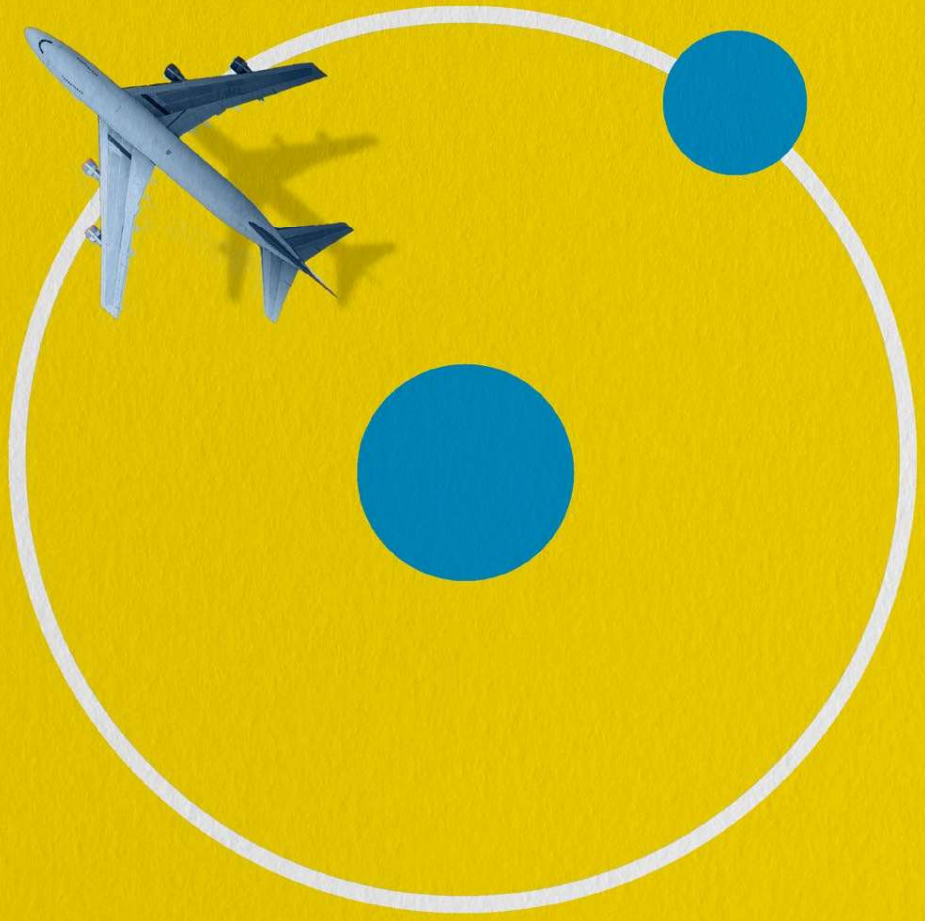
01 | Core Science

Driving capability in nuclear-enabled **hydrogen**, on behalf of our sector for the whole of the UK.



Recognising the potential for nuclear enabled hydrogen, NNL has invested through the Core Science pillar of our Science and Technology Agenda to develop the capability and technical underpinning needed to support the UK's ambition to become a world-leading hydrogen economy.

Over the past year, the Hydrogen Core Science Programme has:

Generated capability that has enabled us to break new ground in our partnerships and ability to collaborate across the energy space and beyond, paving the way for nuclear to play a crucial role in delivering the UK's ambition to become a leading hydrogen economy;

Enabled us to partner in projects that will drive forward energy applications from nuclear at a significant pace, and pave the way for hydrogen production using high temperature reactors;

Pivoted capabilities and talent from across the lab into a new application that provides interesting and challenging work for colleagues and brings valuable long-term skills into our sector.

The production of low carbon hydrogen has been prioritised by UK government and industry as a promising solution for decarbonising heat, long-distance transport such as shipping and aviation, and heavy industry including cement, steel, chemicals and aluminium. These sectors are vital to living standards and our economy, but they are energy intensive and hard to decarbonise through electricity alone. The challenge of this is addressed in the UK's *Hydrogen Strategy*, published by the government in 2021. This set out a vision and plan for kickstarting a world-leading hydrogen economy. It recognised the role of current and advanced nuclear reactors alongside other technologies in delivering what is needed, but these pathways are yet to be fully modelled and demonstrated. Now we are helping to close this gap.

Our technical lead for this programme, Allan Simpson, explains our role in this area: "As the UK's national laboratory, our role is to provide credible and robust support in the delivery of low carbon hydrogen production from nuclear. This involves developing the science and technology evidence base and communicating this effectively to stakeholders. Our aim is to enable nuclear to play a crucial role in delivering the UK's ambition to become a leading hydrogen economy. In doing so, we are pivoting capabilities from across the lab into a new application that provides interesting and challenging work for colleagues and brings valuable long-term skills into our sector."

Counting down to net zero
What is the role of nuclear power?

3 Classes of reactor

Large – Ready Now
Small – Early 2030s
Advanced – Early-mid 2030's

2 Forms of energy

- Heat & electricity to help decarbonise the electricity grid to meet the step change in demand as UK electrifies to meet net zero
- Produce low carbon heat and hydrogen to support decarbonisation of applications such as domestic heating, transport (e.g. shipping & aviation) and industrial processes

1 Stop energy shop

Co-generation of low carbon heat and electricity in a low cost, net zero integrated energy system

Talent

Creating a strong nuclear pipeline: the team delivering for NNL

Through NNL investment in Core Science, Kate Taylor is part of a virtual team of twenty-five engineers and scientists delivering our work to drive the UK's capability in nuclear enabled hydrogen.

"Being part of this team, and having the opportunity to change the course of how the nuclear sector delivers for net zero, has been an eye-opening opportunity that I truly believe will make a difference to the world. Nuclear-enabled hydrogen is a proven technology, but there are still missing pieces of the jigsaw; we are making much-needed, rapid progress towards finding these, and our work is driving many new and necessary collaborations beyond our sector.

"My day-to-day job is chemical process modelling but within this programme I am modelling the economics of hydrogen generation. All of our team come from different parts of NNL, so through our involvement in NNL's hydrogen programme we have developed a whole new area of capability for ourselves and collectively for the lab. One year in, we have delivered some powerful outcomes and our plans for the coming year are even more exciting."

Quality

Known by partners for our science

The capability derived from our investment in the NNL Hydrogen Core Science programme has led to much collaboration with a range of partners, public and private, to strengthen the pathway to nuclear enabled hydrogen.

As well as being invited to join working groups for the government's Hydrogen Advisory Council and its Jet Zero Council, we have delivered seminars across the energy sector including for Ofgem and the National Grid, and opened up new links with academic institutions such as the University of Chester and Energy Research Accelerator, a group of eight Midlands universities.

Partnerships

The 'nuclear derived hydrogen to gas networks' collaboration is an example of partnership in practice

Converting national and regional natural gas networks to hydrogen could enable consumers to continue using gas in homes, businesses and industry, reducing risks to the net zero transition.

Working with DNV, who are a technical authority on a gas network transition in the UK, our work has explored the potential of nuclear to support the conversion of UK gas networks to hydrogen. We have been able to understand the progress already being made in both sectors and build valuable connections between the sectors.

Capability built through the NNL Hydrogen Core Science programme enabled the project, which took place as part of the Advanced Nuclear Skills and Innovation Campus *(ANSIC)* pilot, located at our Preston Laboratory and funded by the Department of Business, Energy and Industrial Strategy *(BEIS)*.

The findings will enable both the nuclear and gas sectors to gain a deeper understanding of priorities and assess barriers and next steps on matters including regulation, safety, siting and economics.

Blue Hydrogen filled H_2 commercial Aeroplane flying in the sky - future H_2 energy concept.

Converting national and regional natural gas networks to hydrogen could enable consumers to use hydrogen in their homes.

Impact

One year in, already delivering successful outcomes

Just one year in, this unique programme of work has delivered a series of outcomes that will be critical to the UK's future capability in nuclear enabled hydrogen.

This is a new and vital area of work for NNL, building the capability of NNL and the whole of the nuclear sector to help ensure the UK delivers on its ambition to become a world-leading hydrogen economy. Some of the key outputs of the programme, which was shaped around the needs of potential nuclear enabled hydrogen consumers, are:

An economic assessment demonstrating that, under the new Regulated Asset Base financing model, the cost of hydrogen from nuclear is competitive with wind;

A safety review to identify the hazards that could be created through the co-generation of hydrogen on a nuclear-licensed site and understand how each of these has been successfully contained in the past – this review confirmed a proven and viable route through each of the safety implications of co-generation;

Process modelling to build a picture of what is needed to bring each hydrogen production technology to commercial maturity, enabling NNL to provide credible commentary and advice on each.

The expertise, talent and credibility generated by these projects, and others like them, has led to new relationships between NNL and some 40 organisations across the energy space and beyond.

The collaborations that have followed are already helping to define nuclear's contribution to the hydrogen economy and growing our capacity to contribute to this.

> "NNL has invested in an area key to the sector delivering on its decarbonisation potential. As a leader in bringing forward innovative solutions, NNL is providing the technical underpinning required for a more expansive nuclear sector supporting a future hydrogen economy. This work is therefore supporting the nuclear sector to bring forward new climate change solutions and enabling UK industry to play a key role, including as part of the High Temperature Gas Reactor demonstration programme."

Tom Greatrex
CEO of the Nuclear Industry Association

That our Core Science Progamme is internally funded enabled the freedom to innovate and move quickly, and the outcomes of this have directly resulted in our ability to engage with a series of externally funded projects that will drive forward energy applications from nuclear at a significant pace.

This includes GEMINI 4.0, a European research collaboration on the development of high temperature gas reactors.