



UK Atomic
Energy
Authority

Our Strategy 2022-2026

Leading the delivery of sustainable fusion energy and maximising scientific and economic benefit



GENERATING CLEANER ENERGY

The benefits of fusion as part of the world's energy supply

1



LOW CARBON

Fusion is low carbon, with low land usage

2



SAFE

The fusion process is readily and safely controllable

3



RELIABLE

Fusion energy will be baseload and does not depend on seasonal variation, the sun, or the wind

4



SUSTAINABLE

Fusion fuel is potentially abundant in our seas and the Earth's crust

5



ENERGY EFFICIENCY

Fusion provides the most power-dense process available on Earth

INTRODUCTION

We are developing fusion energy for a sustainable, low-carbon future

Fusion can be a safe and sustainable part of a future global low-carbon energy system. It has the potential to provide abundant energy whilst creating no high level waste. With dependable output, fusion could be a great complement to renewable sources in the world's future mix of energy. However, before the conditions needed to harness the potential of fusion are extreme and the journey to get there is particularly challenging.

At UKAEA¹ our people are utilising our world-leading capabilities and expertise to drive the delivery of sustainable fusion energy and, through collaboration, address the scientific and engineering challenges that stand in the way. Whilst the imperative to arrest the damaging impact of climate change is at the forefront of our mission, we will do our best to capture the huge economic and social opportunities arising from fusion energy.

The UK Government has set out ambitious plans for fusion in the UK through the Fusion Strategy², with UKAEA as the key delivery partner. The aspirations of the Fusion Strategy are for:

- ▶ the UK to demonstrate commercial viability of fusion by building a prototype fusion power plant in the UK that puts energy on the grid
- ▶ the UK to build a world-leading fusion industry which can export fusion technology around the world in subsequent decades

It is within the context of these aspirations, driven by the global need for long term sustainability, that we set the UKAEA mission to lead the delivery of sustainable fusion energy and maximise scientific and economic benefit. In this hugely challenging but vitally important quest we ask three questions of our work:

- 1 Does this bring us closer to sustainable fusion energy?
- 2 Are we adding to socio-economic prosperity?
- 3 Are we being true to our values and principles?

Our strategy, focussed around four strategic goals, develops these questions; it identifies the key challenges and ideas needed to address them and we will hold ourselves accountable in our response to them.

¹ The United Kingdom Atomic Energy Authority is the UK government research organisation responsible for the development of fusion energy.
² Towards Fusion Energy', The UK Government's Fusion Strategy, 2021.

OUR STRATEGIC GOALS

GOAL 1

Be a world leader in fusion research and development

GOAL 2

Enable the delivery of sustainable fusion power plants

GOAL 3

Drive economic growth and high-tech jobs in the UK

GOAL 4

Create places that accelerate innovation and develop skilled people for industry to thrive

OUR MISSION

Leading the delivery of sustainable fusion energy and maximising scientific and economic benefit

UK FUSION STRATEGY PILLARS

INTERNATIONAL LEADERSHIP

Operating Joint European Torus (JET) in collaboration with the European Union as the world's premier fusion machine, supporting the ITER experiment (a collaboration of 35 nations in the south of France) as the next stage in fusion development with unique skills and expertise. We collaborate and provide leadership to the EUROfusion consortium with many other teams around the globe towards the shared goals of fusion science and technology.

SCIENTIFIC LEADERSHIP

Delivering the STEP programme to design and build a compact prototype power plant in the UK by 2040 as a national endeavour with industry and academia. This is supported and enabled by the broad and vibrant UK Fusion research programme exploiting the unique capabilities of UKAEA's facilities and experts to deliver world-class scientific and technological innovation in plasma science, advanced materials and robotics, tritium science, engineering design and computing, to drive fusion forwards.

COMMERCIAL LEADERSHIP

Transforming Culham Science Centre into the hub of a global fusion cluster through the Fusion Foundations programme and site regeneration following JET. Delivering a wide-ranging programme of support for fusion industry to grow a thriving fusion ecosystem in the UK, and supporting UK industry to win major contracts for ITER, with over £0.5bn to date and targeting a further £1bn in coming years.

FACILITIES, INFRASTRUCTURE, AND SKILLS

LANDSCAPE TO 2026

2022

2026

INTERNATIONAL



JET science programme in preparation for ITER, including high power fusion experiments in 2021 and 2023



JET transitions into decommissioning programme

▶ ITER construction and preparation for first operations

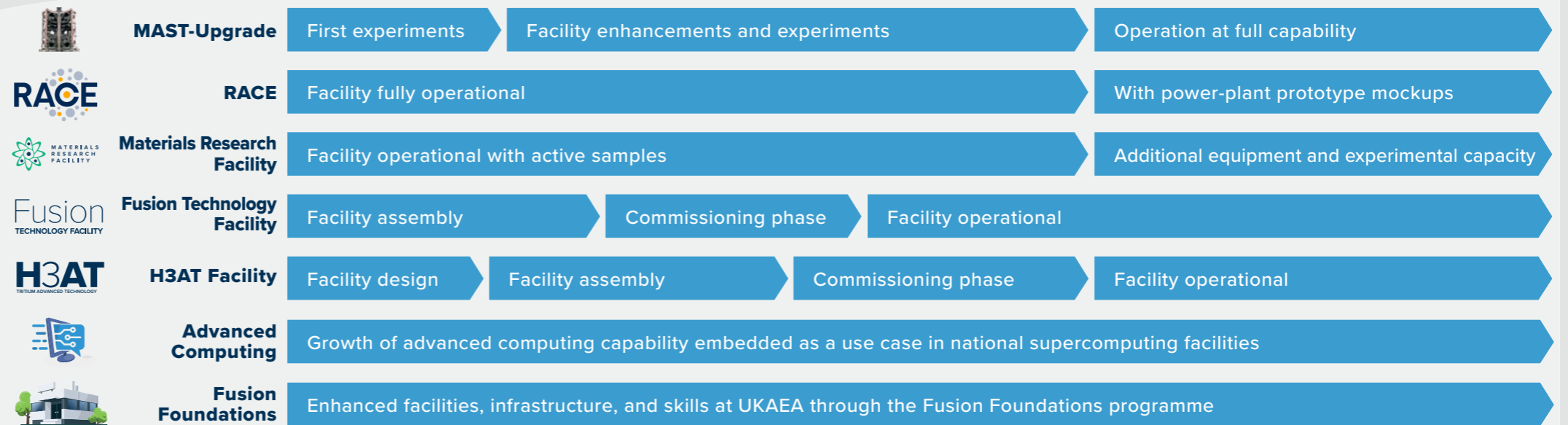
ITER begins first operations

▶ Fusion powerplant design programmes pursued by all ITER partners, including EU DEMO

Gateway review of the EU DEMO power plant design



UKAEA



▶ Concept design phase for the STEP power plant design programme



STEP concept design review

▶ STEP engineering design phase

THE PRIVATE SECTOR

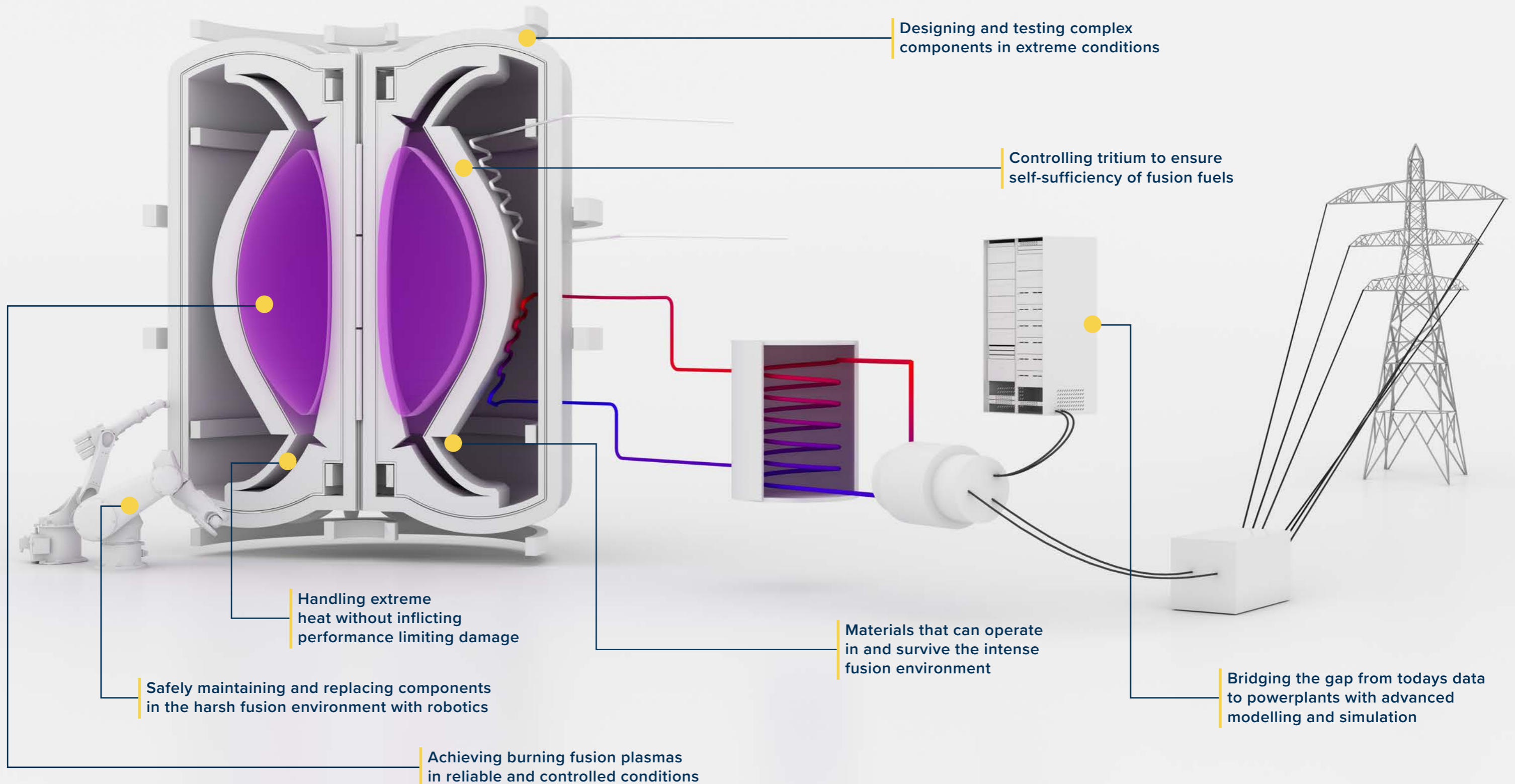
- ▶ Investment in the fusion private sector grows
- ▶ Supply chains strength through work for STEP and ITER



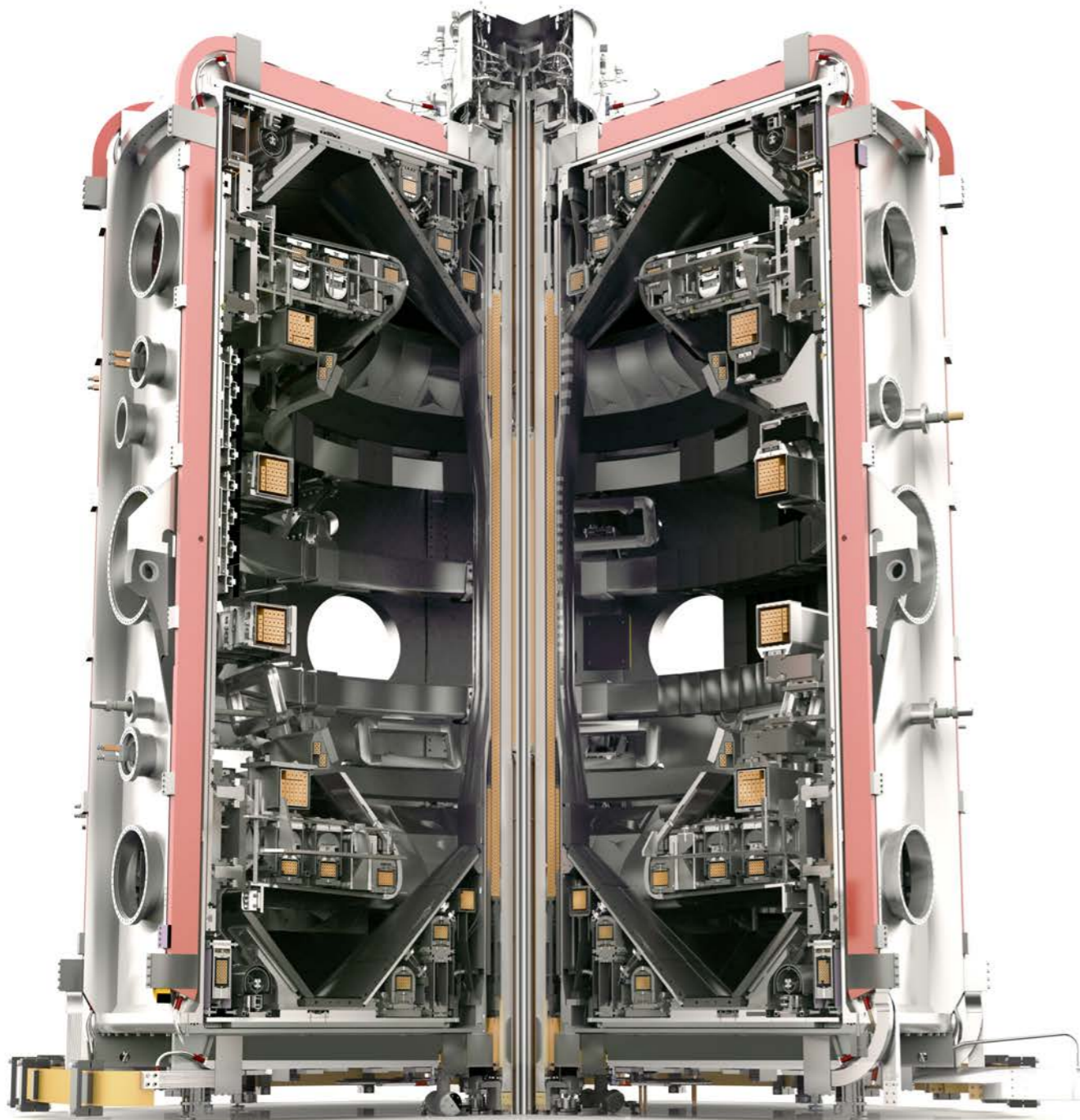
Culham Science Centre developed as the heart of a global fusion cluster, including General Fusion's new demonstration facility

WHAT TECHNICAL CHALLENGES DO WE FACE?

The world needs clean energy, and our mission and goals support the UK's fusion strategy to deliver fusion as a sustainable power source. Our strategy, underpinned by talented people, funding, partnerships, and capability, will drive forwards this delivery as we press on to address the exacting scientific and technological challenges of fusion.



MAST Upgrade



GOAL 1:

Deliver world leading fusion R&D

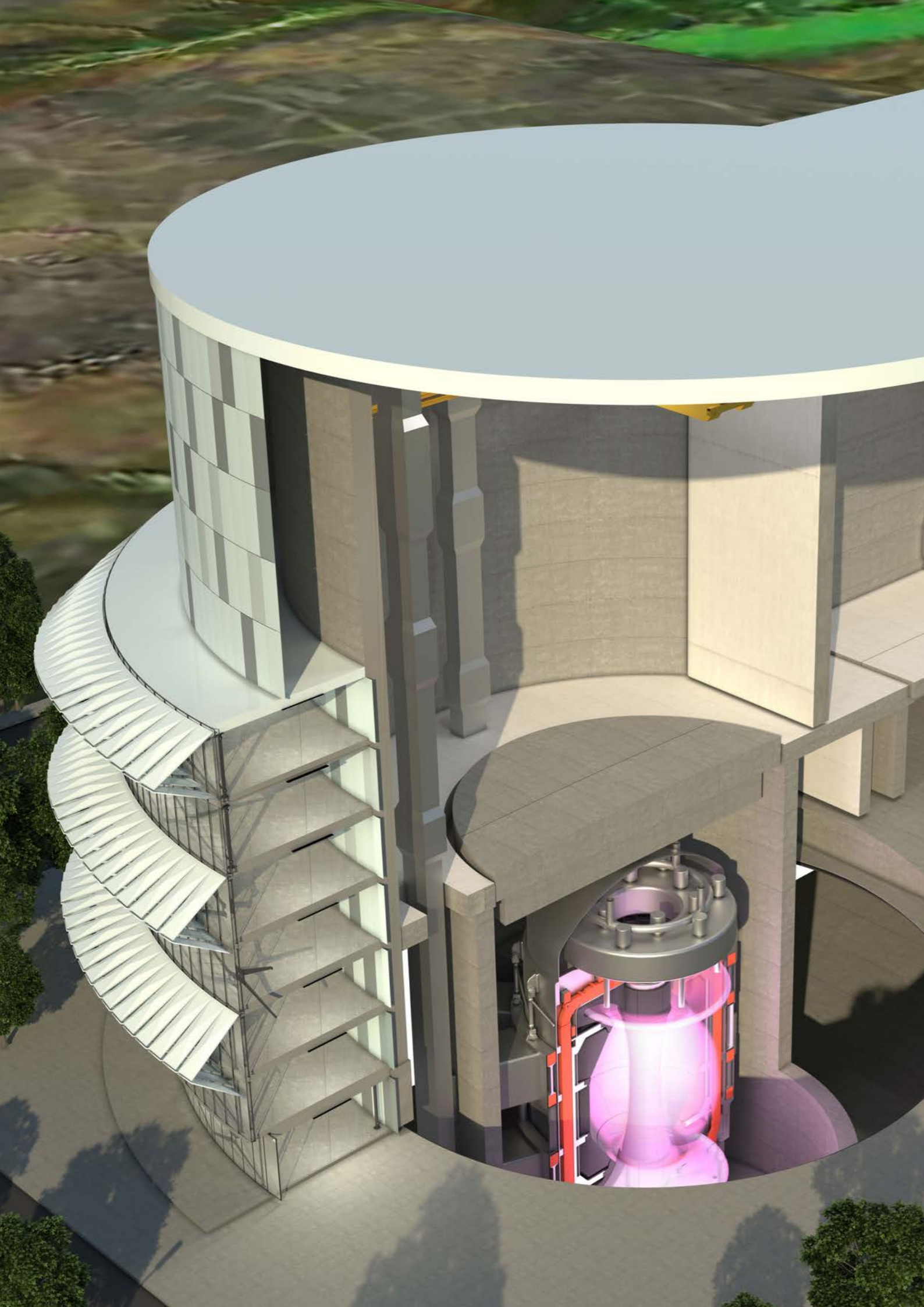
Our research programme, delivered with our academic and industrial partners, focuses on developing, innovating upon, and applying the fundamental science underpinning fusion power plant design. As our science and technology capabilities increase, we will grow our computational capabilities to meet these challenges as the field evolves and provide the platform needed to continue driving fusion forwards in the next decade.

By operating and being a leading contributor to the scientific output of the EU's JET facility at Culham – for 40 years the most capable fusion research facility in the world – and growing our participation in the science and operation of ITER, we will continue to play a key and leading role as the community looks to validate fusion energy gain.

Our Mega Amp Spherical Tokamak - Upgrade (MAST-U) facility is a unique fusion experiment advancing the compact design approach of a spherical tokamak pioneered in the UK. MAST-U will explore an innovative new system which minimises excess heat from the hot fusion plasma – a key challenge on the journey to the first fusion power plant – with early results already demonstrating its effectiveness.

Over the next five years our strategy to deliver this goal will:

- ▶ **Enable innovation to address the challenges of fusion** to improve performance, and reduce the potential cost of sustainable fusion energy generation
- ▶ **Focus on scientific excellence and new ideas** to advance fundamental fusion science in high-performance fusion plasmas, materials, tritium, robotics, fusion technology, and advanced simulation and modelling
- ▶ **Adopt an innovative approach to decommissioning**, maximising the value of JET assets for research and industry in the UK, and delivering new and unique knowledge relevant to fusion power plant decommissioning
- ▶ **Harness the breadth of our scientific capability** to deliver integrated research that meets the multiple challenge of fusions exacting conditions
- ▶ **Collaborate with our international peers** in Europe, the US, and elsewhere, supporting the EUROfusion programme and embedding a strong strategic presence in ITER to support its progress towards the validation of burning fusion plasmas
- ▶ **Place fusion as a central use case within the national supercomputing landscape** delivering the advanced computing and modelling needed to accelerate the delivery of fusion energy
- ▶ **Expand UK academic, public, and school engagement in fusion research**, growing the diversity of future scientific leaders in fusion and enthusing the next generation



GOAL 2:

Enable delivery of sustainable fusion power plants

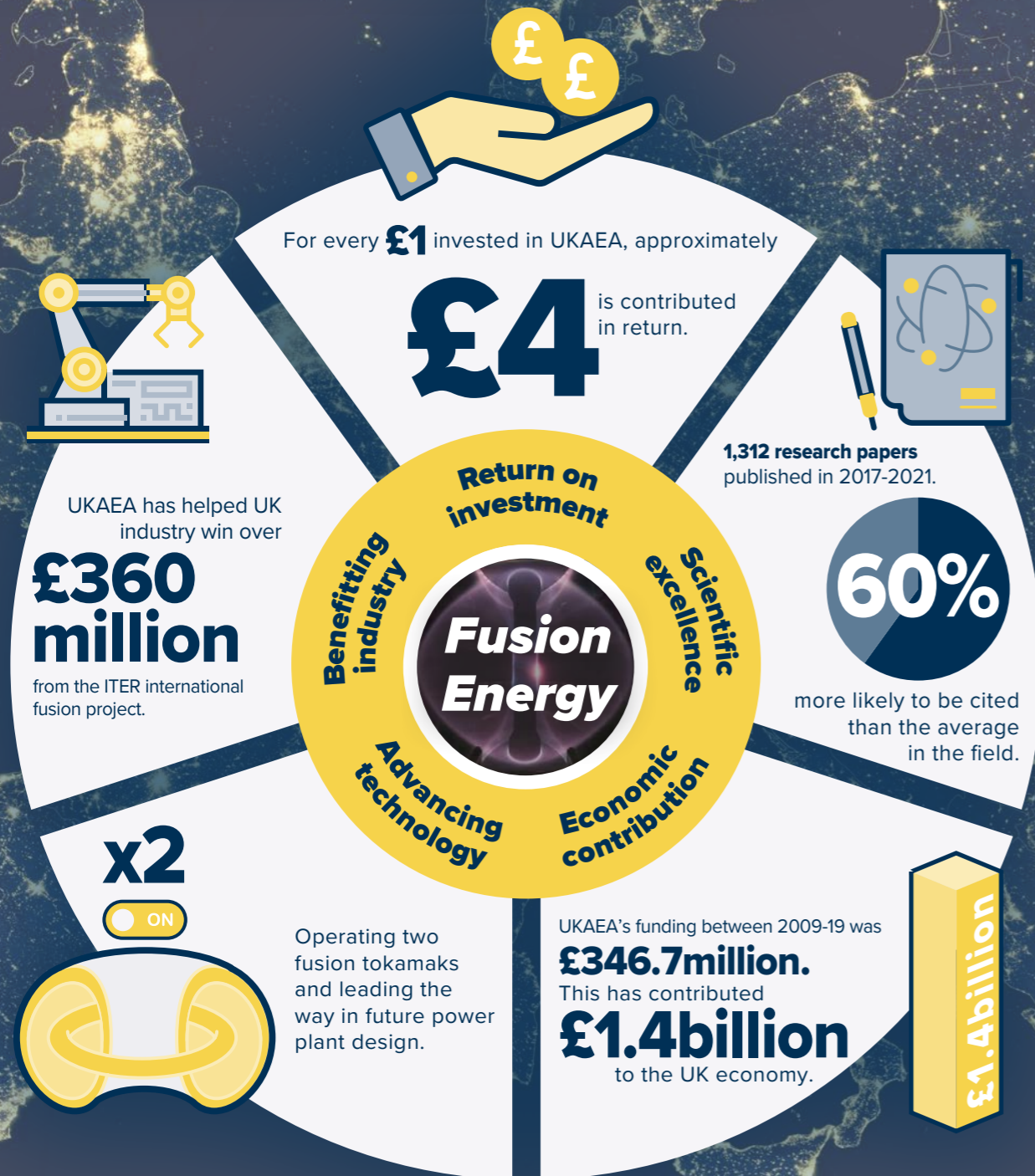
Building on a pioneering legacy in spherical tokamak research, the UK has embarked on the first phase of the ambitious Spherical Tokamak for Energy Production (STEP) programme to design and build a compact, energy-producing prototype fusion power plant. This will be delivered as a national programme, with UKAEA as a key delivery partner. Alongside STEP, we collaborate in the EUROfusion DEMO programme – the largest body of fusion knowledge and expertise in the world. We take an alternative path to STEP based on JET and ITER, leading in areas where our expertise can drive the programme forwards. There are multiple – and highly demanding – technical challenges that must be faced on the path to fusion energy. In these key challenge areas we will focus development where fundamental innovation is required to translate our research, and the research of others, into viable solutions at mid-level technological readiness. In other areas we will be an expert partner, developing in-house expertise to allow close engagement with the leading organisations and industry partners.

Combined with technical advancements, we will develop the enabling environment needed for a commercial fusion sector in the UK, contracting out more than half of STEP R&D activities to industry & academia and selecting the future site for the STEP prototype as a driver of local and national socioeconomic growth. We will advise the Government on regulatory codes and standards, ensuring strong connections with the international fusion community on fusion regulation. We will continue to provide Government with a route to comprehensive and impartial advice on fusion design, through our own expertise, and by convening experts across the fusion landscape. Through ITER we will ensure that the unique skills and expertise developed over decades of operating JET are retained in the UK, bridging the gap to commissioning and operation of the first fusion powerplants.

Over the next five years, our strategy to deliver this goal will:

- ▶ **Drive forwards a philosophy of compact economically efficient, power plant design** alongside an enabling operational, safety, and site development programme, delivered with industry and academia by the STEP programme
- ▶ **Maintain and grow the skills needed to commission and operate the first fusion power plants**, by operating MAST Upgrade and developing an operational skills bridge to STEP by growing an operational presence at ITER from skills developed over many years of JET operation
- ▶ **Accelerate digital power plant design** with an advanced computing and engineering framework based on next generation technology enabled by the growth of a new Advanced Computing business unit
- ▶ **Enhance the UK's capability to address key technical challenges for fusion power plant design** by extending and enhancing existing facilities and developing new ones in fusion technology and tritium systems
- ▶ **Support the EUROfusion DEMO design** providing expertise in areas including remote maintenance, tritium systems, plasma design, and engineering design
- ▶ **Develop the enabling environment for fusion internationally**, through provision of expert advice for UK Government in areas such as regulation and fusion technologies, and stimulating the supply chain growth with outsourced opportunities

HOW UKAEA DELIVERS SCIENTIFIC AND ECONOMIC BENEFITS TO THE UK



The positive impact of fusion research

Information taken from:
"The impact of the UK's investments in UKAEA fusion research"
A report for the Department for Business, Energy & Industrial Strategy (BEIS) by London Economics

GOAL 3:

Drive economic growth and high-tech jobs in the UK

A full scale fusion power plant may be some years away, but the social, scientific and economic impact of the fusion programme are more immediate. UKAEA is committed to maximising the transfer of innovation, skills, and knowledge from fusion into adjacent sectors – areas where we have the potential to enable innovation and learn for our own mission – and supporting industry with our capabilities in the fusion sector and beyond.

Strong partnership with the private sector is essential to developing fusion power plants – to address both the rate of progress and the scale of the technical challenges. UKAEA promotes and develops mutually beneficial, productive, and collaborative relationships with industry, engaging with the private sector to stimulate innovative solutions to technical challenges and develop economic opportunities from fusion, helping to grow the wider fusion technology ecosystem and supply chain in the UK. By focusing on support and partnership with industry in fusion and adjacent sectors, we will ensure that the economic benefit on the path to fusion is felt across the UK.

Over the next five years, our strategy to deliver this goal will:

- ▶ **Enable knowledge and technology transfer from fusion into adjacent sectors**, including nuclear decommissioning, autonomous vehicles, hydrogen storage, industrial plasmas and other areas where our capabilities align and we can derive learnings from our partners
- ▶ **Enhance the fusion technology ecosystem and supply chain in the UK**, stimulating R&D in industry to address the challenges of fusion and supporting fusion technology companies to thrive
- ▶ **Enrich skills in wider scientific and technology sectors** through involvement in our complex, integrated, and multi-disciplinary programmes
- ▶ **Drive increased private sector and inward investment in the fusion sector** by engaging industry with technical challenges, supporting industry with our capabilities, and creating an attractive ecosystem for fusion technology companies to prosper
- ▶ **Translate innovation in the fusion programme into commercial opportunity** by seeking and nurturing our ideas and inventions with business support as they grow.
- ▶ **Support UK industry to win major ITER contracts** by providing access to unique expertise and capabilities that complement industry's existing capabilities



GOAL 4:

Create places that accelerate innovation and develop skilled people for industry to thrive

We are committed to growing a world-leading fusion cluster in the UK with Culham Science Centre at its heart through the unique R&D facilities on site. This cluster will work with and support the private sector to accelerate innovation and commercialisation in many aspects of fusion technology. Place is important and, whilst our main base of activities remains on Culham Science Centre, we will expand our presence elsewhere in the UK to tap into the skills and expertise needed to deliver our mission and play our part in socio-economic development.

Talented and enthused people are central to the delivery of our mission, and those of our partners. Our growth programmes will help to ensure that the fusion sector has the skilled people needed to succeed, supporting the entire talent pipeline with a leading apprenticeship provision, a vibrant and expanding graduate scheme, a growing cohort of PhD students in many disciplines from across the UK and internationally, and wide-ranging post-doctoral opportunities. By expanding our OAS (Oxford Advanced Skills) programme we will continue to develop the local economy, supporting businesses with talented apprentices, and developing the future workforce in fusion and adjacent sectors in the UK whilst providing a stimulating environment for apprentices to develop. With our people at the core of UKAEA delivery, we will invest in the skills, knowledge and experience to support their career ambitions, managing talent to deliver innovation in an exciting work environment.

Over the next five years, our strategy to deliver this goal will:

- ▶ **Generate highly skilled jobs** supporting the excellence of our people and bringing in new, high calibre skills and expertise to support our growing portfolio and within the wider fusion industry
- ▶ **Ensure that the socio-economic benefits from fusion land across the UK** -including our site in South Yorkshire and the future site for STEP
- ▶ **Transform Culham campus to keep it at the heart of global fusion** with new infrastructure and enhanced facilities, and capitalising on the opportunity to develop the JET site, to enable innovation in fusion technology
- ▶ **Become a leading example of a sustainable research and innovation campus** by enhancing the sustainability of our existing estate, and embedding it deeply into our new buildings and infrastructure as part of the long term vision for our sites
- ▶ **Build on and expand our apprentice training** to higher levels, a wider array of disciplines, across multiple regions, and with enhanced accessibility to provide highly skilled apprentices for our programme and local businesses
- ▶ **Support the development of Harwell as the UK's leading national research and innovation campus**, and home to the UK's largest concentration of 'big science' facilities, as landowner and partner in the Harwell Joint Venture



PRINCIPLES AND VALUES

It's not just our goals that matter – there is also importance in how we get there. UKAEA is committed to principles and aspirations that aid us to measure performance, guiding us to deliver with integrity, efficiently and effectively.

PRINCIPLES



Safety

Safety and well-being of our people is our top priority.



Equality of opportunity

Diversity of thought and people who are representative of society is crucial for our mission.



Environmental sustainability

We will strive for energy-efficient delivery, minimising our environmental impact.



Responsible financial management

We will use our resources carefully and will be accountable for our investment decisions.



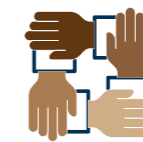
Working with business

Strong and effective public-private partnerships are an essential part of our operation.

The spirit of how we work is captured by our **VALUES** of:



Innovation



Commitment



Trust



Collaboration

FUSION ENERGY

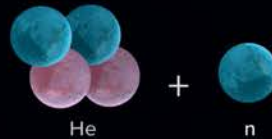


Fusion takes place in the heart of the stars and provides the power that drives the universe.



Scientists and engineers all over the world are developing the technology to recreate this process on earth to create a new source of sustainable energy.

HOW DOES IT WORK?



A combination of hydrogen gases, deuterium and tritium, are heated to very high temperatures to create a plasma.

Energy is released when the lighter deuterium and tritium atoms fuse together to form a heavier helium atom and a neutron.

WHAT NEXT?



The UK is a world leader in the most promising fusion energy technologies.



The UK is participating in the world's largest fusion project, the international ITER project, which aims to demonstrate fusion energy at industrial scale.

2040

We will build a prototype fusion power plant – STEP - in the UK around 2040.



Private companies in the UK and around the world are also developing their own fusion power plant designs.

FUSION ENERGY

Part of the world's future sustainable energy supply.



Efficient



Low carbon



Safe



Abundant