



STEP

Spherical Tokamak for Energy Production

Tris Denton

Head of Commercial and Programme Development

Winter 2020-2021



Q: What world-changing idea, small or big, would you like to see implemented by humanity?

A: **This is easy. I would like to see the development of fusion power to give an unlimited supply of clean energy.**



Stephen Hawking
'Brief Answers to the Big Questions' (2018)

Why Fusion?

Carbon free

Safe

Low land use

Low, manageable waste

Reliable baseload

Unlimited fuel

Why Fusion in the UK?

“The UK is a world leader in the most promising fusion technologies with research capabilities across the technical challenges of fusion. This means that the UK is uniquely well-placed to lead the future commercialisation of this technology.”

Powering our Net Zero Future (December 2020)

- UKAEA operates the Joint European Torus (JET), the world’s largest tokamak and Europe’s flagship experiment. It also operates the UK’s current spherical tokamak, recently undergone £55 million upgrade – MAST-U.
- Culham is home to a full ecosystem of fusion R&D facilities, underpinning a body of world-leading expertise.
- The UK has a thriving private sector fusion industry
- The next step is... **STEP**

Why Fusion now?



Market Pull

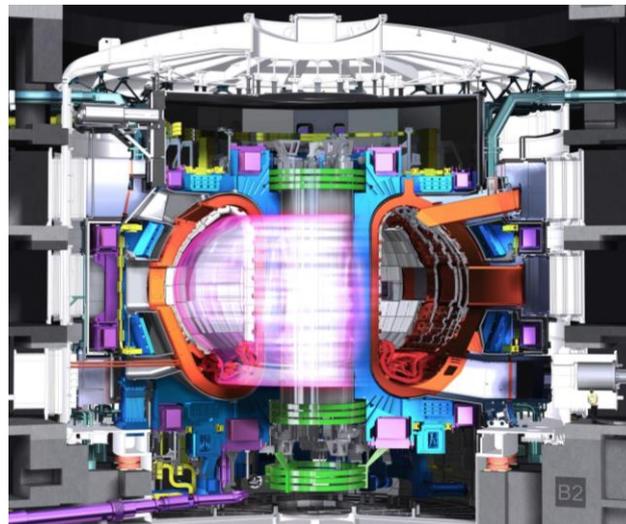
Climate emergency very high in public consciousness

Technical demonstration

ITER will produce 500MW from 50MW input power

Private investment

Over £1.8Bn invested in >40 start-ups



“It’s always 30 years away”

Why is it different now?

- **Full D-T Operation in Jet** Yields further advances in fuel understanding
- **ITER (design and construction)** Game-changing advances in system and component design
- **ITER (operation)** ITER Plasma learnings are important to STEP
- **Materials Research** UKAEA-MRF (and others) nuclear materials science capability
- **MAST-UPGRADE** £55M UKAEA experiment: informs viable plasma scenario
- **RACE (remote access robotics)** Enables viable maintenance and repair approaches
- **Surging private sector** Investment is both an enabler and an indicator of viability
- **Digital design** Enables faster and less costly design optioneering
- **The approach of the sector** Design driven work



STEP Mission:

Deliver a UK prototype fusion energy plant, targeting 2040, and a path to commercial viability of fusion.



What is STEP?

STEP (Spherical Tokamak for Energy Production)

Phase 1 – develop concept design - £222 million government funding to achieve this.

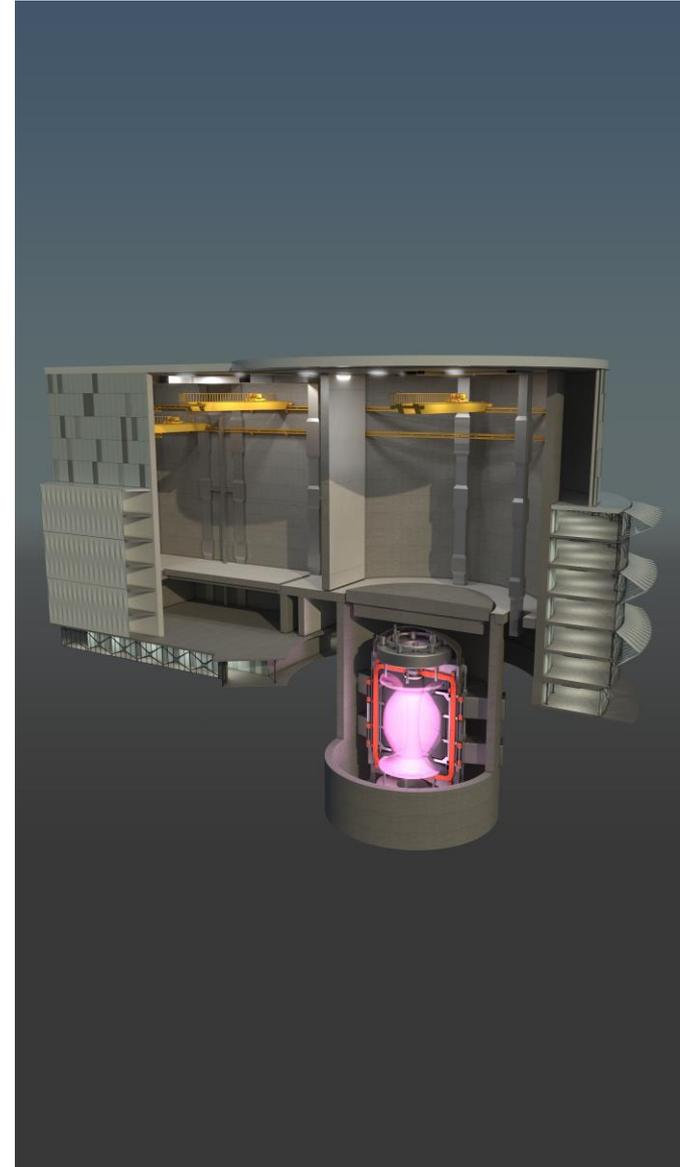
Phase 2 – detailed engineering design and permissions and consents as well as pre-construction works.

Phase 3 – manufacturing and construction – targeting operations around 2040.



Progressing STEP...

- We are at an early stage of design maturity.
- We have strong understanding of the principles (and challenges) of fusion.
- The first five years is about integrating these into a single harmonious concept design.
- Much remains to be decided and designed – we want to work hand in hand with our community stakeholders as we go on this exciting journey.



Programme ecosystem

Physical Delivery:

- Fusion plant
- Turbine, balance, & ancillary Adjacent R&D facilities
- Corporate presence
- Site works
- Off-site enablers
- Grid, utilities, cooling & associated infrastructure

Permissioning & Consenting:

- Environmental permits
- Planning permissions
- Regulatory permissions
- Operational permissions

Links to existing programmes / centres:

- Culham Facilities
- ITER
- DEMO
- International programmes
- Academic research

Skills & Knowledge:

- Apprentice training
- Links with academia
- Direct recruitment
- Supply chain

Changing employment profile:

Design; pre-construction; construction; commissioning; operations; future...

Supply & value chain:

- **Engineering & Science:** Fusion design & ongoing research; Systems Design; Architect-Engineering & Design Authority.
- **Manufactured Components:** Fusion Island; Turbine Island; BOP.
- **Construction:** Mega-project delivery; Fusion specialisms; broader skills and trades.
- **Programme Delivery:** Integration & delivery (non-specific).
- **Materials:** Specialist; Bulks & aggregates.
- **Services:** Corporate services; Site services; Construction support.

Finding a home for **STEP**



STEP siting – principles and process

- Fair
- Transparent
- Equitable



- Open invitation for sites to be nominated
- Nominations open until end March 2021
- UKAEA recommendation to Secretary of State
- Decision around the end of 2022

Site requirements and nominations

- At this stage we want to gather preliminary information from interested parties
- Broadly there are few showstoppers – most criteria should be considered in the balance.
- Important factors include size, water, grid access, ownership, land condition.



- **Any entity can nominate a site - we simply ask that:**
 - ✓ The entity is capable (in personnel and funding) to work with UKAEA through the assessment process
 - ✓ The entity has some form of jurisdiction (council, LEP, business group, devolved Government) for the land included in the nomination
 - ✓ That not more than one entity proposes the same site
 - ✓ Consent of the landowner is secure.

STEP site need not be nuclear site licensed

BEIS guidance to STEP is clear:

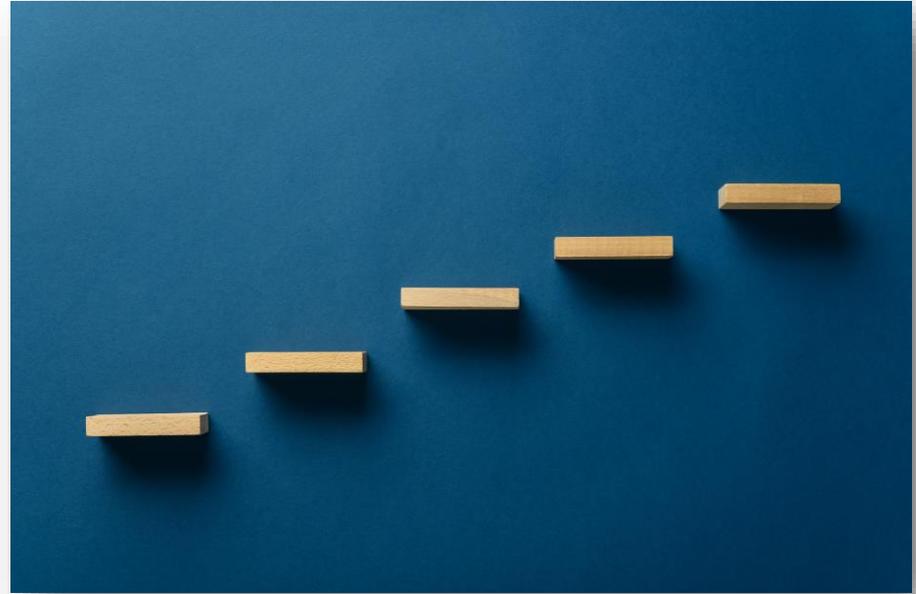
“It is the Department’s view that a prospective site does not need to be covered by – or have been covered by – a nuclear site licence, nor be adjacent to a nuclear licensed site, in order to be proposed. However, proposals of such sites to host STEP are welcome. This is without prejudice to wider decision-making on any future fusion regulation.”

- Of course we recognise the many reasons why new fission plant are often sited close to existing fission plants.
- There are many incidental reasons an existing nuclear community would be attractive (as the criteria make clear) and could score well – but we see no reason to restrict the opportunity to these areas.
- We should be clear that STEP is not a fission plant. Our scale of risk is fundamentally different. Our regulatory parameters are currently different.

Assessment

A staged process

- Initial assessment
- Desktop commercial assessment
- Full desktop assessment
- Site assessment
- Final report



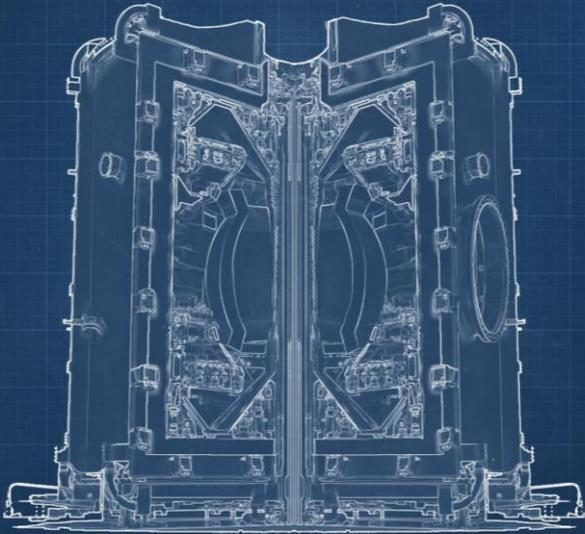
Criteria

- Technical and operational suitability
- Socio-economic and community benefit implications
- Support for the commercial progress of the project

Some points to consider...

- We are assessing sites. Nominations must be site specific.
- There are multiple reasons a site may not proceed at various stages – so there's no harm in more than one site coming forward from the same area.
- If you have gaps in available information to underpin a nomination, please flag them to us early.
- If you have questions: please, please, ask us.
- Wherever we answer a 'new' question, we will anonymise it and update our online Q&A.
- This process informs UKAEA's recommendations to the Secretary of State.

A STEP to delivering fusion



- The site for STEP will have global visibility
- It will form the centre of an ecosystem, ultimately supporting thousands of high-quality high-tech jobs
- It will support economic growth and the training of skilled people
- And it will be an important part of meeting the global net zero challenge

Thank You

www.step.ukaea.uk

<https://www.gov.uk/government/organisations/uk-atomic-energy-authority>

siting@step.ukaea.uk

Tristram.denton@ukaea.uk

