UK Landscape and Drivers

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Overview

- Like the US, the UK has 60 years of relevant nuclear R&D experience
- UK civil nuclear has been different with an emphasis on higher temperature gas cooled reactors rather than LWR
- Currently the UK has no reactor vendor but maintains strong regulator, operator, enrichment and fuel manufacturing & development capabilities
- Going forward, UK energy generation and use will be dominated by its decarbonisation challenge
- Strong collaboration between the UK and US weapons programmes; more stand-off in collaboration on propulsion
- The degree of sharing on these most sensitive of issues is part of what makes the special relationship truly special.

Overview

- In the early 90's the UK closed most of its civil nuclear laboratories, leaving fundamental research within the University sector with NNL and UKAEA exceptions
- Decommissioning, including Sellafield dominates costs
- UK Nuclear Academics have worked hard and done well compered to other energy areas! But more to be done by this community wrt research area inclusivity
- The UK has continued its fusion energy programme, partly because of JET at Culham. There is current growth e.g. MAST upgrade complimented with excellence in ^{3}H, robotics and materials at UKAEA

Current Driver:
Nuclear cogeneration
civil nuclear energy in a low-carbon future

Policy Briefing:
Part of the Low Carbon Energy Programme

https://royalsociety.org/topics-policy/projects/low-carbon-energy-programme/nuclear-cogeneration/

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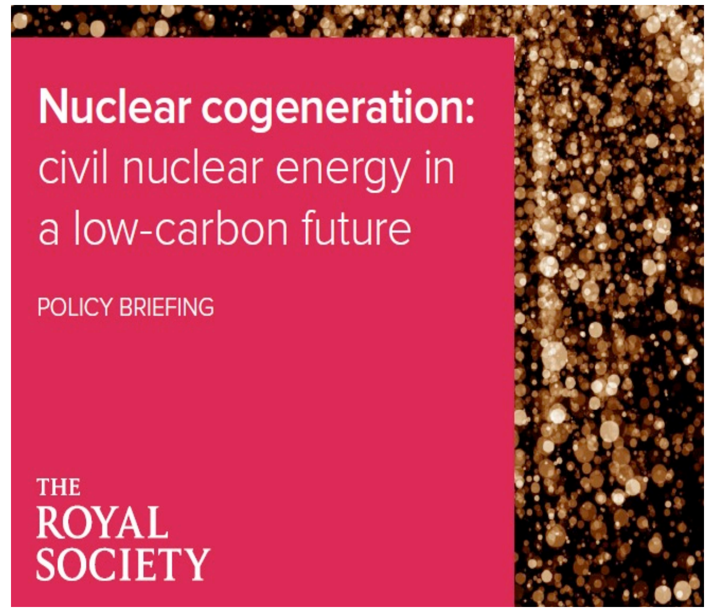


Road-Map being considered

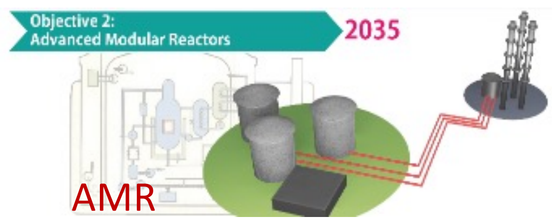
Continues to provide the "stable baseload" electricity requirement

GW production

+

Manages intermittency + some co-generation

+



Significant co-generation

The UK nuclear education landscape

- Returns from 18 Universities
- 2424 students reported since 2016 (F/M ~19%)
- At PhD level this included three CDTs
  - 2x fission, 1x fusion
- Many MSc level general and focused, e.g. MSc in
  - Nuclear Decommissioning and Waste Management
  - Physics and Technology of Nuclear Reactors
  - Nuclear and Environmental Physics
  - Nuclear Science and Applications
  - One consortium MSc
- At undergraduate level always nuclear with X
  - e.g. chemical and nuclear engineering
  - Intro courses at many universities (student numbers not included in total here)

National Nuclear User Facility

NNUF
National Nuclear User Facility

- NNUF was established to support the Government Nuclear Industrial Strategy launched in March 2013
- Phase 1 (2014), funded by DECC
  - new facilities on 5 sites with a budget of £16.1M
- Phase 2 (2019) funded by BEIS, delivery partner EPSRC
  - Budget of £81m: project will run until March 2023
  - £60m capital, £12m support, £6.5m to fund UK researchers to use NNUF facilities
  - 28 facility projects funded in two rounds

NNUF funded user access scheme

NNUF
National Nuclear User Facility

www.nnuf.ac.uk/how-gain-access

- Designed to encourage access to NNUF facilities by researchers in UK universities
- **Free at point of access:** covers **facility** and **equipment** costs, **T&S**, **sample transport etc.**
- £6.5m to be spent by March 2023
- External users can either attend facilities in person, or have experiments conducted on their behalf by facility staff scientists (contact individual facility for details)

Continuous quarterly application process

- Discuss feasibility with facility, then complete simple application form at www.nnuf.ac.uk
- Applications reviewed by NNUF Management Group on basis of quality, impact and scope
- **Second call closed on 4th December 2020**. Will primarily cover **access for period Jan – March 2021**.

NNUF US inspired project

- **UK Irradiated Materials Archive**
- Materials with known provenance, recovered during decommissioning, surplus inspection samples etc
- US Materials Archive developed by Rory Kennedy @INL
- UK version led by University of Bristol CCFE/UKAEA
- Stage one: Planning for an archive of neutron-irradiated materials, options study almost completed
- Stage two in development.

UK-US Nuclear Skills Collaboration Areas

From the UK we can identify the following initial priority areas for collaboration with US groups:

1. Radiation Detection

New detectors for radioactive materials monitoring offering improvements in sensing, efficiency, and simplicity of use:

- Plastic scintillators & pulse processing/PSD
- new detector materials for spectroscopy and imaging (perovskites, traditional semiconductors)
- detectors for extreme environments and low background/underground measurements

UK-US Nuclear Skills Collaboration Areas

2. Novel Imaging Techniques

Demonstrating the viability of new techniques for imaging:

- compact gamma and neutron imaging systems
- cosmic ray muon imaging of nuclear waste
- real-time CT imaging methods

3. Nuclear Fuel Cycle Monitoring

- Reactor monitoring, Watchman/AIT activities
- Nuclear Safeguards, fuel cycle modelling

UK-US Nuclear Skills Collaboration Areas

4. Machine Learning and Big Data

Currently this has a low level of activity in the UK, constrained by access to realistic training data. Some recent areas of activity include:

- AI processing of large sensor networks
- Search and localisation algorithms

But perhaps also 5. Radionuclide source identification

- To detect the difference between natural, medical or other sources

6. Disarmament Verification - underpinning science

Summary

- UK and US have collaborated in nuclear R&D for over 60 years
- While gov-to-gov collaboration has been directed, academic-to-academic has been more ad hoc
- There are plenty of opportunities: from detector materials to fuel cycle and reactor monitoring etc.
- Facilitated by:
  - sharing experimental facilities
  - sharing of materials
  - Judicious funding…