be retired by 2030 and all coal plants closed by 2025 or sooner. Concern is growing about the UK's projected energy gap and increasing reliance on energy imports.

The 2020 Energy Systems Catapult (ESC) "Innovating to Net Zero" report found that:

- Electricity generation will need to double, or possibly triple
- Hydrogen will need to grow from a standing start to levels equivalent to today's electricity generation
- Success depends on innovation across the whole system

Futher, the 2020 "Nuclear for Net Zero" techno-economic assessments conducted by ESC demonstrate an enhanced role for large, small and advanced nuclear in supporting different decarbonisation pathways for the UK. The only credible future low carbon energy system is one of a blend of nuclear and renewables, producing energy, hydrogen and synthetic fuels.

The 2018 Nuclear Sector Deal builds on the long history of nuclear knowledge and expertise in the UK and sets out how, through sector-wide collaboration with the right support from government, we can meet our Clean Growth Grand Challenge.

Cumbria is the leading economic contributor of any of the UK's nuclear clusters, and will continue to provide strategic facilities and services to the nuclear sector for decades to come. Cumbria has the potential to become a significant contributor of low carbon power for the UK. Investment here will enable us to commercialise our knowledge, develop our strategic sites and support the delivery of the Northern Powerhouse Partnership "Powerhouse 2050" strategy, building on the north's nuclear strengths and growing a low carbon economy. The Energy and Clean Growth strategy, produced by the Northern Powerhouse 11 establishes clear ambition for the region by boosting the energy economy considerably, creating green jobs, and reducing carbon emissions at an enhanced rate. By co-ordinating across the region, we are ideally placed to lead the UK's journey towards Net Zero.

Cumbria could contribute between 5-7GW of new, low carbon energy to the UK through a combination of new nuclear, advanced nuclear technologies, hydrogen and offshore wind.

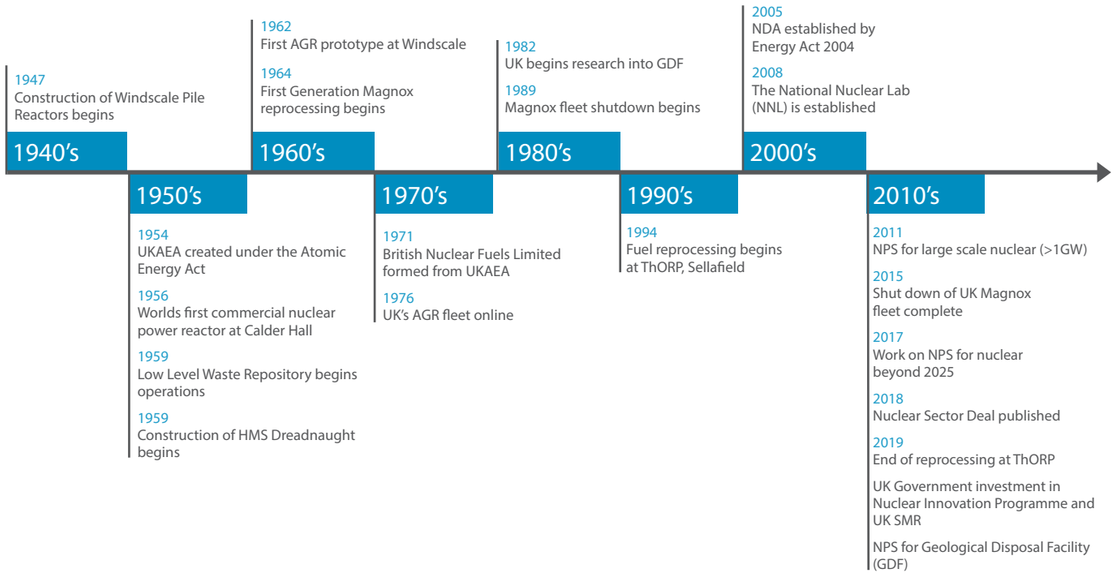
Investment in research and development, innovation and digital technology will open up new markets, and allow us to share our expertise of working in challenging environments with other sectors, such as Fusion, and with other nations such as Japan, who are facing decommissioning challenges.

The Role of this Prospectus

This Prospectus is formed around five investment themes that will deliver the Cumbria Clean Energy Vision (see page 10/11).

The document sets out proposals that build on our nuclear heritage and which, with investment and support from Government, will be a catalyst for Cumbria's low carbon energy economy, powering the North and driving clean growth for the UK.

The proposals are complementary to Cumbria's Local Industrial Strategy, Clean Energy ambitions and Infrastructure and Internationalisation strategies.



Our journey: nuclear pioneers for the past 70 years

Our Heritage

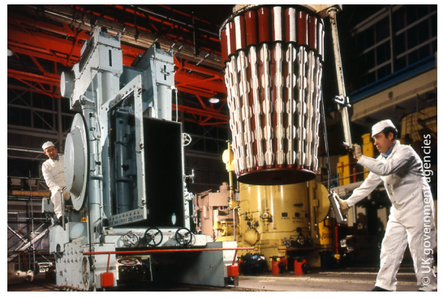
The UK was a pioneer of nuclear energy, and the Windscale Pile reactors, Calder Hall and Windscale Advanced Gas-Cooled Reactor (AGR) prototype in Cumbria were the seeds of the UK's civil nuclear programme. Cumbria has also led the way on activities across the fuel cycle: from Magnox fuel reprocessing since the 60s and commercial fuel reprocessing in the 90s, Mixed Oxide Fuel manufacture in the 2000s, first-generation reactor decommissioning and ongoing higher activity waste management. Since HMS Dreadnaught in 1960, the BAE Systems shipyard has delivered every first-in-class nuclear submarine, using modular design and construction to reduce cost and complexity.

We have grown generations of globally recognised experts in nuclear plant operations, design, engineering, construction management, material science, decommissioning, and research and development and continue to attract the best scientific and engineering minds to this day.

We have already solved some of the industry's biggest challenges, including; minimising the hazards associated with some of the most radiologically active facilities in Europe, researching ways to make our waste safer for long term storage, diverting and recycling wastes at great value to the UK economy, reducing the UK's carbon footprint, and providing guidance and technical expertise to aid the clean-up of Fukushima Daiichi in Japan.

We have built a nuclear knowledge economy that encompasses the majority of the nuclear life cycle – from generation, reactor operation support, fuel fabrication and reprocessing, to waste management and decommissioning. This wealth of knowledge and experience makes Cumbria a Centre of Nuclear Excellence.

The Thermal Oxide Reprocessing Plant (ThORP) at Sellafield generated £9Bn in revenue over 24 years of operation



Fuel loading at Calder Hall, the UK's first commercial nuclear power station

OUR PEOPLE AND SKILLS

Cumbria is a Centre of Nuclear Excellence: our people are the driving force of the UK's nuclear sector, and our academic institutions are growing the nuclear workforce of the future

Cumbria is home to a density of higher-level skills and nuclear expertise that cannot be found anywhere else in Europe. Our capability spans the full fuel cycle, including generation, operations, reprocessing, waste management and decommissioning as well as Research & Development (R&D), nuclear materials transportation, manufacturing and robotics. All of this is connected with the UK and the world by logistics hubs at the Ports of Workington and Barrow, Carlisle Airport and the M6.

We are host to the Nuclear Decommissioning Authority headquarters, the Sellafield site, UK Low Level Waste Repository, BAE Systems Submarines shipyard and National Nuclear Laboratory's central labs. Our nuclear sites support the UK civil and defence nuclear sectors, with important links to academic institutions and R&D programmes in the UK and around the world.

Our inherent nuclear and wider energy supply chain capability is reflected in the Britain's Energy Coast Business Cluster (BECBC), a 325-strong member organisation including global multinationals and local SMEs from public, private, academic and third sectors. BECBC is the UK's strongest regional business enterprise cluster: this is Cumbrian Collaboration with Global Reach.

Our academic and training facilities include University of Manchester Dalton Facility, Energus – host to the world-leading nucleargraduates programme, National College for Nuclear, Gen2 and the Energy Coast UTC. With over 2,000 trainees on graduate and apprentice programmes at any time, we are creating the nuclear workforce of the future.

Our Centre of Nuclear Excellence is connected into the combined capability of the wider North West Nuclear Arc, including uranium enrichment facilities at Capenhurst and unique nuclear fuel manufacturing facilities at Springfields, the Nuclear Advanced Manufacturing Research Centre (NAMRC) and world-leading academic institutions across the Arc.

We are in a unique position to build on our history as pioneers of the nuclear industry, to become significant contributors to the UK's Net Zero ambitions, and a major growth engine for the UK economy and the Northern Powerhouse.

KEY STATISTICS

GVA CONTRIBUTION P.A

£2.5bn
in Cumbria

>£3.5bn
UK from Cumbria

22%
of Cumbria's GVA

PEOPLE AND EMPLOYMENT IN CUMBRIA

31%
of UK nuclear workforce

27,000
people

400
Graduates on programmes

1,600
Apprentices on programmes

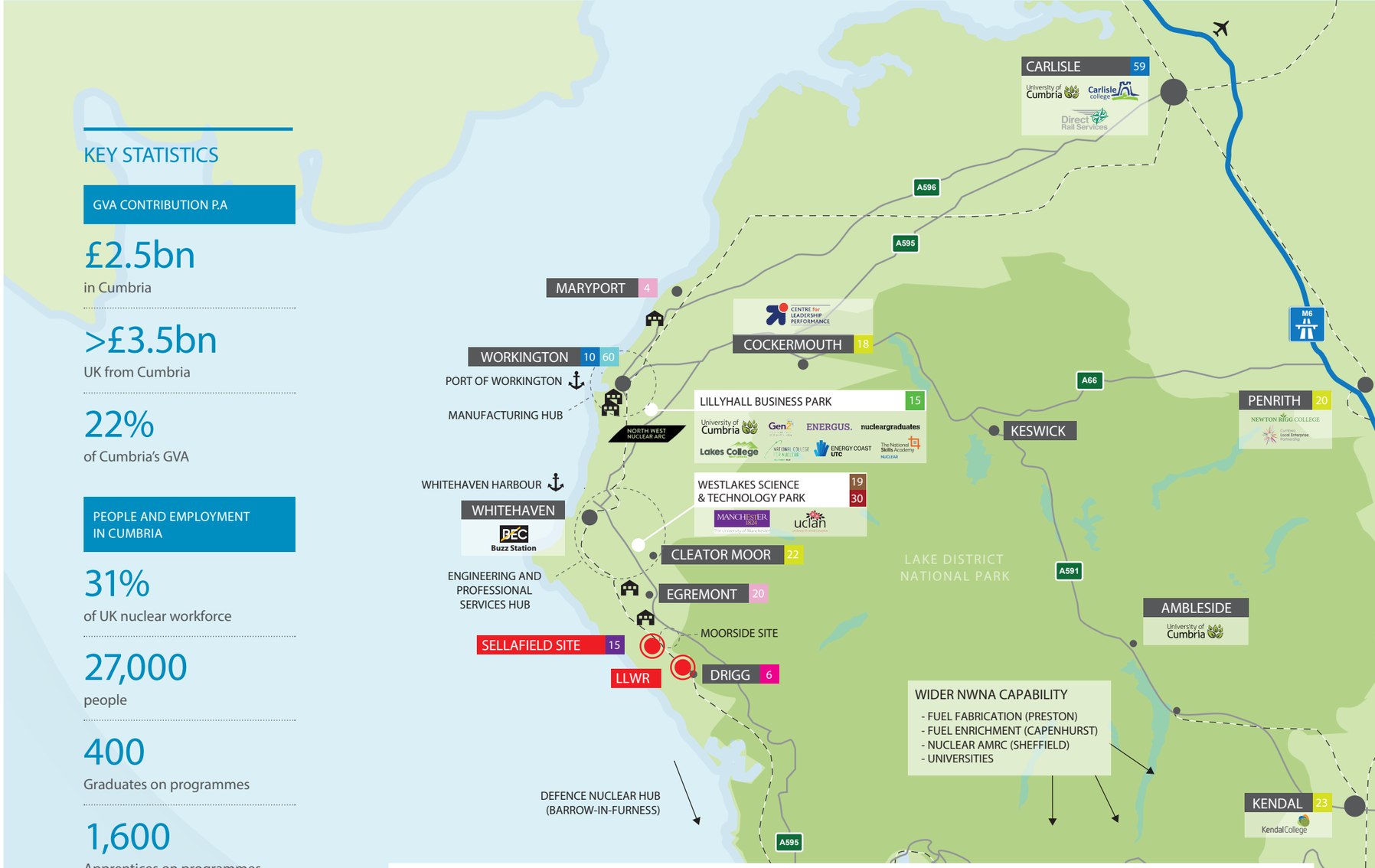
UK EMPLOYMENT

70,000-80,000
including direct, indirect and induced jobs

SUPPLY CHAIN IN CUMBRIA

>400
Companies

8,000
Employed



Existing Nuclear Capabilities in Cumbria

With headquarters in Cumbria, the Nuclear Decommissioning Authority (NDA) is an executive non-departmental public body, tasked with cleaning up the UK's legacy civil nuclear sites.

Sellafield Ltd

From pioneering civil nuclear power in the 1950's, and leading subsequent UK/International fuel reprocessing programmes, Sellafield Ltd is now a world-leading centre for decommissioning and environmental remediation.

LLW Repository Ltd

The national Low-Level Waste Repository (LLWR) located south of Sellafield is a strategic asset for the UK supporting the disposition of low level nuclear-contaminated materials from a variety of industry sectors.

International Nuclear Services is an expert in irradiated fuel management and transportation of nuclear materials. No other company in the world can offer the breadth of design, licensing and nuclear transport experience.

Direct Rail Services

Established by the NDA to provide strategic transport services to support decommissioning, Direct Rail Services now employs 450 people providing services to a range of sectors beyond nuclear.

BAE SYSTEMS

Since 1959, the BAE Systems Submarines shipyard in Barrow has been the home and centre of excellence for the design, manufacture, fabrication, integration and commissioning of small and increasingly modular nuclear power plant.

NATIONAL NUCLEAR LABORATORY

With globally unique facilities, National Nuclear Laboratory (NNL) is arguably a world-leading centre for research & development in nuclear fuel technologies, covering manufacture, testing and reactor operations support.

BEC

Westlakes Science & Technology Park osts a cluster of science, engineering and professional services firms supplying the nuclear sector, including multinationals and local specialist SMEs, with international market penetration.

KEY

- Inactive development & testing facility
- Sea port
- Airport
- Nuclear licensed site
- Key town (scaled for size)
- Railways
- Motorway
- A roads

Clusters of supply chain companies

- Nuclear education & skills
- Nuclear engineering
- Nuclear technology & scientific research
- Nuclear design/engineering/services
- Nuclear construction & plant services
- Transport & logistics services
- Submarine design and shipbuilding
- Professional services
- Nuclear licensed site support services
- Engineering support services
- 00 Number of supply chain companies (Supply chain companies based on BECBC members ca. 2018)

INVESTING IN CUMBRIA

Cumbria is a Centre of Nuclear Excellence: the Northern "Living Lab" for Clean Energy, decarbonising heat, power and transport, and enhancing the UK's energy security. Cumbria is the key that will unlock the UK's energy future.

One Voice: Cumbria Clean Energy Vision

This prospectus invites investment in proposals that will transform our nuclear future and deliver the Cumbria Clean Energy Vision (see page 11). The proposals align to five themes:

CLEAN ENERGY

Delivering the UK's future energy system as part of a major energy platform for the North

BUILDING ON OUR STRENGTHS

Commercialising our expertise, exporting into domestic and global markets, to solve the world's challenges

ADVANCED NUCLEAR TECHNOLOGIES

Cumbria is the place to develop and deploy Advanced Nuclear Technology

MANAGING THE LEGACY

Driving technological innovation to reduce our legacy footprint, unlocking the UK's future nuclear programme

PIONEERING RESEARCH & INNOVATION

Commercialising innovation in Robotics, AI and Digital technologies

The five investment themes on pages 12 to 21 are underpinned by the following principles:

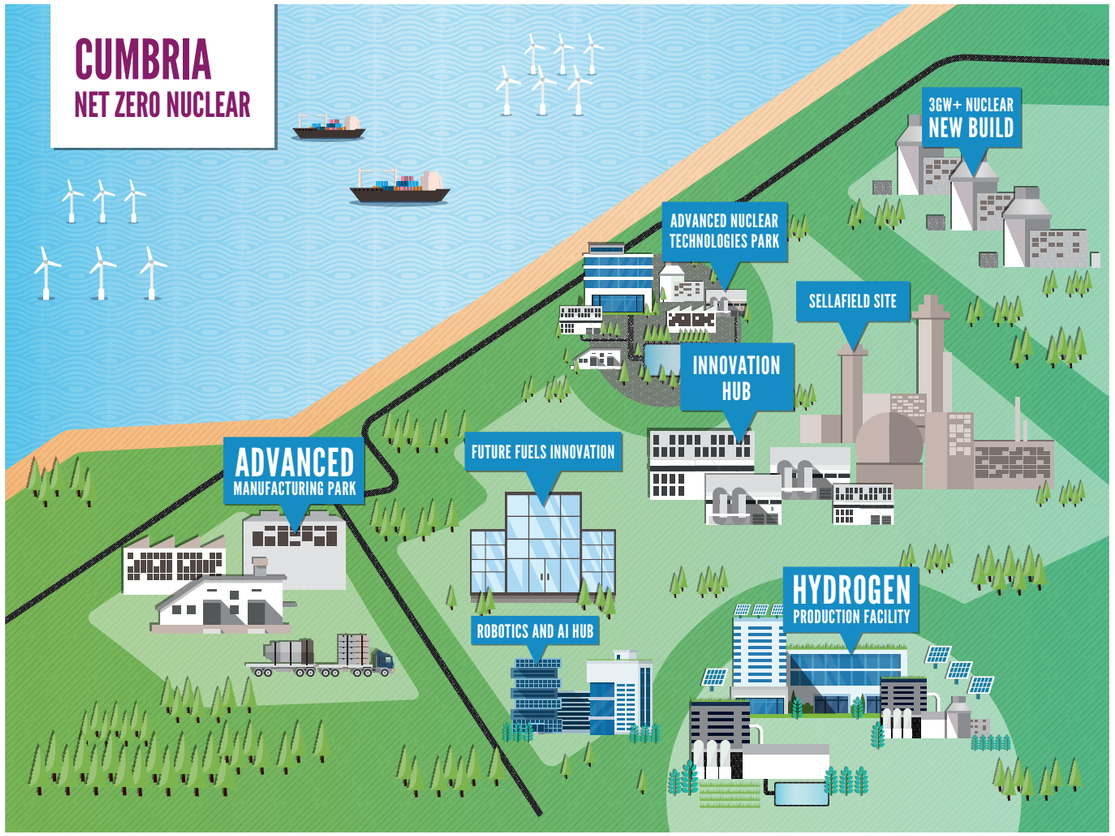
Cumbria as the Northern "living lab" for Clean Energy
Contributing to economic, cultural and societal change in an innovative, sustainable economy

Decarbonising Heat, Power and Transport
Through Nuclear, Offshore Wind and Hydrogen contributing to UK Net Zero by 2050

Enhancing the UK's Future Energy Security
Through large-scale growth of inherent UK capability

Unlocking the Future
Strategic investment in Cumbria now will unlock future policy decisions for the UK

Reducing Risk
Supportive physical and knowledge infrastructure makes Cumbria the place to reduce investment risk



Cumbria Clean Energy Park vision based on the "Net Zero Nuclear" concept presented at Global Reach 2019

Nuclear Energy and Environmental Remediation at the heart of the Cumbrian Economy

As part of a global effort to address climate change and decarbonise economies, the UK has committed to achieving net zero carbon by 2050. With over 50 percent of UK energy requirements in 2018 being met by carbon intensive forms of energy, mitigating further harmful effects of climate change will require investment in technologies that can provide low carbon, firm power as part of a whole system approach that supports production of low carbon synthetic fuels.

The Cumbria Clean Energy Park will be the deployment site and testing ground for low carbon energy technologies, including nuclear new build, Small Modular Reactors and other Advanced Nuclear Technologies, as well as pioneering research and development in Robotics and AI, environmental remediation, advanced fuels and manufacturing.

The site could support 5GW+ of new nuclear generation and also feed the National Grid with a further GW of new offshore wind power from the Cumbrian coast by 2030. This regional energy platform will support new opportunities for production of hydrogen and synthetic fuels, heat networks and energy storage systems as part of a major North West contribution to the UK.

The Park will support the rapid development of highly-skilled, green employment opportunities, readily available to support UK and global decarbonisation markets. Production of low carbon heat, power and fuels on the Park will provide opportunity to decarbonise our transport infrastructure, as well as attracting new energy-intensive industry to Cumbria.

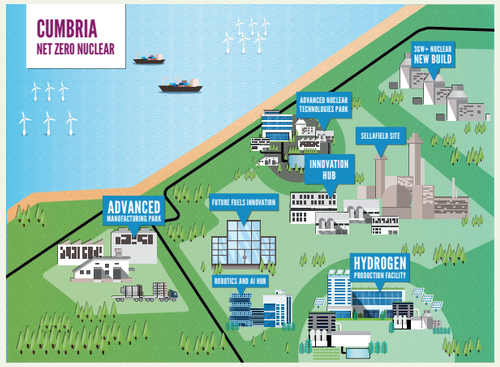
We have a readymade customer for low carbon energy on our doorstep: the Sellafield site is one of the UK's oldest industrial heat and power networks - there is potential to develop a closed-loop energy system to power the ongoing decommissioning and environmental remediation mission.

Cumbria has the pioneering heritage, innovation culture, visionary leadership, collective ambition and global reach to develop and deploy the UK's future energy systems.

The Park will sit within a network of Clean Energy and Technology Parks across the North West Nuclear Arc region adding up to a major Clean Energy Platform for the UK.

CLEAN ENERGY

Nuclear Energy and Environmental Remediation at the Heart of the Cumbrian Economy: the deployment site and testing ground for low carbon energy technologies - delivering the UK's future energy system as part of a major energy platform for the North.



MAIN INVESTMENT PROPOSAL

Cumbria Clean Energy Park

The site could host a large new nuclear station or a mix of large, small and advanced nuclear. This could result in 3GW+ of large new build plus a further contribution of low carbon power from other technologies on or adjacent to the site.

Part of the site could be devoted to testing and deployment of Advanced Nuclear Technologies, to produce heat, steam, hydrogen or other low carbon synthetic fuels.

This low carbon heat and power could be supplied to existing local customers, Sellafield, the defence nuclear hub in Barrow and the manufacturing hub in Workington, or to attract new energy-intensive industries to Cumbria as part of a new industrial cluster.

Small Modular Reactors (SMR)

Our nuclear sector capability, supply chains, manufacturing capability and knowledge infrastructure make Cumbria the go-to place to lead development and deployment of Advanced Nuclear Technologies.

SMR projects developed in Cumbria could become a "springboard" for global export of a UK product, with benefits to energy and market security. The economic impact could be significant, with multiple manufacture/fabrication hubs and dispersed supply chains.

Advanced Modular Reactors (AMR)

The Advanced Nuclear Technology Park will be the testing ground and deployment site for first of a kind or prototype or a range of advanced technologies, which could reuse existing stocks of nuclear materials stored at Sellafield or produce hydrogen for export as a fuel or as a form of energy storage.

Powering the Sellafield Site

As the largest energy user in West Cumbria, Sellafield presents both a challenge and opportunity in achieving ours and the UK's Net Zero ambitions. In future, a SMR or AMR at Fellside could provide low carbon heat, power and steam to the site.

Any surplus could be distributed locally to provide low cost, low carbon electricity to communities near to the site or to supply a local heat network.

Energy Coast Hydrogen Network

We will be at the forefront of the production of hydrogen, using locally generated low carbon electricity to decarbonise electrolysis or directly by using advanced nuclear technologies, tying into wider hydrogen networks across the Northern Powerhouse.

Enablers

The Clean Energy Park vision is ambitious, with a level of investment that can only be realised through collaboration by public and private sector with support from government:

UK Energy Policy

Supportive Energy Policy would give confidence to developers, investors, utilities and supply chains in a GW contribution from nuclear to the UK's future energy mix.

Streamlined Regulatory Process

An optimised and flexible regulatory approach to Advanced Nuclear Technologies is a key enabler to bringing technologies to market.

Finance Model

UK Government must agree a finance model for nuclear new build projects which is attractive to private investors while limiting exposure to the taxpayer and keeping the price of electricity low.

Nuclear Infrastructure Delivery Model

A delivery vehicle with a clear mandate from Government and support from industry to accelerate deployment of the UK's Low Cost Nuclear programme, providing a platform for UK Plc as a global leader in Advanced Nuclear Technologies, unlocking export opportunity and attracting private sector investment.

Cost Reduction Task Force

Taking learning from the Offshore Wind sector to form a collaboration of industry, supply chain and government focused on reducing the cost of nuclear power.

Infrastructure Investment

There are opportunities to coordinate investment in infrastructure to support the Clean Energy Park and other regional initiatives, including the Cumbrian Coast Rail Line, A595, Whitehaven Relief Road and ports at Workington and Barrow.

There are synergies here with the infrastructure, such as grid connections, required to support other clean energy developments including Offshore Wind.

Site Development

Public and private sector must collaborate in the creation of the Clean Energy Park - to make land assets available, to deliver the supporting infrastructure and to facilitate a multi-technology approach.

Supply Chain Strategy

A supply chain strategy for the Clean Energy Park and its constituent projects, integrated with the wider UK new build programme, would ensure a significant positive impact for the local and regional economy.

WHY?

To decarbonise the UK's energy system, we require a coherent system of low carbon energy technologies. Large Nuclear New Build, SMR and AMR in Cumbria will produce electricity and other forms of energy to lead the UK towards Net Zero by 2050.

Development of the Moorside site is of strategic national importance: a large nuclear station here could meet 7% of UK's or 6 million homes, creating 21,000 jobs over its operational lifetime.

We must plan for the future beyond current large scale nuclear technologies, by investing in the development and deployment of Small and Advanced Modular reactors. Cumbria has the sites and capability to deliver advanced nuclear for the UK.

CASE STUDY

UK SMR

UK government has invested £18m of Industrial Strategy Challenge Funding in the UK SMR consortium, to develop their compact clean power station towards commercial deployment. Initially the consortium will look to concurrently deploy at least 10 of the 440MWe units, potentially on existing NDA-owned land in Cumbria and North Wales.

Partners from Cumbria and North Wales have already come together through the North West Nuclear Arc to support the development of a UK delivery model for the project.

A fleet construction programme with support from Government would give confidence to investors and supply chain to a project that could be a stimulus for levelling up the UK economy.

This UK project could create 6,000 supply chain jobs by 2025 and would stimulate infrastructure investment in fuel manufacture, modular construction and forging capability, delivering regional economic benefit beyond project delivery.

ADVANCED NUCLEAR TECHNOLOGIES

Through the Nuclear Innovation Programme, we are already developing future fuels and de-risking policy decisions for the UK's future low carbon energy system. Our higher level skills, unique facilities and manufacturing capability make Cumbria the go-to place to develop and deploy Advanced Nuclear Technology.

MAIN INVESTMENT PROPOSAL

Advanced Nuclear Technology Park

Cumbria is the go-to place to bridge the gap between R&D and commercial deployment of the technologies that will form our future energy system.

The Advanced Nuclear Technology Park will be a testing ground and deployment site for first of a kind and prototype Small and Advanced Modular Reactors, which might include Small Modular Reactors, High Temperature Gas Reactors, lead-cooled reactors or micro-reactors.

These technologies are suitable for a range of applications and could be used to produce high-grade industrial process heat, steam or fuels such as hydrogen.

Advanced Fuels Development

UK government investment in the £180m Nuclear Innovation Programme is the first public investment in nuclear fission research and innovation for a generation.

Through National Nuclear Laboratory's work on the Advanced Fuel Cycle Programme, we are already supporting development towards commercial deployment of the next generation of nuclear technologies. By doing so we are delivering world-leading innovation and generating valuable Intellectual Property for the UK.

Making more efficient and safer fuels for current and future reactors is crucial if the UK is to retain an indigenous fuel manufacture capability.

Continued investment in NNL's unique facilities and Cumbria's specialist skills will preserve our subject matter expertise in this field for the future prosperity of the UK.

Future Fuels Manufacturing Facility

Cumbria can help bridge the technology readiness gap between R&D and commercialisation, by providing the sites, facilities and expertise required to deliver the UK's plutonium disposition strategy, either by manufacturing mixed oxide fuel (MOX) for use in AMRs or immobilisation for disposal:

- Research and pilot scale manufacture of advanced fuels
- Fuel manufacture to support advanced nuclear technologies
- Manufacturing of MOX fuel for advanced modular reactors, as a disposition route for the UK's nuclear materials

Advanced Manufacturing

Cumbria's economy is underpinned by an extensive manufacturing base which has seen steady growth to 13% of the county's economy, supporting 16,000 jobs. A number of members of Britain's Energy Coast Business Cluster already supply high value precision manufacturing services to the global nuclear and wider energy markets.

The influence of key organisations like BAE Systems, Sellafield Ltd., Iggesund and Ørsted is driving a strong SME base and supply chain.

Our aim is to attract key energy projects, including advanced nuclear, so that established clusters of supply chain and manufacturing businesses can deliver and grow new export opportunities, placing Cumbria at the forefront of new clean energy developments to contribute to Net Zero by 2050.

Cumbria could manufacture components to supply Advanced Nuclear projects, growing an economic sector which is essential to the ANT programme, and anchoring supply chain benefit in Cumbria.

North West Nuclear Arc

Sustainable energy that doesn't cost the earth

Cumbria is a key partner in the North West Nuclear Arc (NWNA), a regional network of unrivalled nuclear fuel cycle capability stretching from Cumbria to North Wales and encompassing uranium enrichment at Capenhurst, fuel manufacture at Springfields, the Nuclear Advanced Manufacturing Research Centre, the National Nuclear Laboratory's unique capability and leading academic institutions. Almost half of the UK's existing nuclear research and development activity is in the NWNA region.

The ambition is place-based growth and development through enactment of clean growth, energy and nuclear policies on the ground. Key NWNA partners have come together organically to create a genuine shared vision, united by sense of place and desire to effect change for the benefit of our communities.

Our goal is joined-up action to build a stronger innovation eco-system and support the development of the marketplace for the UK's advanced nuclear programme, underpinning a GW contribution from nuclear to the UK's future energy system.

WHY?

The 2020 Nuclear Innovation Research Advisory Board "Achieving Net Zero" Report cites a much greater role for Advanced Nuclear Technology in decarbonisation of heat, power and fuels, at low cost. The report recommends an AMR demonstrator in the period 2030-2035, which could be sited at Fellside near Sellafield.

Advanced fuels development including technology, infrastructure and capability is required now to avoid foreclosure of future energy strategy options and policy decisions, such as which technologies form part of the energy mix to 2050 and whether we are able to reuse our existing stockpiles of nuclear materials. Fuel Cycle Strategy is critical to energy strategy, and the Advanced Fuel Cycle Programme will maintain the UK's position as a centre of excellence for nuclear fuels.

By investing in the Cumbrian supply chain, manufacturing capabilities, R&D programmes and partnerships, and through our relationships with advanced nuclear technology vendors, we can achieve domestic and international contract wins in this emerging global market.

CASE STUDY

TSP Engineering

TSP Engineering offers technical solutions to complex problems, delivering heavy engineering to precision with a full range of services from design, consultancy and project management, to manufacture and refurbishment along with electrical engineering, instrumentation and testing. TSP's state of the art facilities, locality and engineering experience make them a key supplier to the following industries; nuclear, defence, oil and gas; steelmaking; renewables; and construction.

In 2019, TSP Engineering became the first company globally to achieve ISO 19443:2018 accreditation, reflecting their ability to supply precision metal components for the nuclear sector, specifically in support of safe and secure application in small and advanced modular reactors.

PIONEERING NUCLEAR RESEARCH AND INNOVATION

Creation of a viable innovation pipeline is key to unlocking the full potential of Cumbria's future economy. A joined-up programme of research, development, testing and application will enable us to successfully commercialise these innovations.

MAIN INVESTMENT PROPOSAL

Advanced Robotics Cluster

Regional partners including National Nuclear Laboratory, NDA, Sellafield Ltd, UK Atomic Energy Authority and University of Manchester are collaborating on the growth of nuclear robotics capability. This collaboration will stimulate cross-fertilisation of ideas to drive the innovation required in development of fusion technology, and to deliver the Sellafield mission safer, sooner and cheaper to achieve our Legacy Cost Reduction commitment.

The cluster effect will strengthen our ability to commercialise and export technologies, supporting the intra- and cross-sector transfer of innovations between fission and fusion, and into domestic and international markets.

Staying at the Cutting Edge

Since 2013, the University of Manchester Dalton Cumbria Facility (DCF) at Westlakes Science & Technology Park has acted as the national focal point to re-energise the research community in the critical area of radiation science. DCF is an important part of the national research infrastructure through its central roles in the National Nuclear User Facility, the Henry Royce Institute and the UK National Ion Beam Centre.

The research and development carried out at these truly unique research facilities is essential to the future of our sector and attracts talented people with higher-level skills to Cumbria. By investing in Centres for Doctoral Training, industry-sponsored PhDs and Level 8 Degree apprenticeships for subject matter experts, Cumbria will help the UK nuclear sector to stay at the cutting edge.

Manchester in Cumbria

The Robotics and AI Cluster could be supplemented by a research and innovation capability which brings together the University of Manchester Dalton Cumbria Facility and existing Robotics in Extreme Environments Lab (REEL) in Cumbria with a multi-university and business approach to drive innovation in digital, robotics and materials science to support the development and deployment of Advanced Nuclear Technologies in the UK.

This would anchor further R&D investment in Cumbria, developing higher level skills and subject matter expertise in a field that is critical to achieving the new build and legacy cost reduction commitments set out in the Nuclear Sector Deal.

Zero Carbon Electricity

Innovative companies in Cumbria are exploring ways to harness the radiation emitted by radioisotopes found in nuclear waste, by converting it to zero carbon energy.

Investment in these technologies could simultaneously convert a waste product into a fuel, while creating a zero carbon energy source suitable for on-grid power generation or to provide long-life power supply in remote or challenging environments such as nuclear decommissioning, fusion, oil & gas or even in space.

UK Research Reactor

Radioisotopes play a vital role in 21st century medicine, from imaging and radiotherapy to diagnosis of dementia and heart problems. Each year in the UK, 1 million patients undergo treatments that rely on radioisotopes, 80% of which are imported.

The global growth in demand for medical radioisotopes for diagnostic and therapeutic treatments presents an opportunity to build a high-value supply business and grow UK export potential.

A new UK research reactor, for production of medical radioisotopes would place Cumbria on the global radioisotope map, building on existing skills and capability to deliver a new mission with high social impact, locally, nationally and globally.

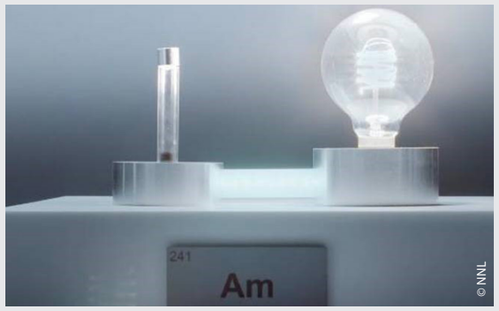
WHY?

The 2019 Nuclear Innovation Research Advisory Board (NIRAB) report on "Clean Growth Through Innovation" made the following recommendations in order to build on the UK's position as a place of R&D excellence:

- Investment in a Nuclear Innovation Programme in the region of £1 billion, to include support for the construction of Advanced Nuclear Technology demonstrators by 2026;
- Government and private industry should facilitate an Advanced Nuclear Technologies build programme in the UK (operation of a mature commercial advanced nuclear technology by 2030 and a demonstrator of a lower maturity technology by mid 2020s);
- Government should identify the role it needs to play in de-risking civil nuclear projects, including innovative finance models, such that they are investible to the private sector.

Robotics, AI and Digital are the levers by which to create greater value from the investment at Sellafield. Sellafield provides the "pull" for innovation to deliver its mission safer, sooner and cheaper to meet the UK's Nuclear Sector Deal 20% Legacy Cost Reduction commitment.

By commercialising this innovation, we will not only increase productivity, but create spin-off and start-up enterprises based on commercialisation of innovation, growing our digital economy and opening doors to new domestic and export markets.



CASE STUDY

NNL

A team of scientists led by the National Nuclear Laboratory (NNL), working with the University of Leicester, have extracted a rare element from a sample of the UKs plutonium stockpile, and used the heat generated from this highly radioactive material to generate enough electric current to light up a small lightbulb. The element, americium, is not found in nature but is a by-product of the decay of plutonium, which is produced during the operation of nuclear reactors.

This breakthrough means the potential use of americium in radioisotope power systems to power spacecraft heading into deep space or to challenging environments on planet surfaces where other power sources, such as solar panels, no longer function.

Infinite Power

Infinite Power, based at Westlakes Science & Technology Park, are high-tech innovators in zero carbon power. They have developed a semiconductor technology that can harness isotopic energy, with two significant applications:

1. Power cells for challenging environments, such as in Fusion reactors
2. Large scale isotope power generation: on grid or via power cells

The technology can use commercial Cobolt 60 isotope sources, but has the potential to harness the radiation emitted by radioactive materials stored at Sellafield, converting this into zero carbon electricity.

The presence of raw materials, the isotope handling capability and manufacturing supply chain locally make Cumbria the place to lead on this innovative approach to extracting value from the waste currently stored at Sellafield.

With a 50/50 gender balanced workforce and by offering a number of apprenticeships, Infinite Power Co are attracting diverse, talented young people to high value careers in Cumbria.

BUILDING ON OUR STRENGTHS

We have developed world-leading capabilities to meet the decommissioning challenges at Sellafield. Building on our existing strengths, we will commercialise our expertise, exporting into domestic and global markets, to solve the world's challenges.

MAIN INVESTMENT PROPOSAL

Delivering the mission safer, sooner, at higher value

The circa £2Bn investment at Sellafield each year drives risk reduction in the UK's highest hazard nuclear facilities, continued operational support to the UK reactor fleet and ongoing safe and secure storage of legacy materials.

Every job at Sellafield sustains a further 2.8 in the economy, with far higher than average GVA contribution per capita. Sellafield is the engine of our current economy.

Over the next 20 years, this investment will support continued management of the UK's legacy materials (see page 20), facilitate broad-front decommissioning and environmental remediation.

By harnessing and commercialising the unique capability developed in carrying out this mission, we will generate even greater value from the investment, driving economic diversification into new domestic and international markets.

Enterprise Campus and Innovation Hub

Creation of a cluster of networked public, private and academic organisations with ambitions to grow, diversify and export nuclear and non-nuclear products and services from Cumbria into UK and international markets.

This project will support economic growth based on capability developed in delivering the Sellafield mission, while diversifying our local economy, increasing UK exports and "Winning UK Business".

The hub will connect into a wider innovation campus network across the North West Nuclear Arc.

UK Environmental Remediation Hub

We will set out our "shop window", displaying the assets, infrastructure, skills and capabilities we can bring to bear on any given challenge around decommissioning, decontamination, waste characterisation, conditioning, treatment, packaging and disposal.

We will link this to a list of opportunities (via the emerging National Decommissioning & Waste Management Pipeline) to deal with the civil nuclear legacy much sooner in our own region and highlight the prospects for Cumbrian businesses to access decommissioning opportunities in other sectors.

A UK Environmental Remediation Catapult in Cumbria would maximise this opportunity.

Sellafield as a Living Lab

The Sellafield site is a de facto technological test bed on which to develop, deploy & prove (TRL4-7) cutting edge decommissioning, waste management & remediation technologies for delivery of domestic remediation missions and for export.

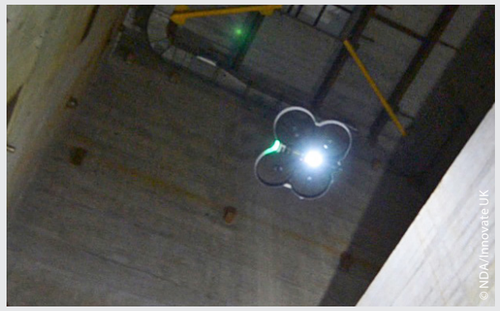
We will use digital innovation, technology and big data to assess and masterplan future activities on the site, becoming an exemplar industrial smart city and test bed for globally significant innovation. Sellafield will reduce its energy demand and decarbonise its operations using locally available low carbon energy.

Alpha Resilience & Capability

As a centre of expertise, through the UK Alpha Resilience & Capability Programme, Cumbria will de-risk current UK alpha programmes, build the capability and capacity to launch future programmes and help the UK maintain its position as a global leader in this field.

The programme will:

- Nurture talent by balancing supply and demand and attracting, recruiting and retaining a professional mobile alpha workforce;
- Through provision of strategic national facilities and a unique alpha skills training facility, ensure that the UK is recognised as a global alpha capability hub for training, experience, education, research, development and innovation;
- Sustain the UK's niche expertise in specialist professions for future generations;
- Ensure alpha programmes are underpinned by digital infrastructure.



CASE STUDY

REACT/Createc

Combining REACT Engineering's expertise in decommissioning consultancy and project management, with local technology firm Createc's application of remote technologies in challenging environments, the RISER drone has been deployed to support decommisioning at Fukushima Daiichi, Japan.

CASE STUDY

University of Cumbria Project Academy

Initiated in 2014 as a strategic response to projected project management skills shortages in Cumbria and the nuclear sector, the Project Academy has since developed a significant national and international reputation, capacity and capability as a Centre of Excellence for Project Delivery. The Academy provides a fully integrated pathway of Higher Education, CPD training/development and professional qualifications from entry level to Masters/PhD across a range of disciplines from project management to leadership and digital skills, tailored to the needs of Project Professionals.

Working closely with industry partners including Sellafield Ltd, Rolls-Royce, BAE Systems, the BBC, other major employers, supply chain organisations, SMEs and charities, the Academy is developing project professionals to operate effectively within the changing project landscape in the nuclear sector and beyond.

WHY?

Winning UK Business

The NDA estimates UK "Generation One" civil nuclear clean up at £120Bn; the MoD forecasts £7 Billion on UK defence nuclear liabilities; and EDF estimates UK nuclear sites at over £20 Billion.

The global waste management and decommissioning sector is growing, with 90 percent of the current European nuclear fleet anticipated to be decommissioned by 2030. The Cumbrian nuclear supply chain is uniquely placed to exploit this growing services-led market.

We will maximise the value of the Sellafield site and our inherent decommissioning capability by connecting our supply chain with this global opportunity.

Legacy Cost Reduction

We will enable the Sellafield mission to be delivered safer, sooner and cheaper by harnessing the digital, robotics and AI innovation to increase productivity (see page 16) to achieve 20% Legacy Cost Reduction by 2030.

Diversification

By commercialising the capability developed in delivering the Sellafield mission, we will diversify our local economy, provide access to new markets for our supply chain companies and attract new and diverse businesses to the region.

Unlocking Future Policy

Key decisions in the next 5 years about reuse of Alpha materials will determine the future of advanced nuclear fuels and the UK's fuel cycle strategy. Through the ARC programme, we are maintaining the UK's position as a global centre of expertise,

MANAGING THE LEGACY

Safe, secure and cost-effective management of the full fuel cycle is key to unlocking the UK's future nuclear programme. Cumbria is a global leader in nuclear materials management and environmental remediation, driving technological innovation to reduce our legacy footprint and associated costs.

MAIN INVESTMENT PROPOSAL

Long Term Waste Management

The Sellafield site, as the current storage site for the majority of the UK's higher activity material inventory, will form the front end of the operational phase of a future long term management solution.

Whether this is Geological Disposal and/or Near Surface Disposal, Cumbria has a role in these internationally significant, £multi-billion environmental protection projects, which will create employment opportunities and wider social impact for over 100 years.

Sellafield: Reducing the UK's Nuclear Footprint

Sellafield is the only place in the UK capable of managing low, intermediate and higher level radioactive waste, spent fuels and nuclear materials. This is a complex, high-tech mission and our highly skilled people including the supply chain are finding new ways to overcome unique challenges.

For decades, thermal treatment techniques have been employed at Sellafield to manage higher level wastes. Now, NDA, Sellafield Ltd, LLWR, NNL and the supply chain in Cumbria are already innovating in the way that legacy materials and waste are managed in order to meet the NDA Grand Challenge of 50% waste volume reduction for disposal.

Infrastructure investment in Cumbria to support the NDA's integrated waste management strategy would help to reduce the amount of waste to be packaged for disposal.

This could significantly reduce the volume of waste to be managed long term. This innovation could deliver cost savings to the UK taxpayer in the £billions.

The scientific and technological innovation at Sellafield and in the local supply chain is resulting in generation of UK intellectual property and exportable products and approaches.

Packaging Materials for Permanent Disposition

The ongoing programme of safe and secure storage of radioactive materials at Sellafield requires the manufacture of thousands of high integrity waste containers.

This represents a multi-decade, £multi-million pipeline of high-value manufacturing scope, that could be delivered by Cumbria's advanced manufacturing base, which is well-placed to provide these containers for low, intermediate and high-level radioactive wastes.

A supportive supply chain approach by NDA and Sellafield Ltd could ensure that more of this scope is delivered in Cumbria, at benefit to local supply chain and economic growth.

Nuclear Knowledge Management

Cumbria's nuclear knowledge plays a crucial role in keeping future policy options open for the UK's nuclear programmes.

Ongoing safe and secure storage of spent fuel and nuclear materials at Sellafield preserves the option to reuse these materials in a future closed fuel cycle nuclear programme.

In 2019, the UK taxpayer invested £1Bn in a new facility at Sellafield to repackage legacy plutonium for safe and secure storage for up to 100 years in line with NDA strategy, keeping open future UK Government policy decisions on disposition options. Cumbria has the Alpha expertise and capability to support future missions for reuse of nuclear materials as fuel for an advanced reactor programme.

WHY?

Economic Value

The Sellafield site drives significant wider economic value for Cumbria and the UK. Each pound spent at Sellafield creates £1.93 of Gross Value Added to the wider economy – Sellafield's economic output ranks in the top 10 when benchmarked against 80 sectors of the UK economy. GVA per capita is 41% higher than the national average, at £65,000 and each of the 11,000 jobs at Sellafield sustains 2.8 more. 57% of Sellafield's supply chain spend each year is in Cumbria.

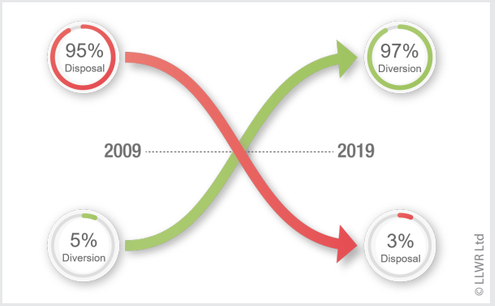
Industrial Strategy and Nuclear Sector Deal

By finding innovative ways to clean up the site, Sellafield Ltd and the Cumbrian supply chain are taking the lead in solving the Nuclear Decommissioning Authority's Grand Challenges:

- Reducing and Reshaping the Waste Hierarchy
- Intelligent Infrastructure
- Keeping Humans out of Harm's Way
- Digital Approaches and Data Driven Decision Making

Cross-sector Transfer

The science, techniques and technologies developed at Sellafield and in the supply chain are a valuable UK commodity, with the potential to solve the world's complex problems, in nuclear decommissioning and in other sectors such as Oil & Gas and Defence.



CASE STUDY

Low Level Waste Repository (LLWR)

The UK Low Level Waste Repository implements the UK solid radioactive waste strategy and the Nuclear Decommissioning Authority's Strategy by providing integrated waste management, treatment and disposal services and leading the National Waste Programme. LLWR's 100-year mission offers great opportunity to work closely with the community and local supply chains to leave a positive legacy.

In 2019, completion of 3 decades of work on the Plutonium Contaminated Facilities decommissioning programme retired a nuclear liability from the 1950s.

Since 2009, activities to divert waste from the repository have protected the capacity at LLWR so that the strategic asset is able to support nationally important missions: hazard and risk reduction at Sellafield, broad-front decommissioning and accelerated Magnox reactor decommissioning.

NEXT STEPS

With investment and support from partners and government, the proposals in this Prospectus will deliver our vision - Nuclear Energy and Environmental Remediation at the heart of the Cumbrian Economy: decarbonising heat, power and transport, delivering the UK's Industrial Strategy and driving Clean Growth as we head towards Net Zero by 2050.

A Future Proof Strategy

This prospectus sets out the makeup of Cumbria's future nuclear economy – a global Centre of Nuclear Excellence with capability across the fuel cycle - power generation, fuel manufacture, decommissioning, waste management and recycling.

Cumbria is the only place in the UK with the ability to support new nuclear as well as managing our nuclear legacy. We know what it means to deliver nationally significant missions that extend into the next century. For decades, we have supported the UK's low carbon economy and the interventions described in this document will ensure that Cumbria continues to do so, driving clean growth and value for the UK economy.

Delivered by Partners

This Prospectus has been developed to align with the Clean Energy Ambitions of Cumbria LEP's Clean Energy panel.

The Prospectus is endorsed by the Future Opportunities Group: West Cumbria's leaders of industry, supply chain, academia, community and government who are the keepers of our current and future economies, and who are catalysts for change.

We have long-standing relationships with our industry partners: the Nuclear Decommissioning Authority, Sellafield Ltd, LLWR Ltd and National Nuclear Laboratory, and with the supply chain through the Britain's Energy Coast Business Cluster.

Through Cumbria's role in the North West Nuclear Arc, we contribute to industrial, manufacturing, supply chain, academic and skills infrastructure across the nuclear fuel cycle.

This prospectus should inform a joined up Cumbria internationalisation strategy with backing from NDA, NNL and Government, to attract inward investment and link Cumbria's nuclear capability with global market opportunity.

Therefore we have confidence in delivering the future set out in this Prospectus, to the benefit of both the Cumbrian economy and the whole of the UK.

With Support from Government

With the right support from government, Cumbria will help the UK to achieve its Net Zero target by 2050, through provision of low carbon electricity at scale, decarbonisation of domestic and high-grade industrial heat and hydrogen generation. Much of this relies on a supportive enabling framework for large, small and advanced nuclear technologies, including:

- Supportive UK Energy Policy, underpinned by funded delivery plans
- Attractive financing models for large nuclear and a market framework approach to small nuclear
- Legislative and regulatory readiness and streamlining to ensure an economically viable and timely pathway to delivery
- Land access and a siting strategy for Advanced Nuclear Technologies
- International collaboration and a global fleet approach
- Support to regional supply chain development
- Investment in Research & Development

A UK delivery vehicle for nuclear would enable government to drive delivery of new nuclear on the scale required to address our future energy needs. Demonstration of new and emerging technologies in Cumbria could de-risk investment and stimulate institutional financing at scale.

UK government, its agencies and delivery organisations should take a joined-up approach to strategic national projects, including Nuclear New Build, Advanced Nuclear Technologies, legacy management and cross-sector programmes such as robotics and AI, to ensure that maximum economic and social value is generated, regionally and for the UK.

Cumbria is a Centre of Nuclear Excellence, driving clean growth for the UK as we head towards Net Zero by 2050.

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