

# Advanced Nuclear and International Research Programmes

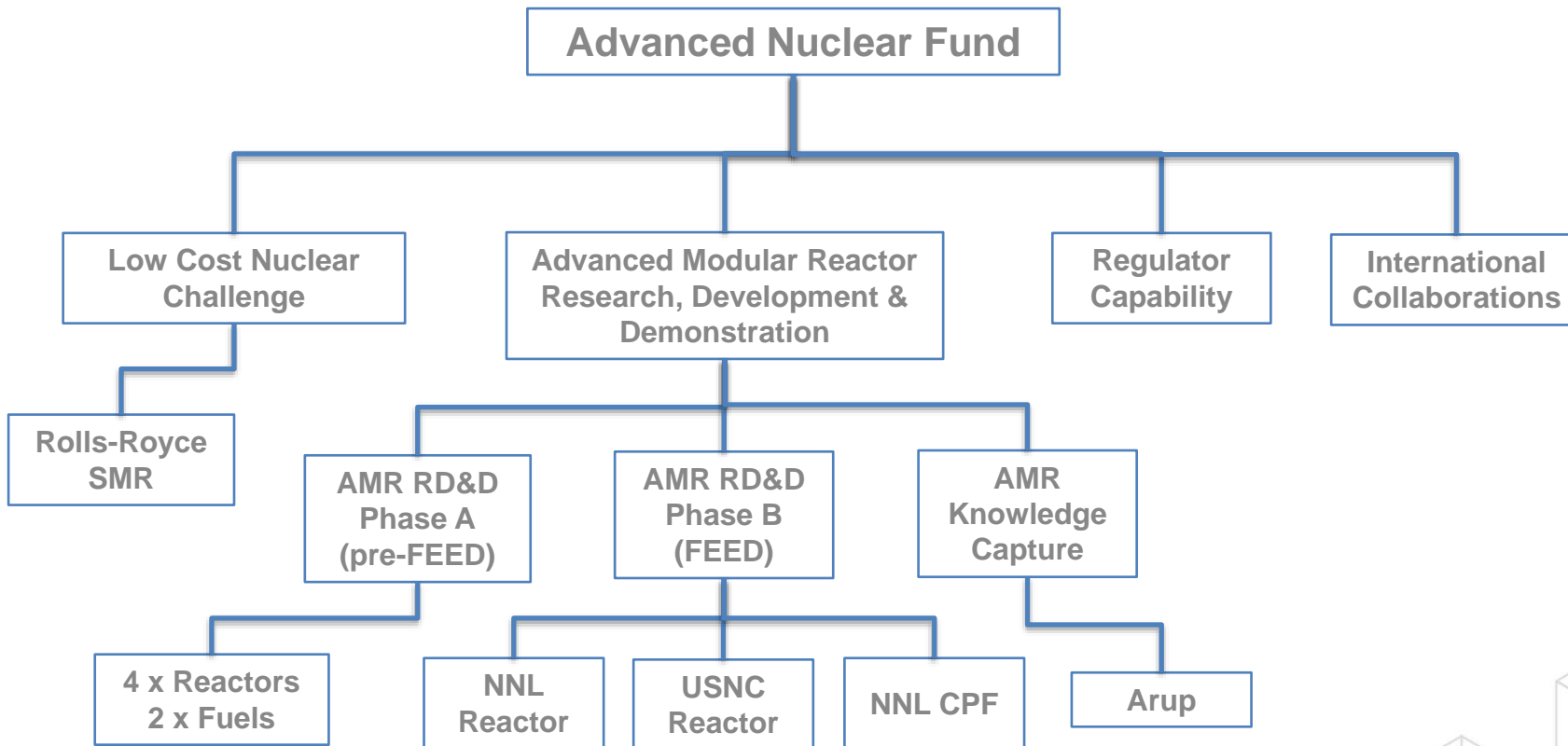
Gary Bolton  
Senior Technical Advisor



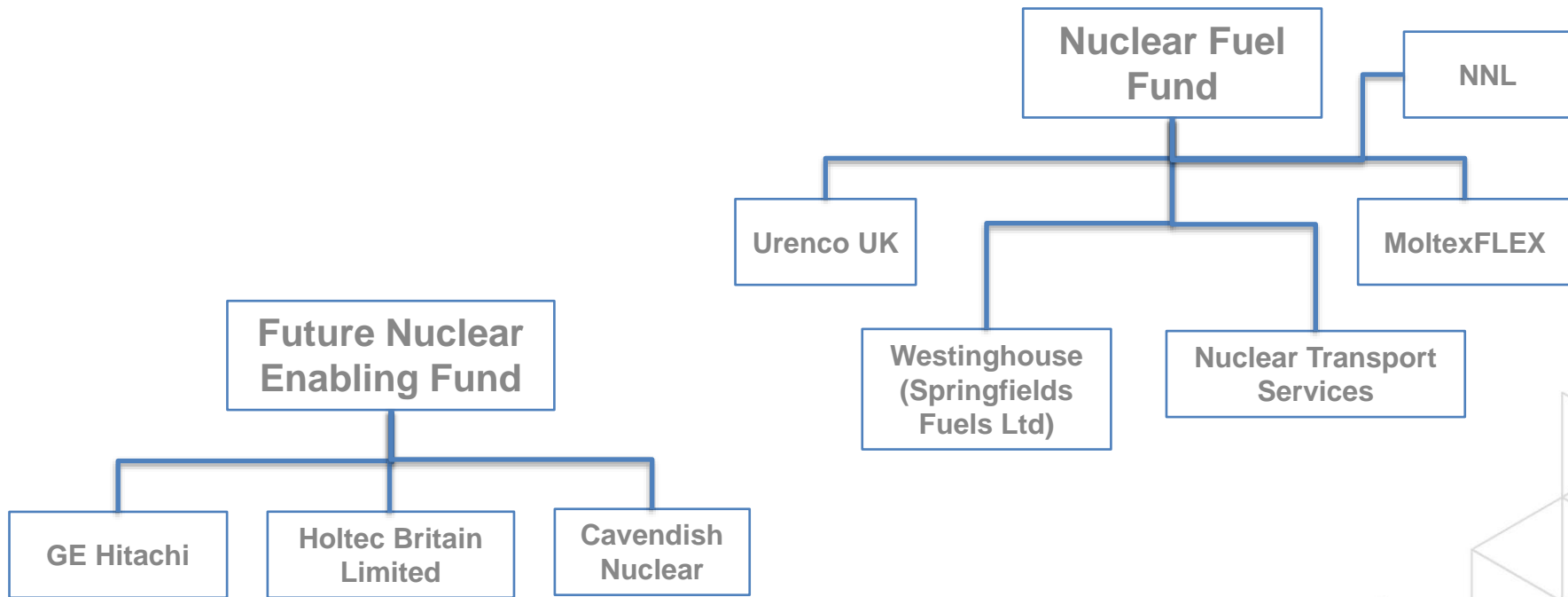
- **UK Landscape for Advanced Nuclear Technology**
  - Advanced Nuclear Fund
  - Future Nuclear Enabling Fund
  - Nuclear Fuel Fund
  - HALEU Programme
- **International Research Collaborations**
  - Generation IV International Forum
  - Second Framework for Irradiation Experiments (FIDES-II)
  - Halden Human Technology Organisation (HTO)
  - Jules Horowitz Reactor (JHR)
  - US-UK Action Plan



# Advanced Nuclear Fund



# Future Nuclear Enabling Fund and Nuclear Fuel Fund



# HALEU Programme

- £300 million UK investment to support domestic production of fuel required to power next-generation nuclear reactors.
- First European country to launch high-assay low enriched uranium (HALEU) programme
- Programme will produce enriched uranium needed for next generation of reactors and provide jobs and investment in North West England



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## GIF: a framework for international co-operation in research and development for the next generation of nuclear energy systems, launched in 2001



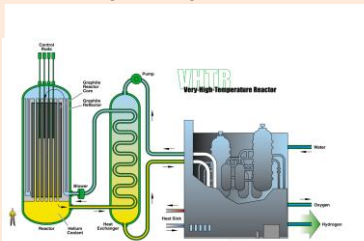
### 13 Member Countries + the EU

#### Key theme through 2024: Accelerating the Readiness of Gen IV Systems to Meet Net Zero Goals:

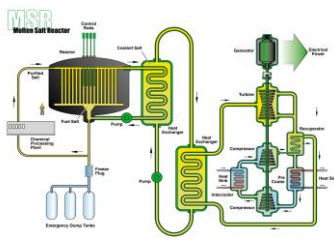
1. Strengthening Gen IV system features for combatting climate change (e.g., flexible operations and non-electric applications)
2. Supporting transition from R&D to demonstration and deployment through technical readiness, regulatory readiness and improved economics
3. Strengthening GIF relevance to industry
4. Supporting the Gen IV talent pipeline

# Six Generation IV Reactor Technologies

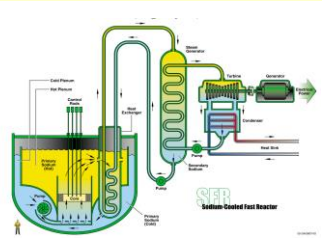
**Very High Temperature Reactor (VHTR)**



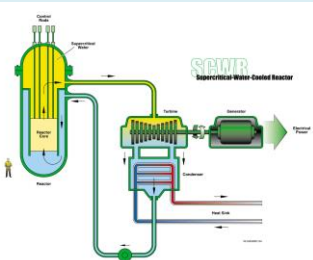
**Molten Salt Reactor (MSR)**



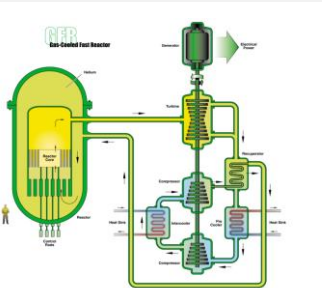
**Sodium-cooled Fast Reactor (SFR)**



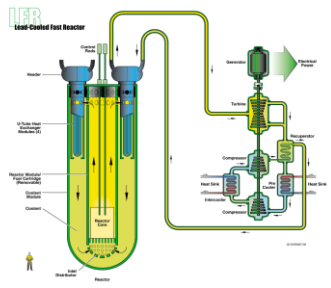
**Supercritical Water-cooled Reactor (SCWR)**



**Gas-cooled Fast Reactor (GFR)**



**Lead-cooled Fast Reactor (LFR)**



## Cross-cutting Collaborations

- ❖ Economics & Modelling
- ❖ Education & Training
- ❖ Proliferation Resistance & Physical Protection
- ❖ Risk & Safety
- ❖ Safety Design Criteria
- ❖ Non-Electric Applications of Nuclear Heat
- ❖ Advanced Manufacturing & Materials Engineering

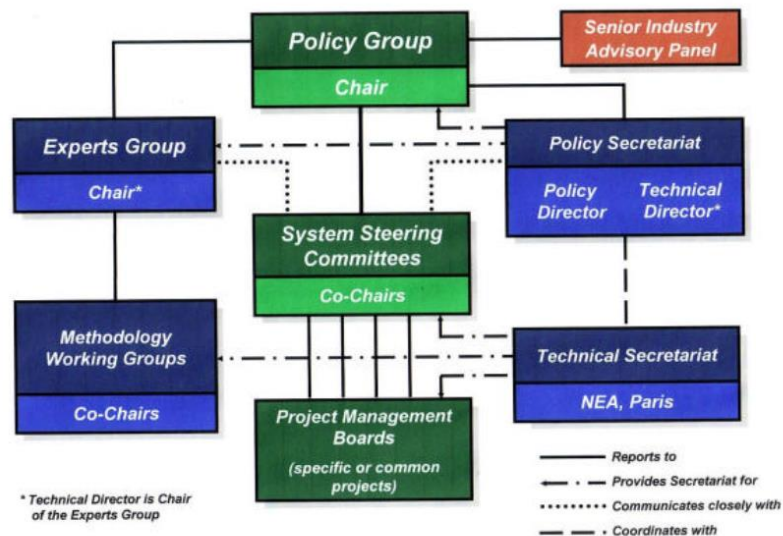
## To achieve goals in four areas:

1. Sustainable energy with minimum waste
2. Life cycle cost advantages
3. Safety and reliability
4. Proliferation resistance & physical

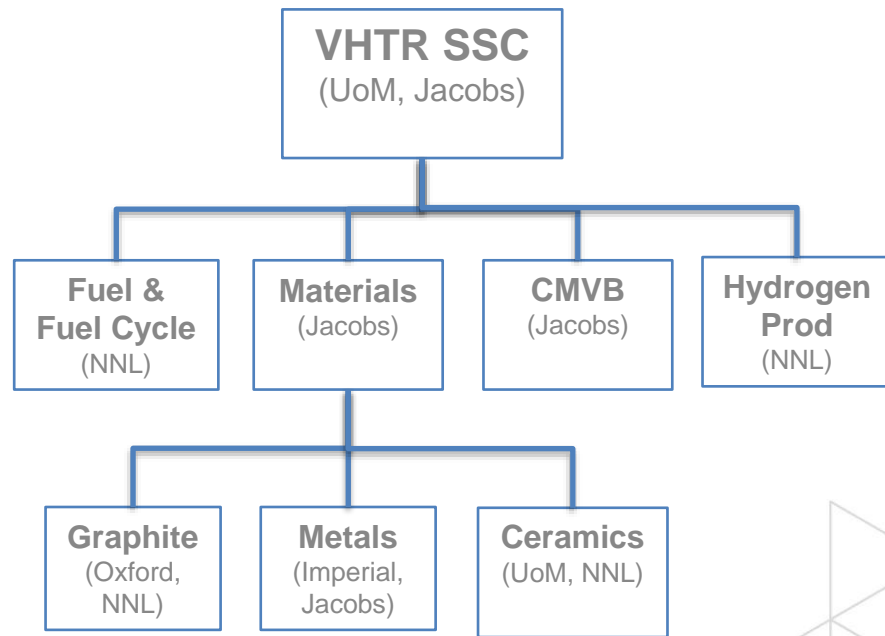
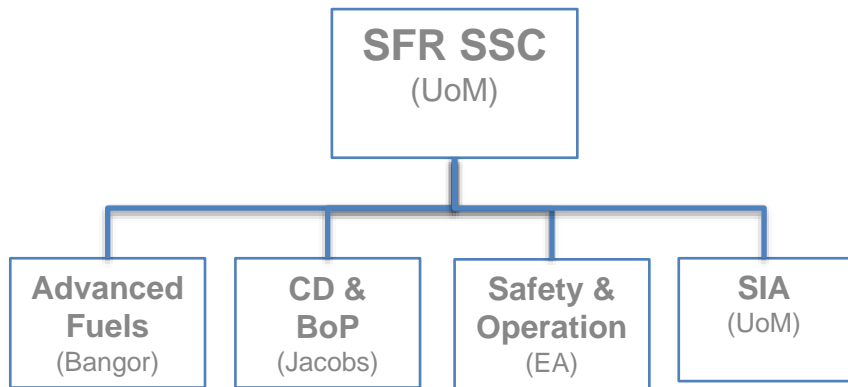


- Policy Group/ Leadership Team
- US, France, Japan, Korea, Canada, UK
- UK was early signatory to original Framework A withdrew and rejoined in 2018
- Early 2024 – UK received unanimous approval (2018)
- UK observer on SFR
- In 2023 UK led the development of an Industry (theme of current leadership team)
- 2 x PGEG meetings per year

## GIF Governance Structure



# UK Involvement in VHTR and SFR Arrangements



# UK Involvement in Other Groups

## Governance Groups

- ❖ Policy Group (UoM, DESNZ)
- ❖ Expert Group (NIRO, DESNZ)
- ❖ Senior Industry Advisory Panel (Jacobs, Rolls-Royce SMR)

## Working Groups

- ❖ Proliferation Resistance & Physical Protection (NNL)
- ❖ Education and Training (Cambridge, EA, Jacobs)
- ❖ Risk & Safety (ONR, EA)
- ❖ Advanced Manufacturing & Materials Engineering (Nuclear AMRC)

## Task Forces

- ❖ Non-Electric Applications of Nuclear Heat (NNL)

~ 30 UK GIF Representatives



# Second Framework for Irradiation Experiments (FIDES-II)

- Permanent closure of the Halden Reactor in Norway in June 2018
- International community identified the need to strengthen the network of international test facilities with the ability to perform neutron irradiation
- FIDES emerged from these discussions
- UK joined towards the end of the first triennial 2021-24
- NNL is the UK Party to the FIDES-II Agreement
  - UK 3<sup>rd</sup> Parties – ONR, UKAEA, EDF Energy UK, Jacobs, Rolls-Royce, and Bangor, Imperial, Manchester and Oxford
- UK has recently committed to the second triennial 2024-27

## Participants

Belgium, Czechia, Finland, France, Germany, Hungary, Japan, Korea, Netherlands, Spain, Sweden, Switzerland, United Kingdom, United States, European Commission (EC)

## Project period

2024-2027

## Budget

*Member contributions to FIDES fees: EUR 13 Million*

*Work scope value: Approximately EUR 30 Million*

## Second Framework for Irradiation Experiments – FIDES-II

- NEA joint undertaking, established pursuant to Article 5 of the NEA Statutes in co-ordination with the Nuclear Science Committee (NSC) and the Committee on the Safety of Nuclear Installations (CSNI)
- A stable, sustainable, reliable platform for fuel and material testing using nuclear research reactors (RRs) in NEA member countries
- A community of experts serving as a forum to exchange and preserve experimental, analytical and technical know-how

**P2M**  
Tests in  
BR2  
& LECA PIE  
Facility  
Belgium &  
France

**INCA**  
ATF  
Cladding  
creep tests  
in LVR15  
Czechia

**HERA**  
RIA tests  
with high  
burnup fuel  
in TREAT  
and NSRR  
US & Japan

**LOC-HBI**  
High  
Burnup  
LOCA  
testing in  
TREAT  
US

**INCREASE  
(Phase 2)**  
Stress-  
relaxation tests  
of structural  
material in HFR  
the Netherlands

**INCREASE  
(Phase 1)**  
Stress-  
relaxation tests  
of structural  
material in MITR  
US

**ATOMIC**  
GenIV fuel  
irradiation and  
microstructure  
evaluation in  
ATR  
US

**HITEC**  
High-  
temperature  
creep rupture  
testing in HFR  
the  
Netherlands

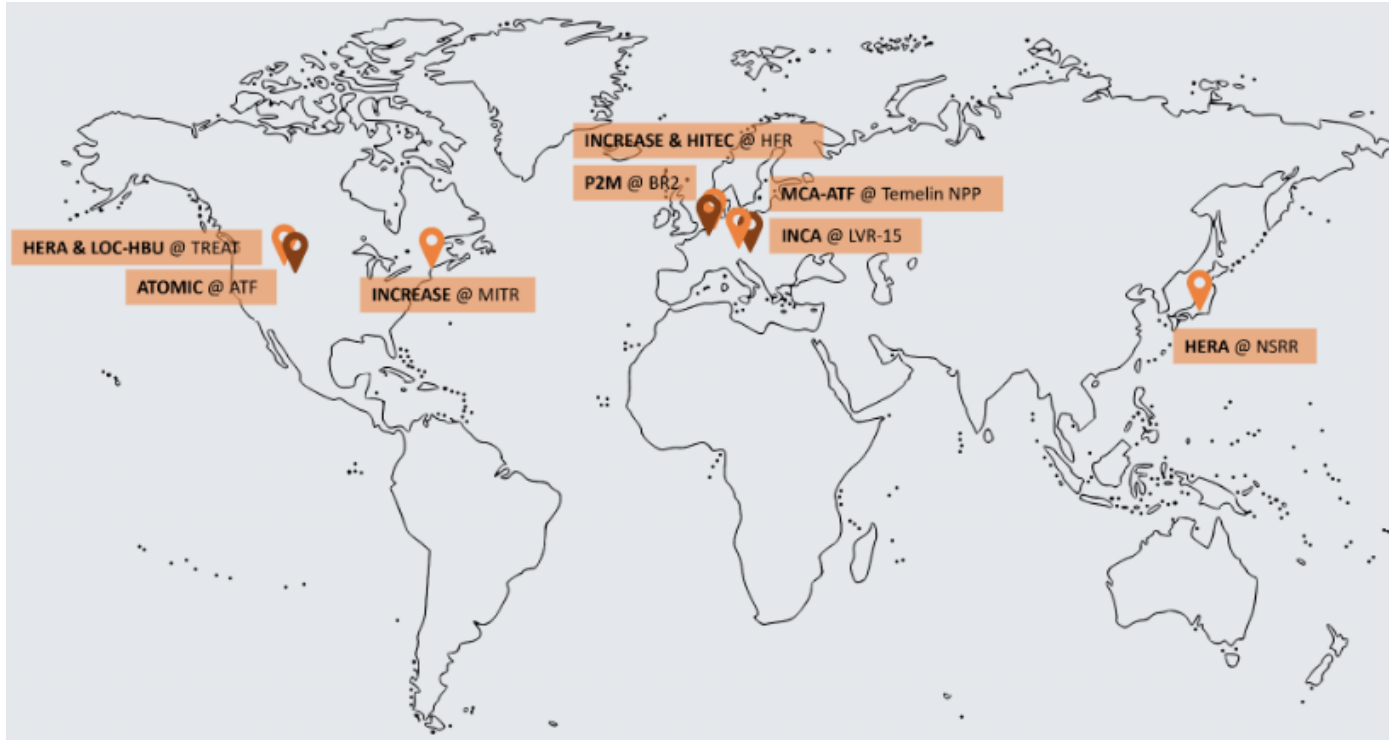
**MCA-ATF**  
Long-term  
irradiation of  
ATF cladding in  
a commercial  
Reactor  
Czechia

Data Preservation and Quality Assurance

Training and Education

Modelling and Simulation

# FIDES-II Research Reactors



- Research consists of seven topics of prioritised Human Factors and Digital Systems Research for existing and new reactors including SMRs.
- NNL is the signatory to the Halden HTO Agreement
  - UK 3<sup>rd</sup> Parties – ONR, EDF, FNC, Jacobs, Rolls-Royce, Rolls-Royce SMR, Sellafield Ltd, UKAEA
- Research performed by Institute for Energy Technology (IFE), Norway
- NNL deliver an annual UK Members group meeting
- UK Representative (NNL) elected Chair of the Halden Programme Review Group 2024

## Participants

Canada, China, Czechia, Germany, Japan, Korea, Netherlands, Norway, Sweden, United Arab Emirates, United Kingdom, United States

## Project period

Current mandate: January 2024 - December 2026

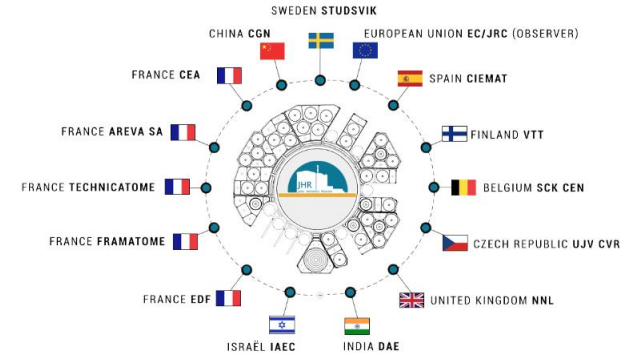
## Budget

EUR 14.58 million

- 01 Human Performance
- 02 Digital I&C - Safety Assurance
- 03 Control Room Design & Evaluation
- 04 Human-Automation Collaboration and Multi-Unit Operation
- 05 Digital Systems for Operations and Maintenance
- 06 Sustainable Decommissioning and Asset Lifecycle Management
- 07 Cyber Security for Main Control Rooms

# Jules Horowitz Reactor

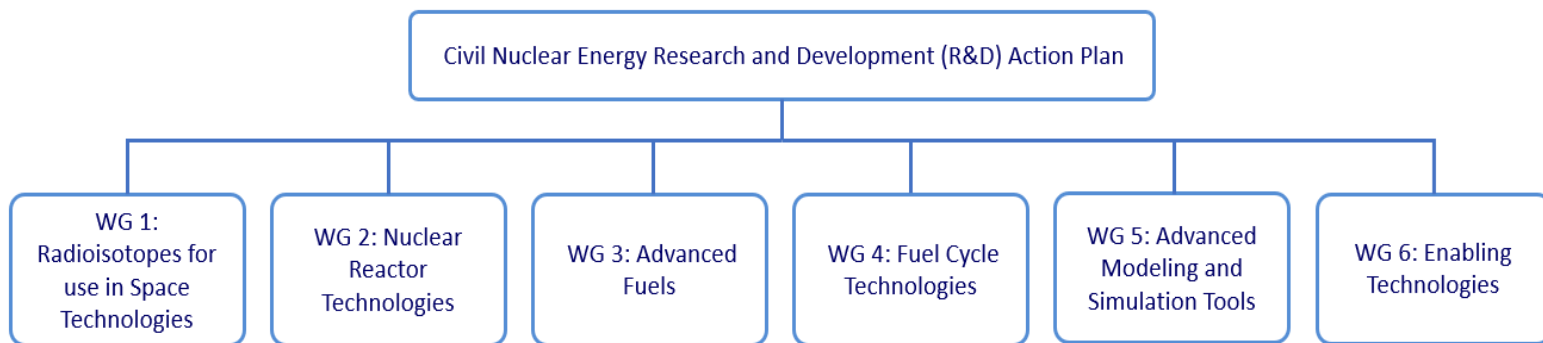
- JHR is a new Materials Test Reactor under construction at CEA Cadarache
- JHR will be operated as an international user-facility with the 15 partners (including UK) forming an international consortium
- Evolution of the reactor design (to address changes in safety standards) and scope (to provide a more flexible experimental capability) have impacted cost and schedule
- Current schedule has reactor operation 2032-34
- UK Representative (NNL) appointed Chair of the Governing Board 2024 to 2028





# US-UK Action Plan

- Civil Nuclear Energy R&D Action Plan signed at the British Embassy in Washington, D.C. in September 2018
- Action Plan seeks to facilitate cooperation in R&D for advanced civilian nuclear energy technologies between the two countries.



# Advanced Nuclear and International Research Programmes

**Any Questions?**

