

# HTGRs in the UK

Dr Keith Franklin

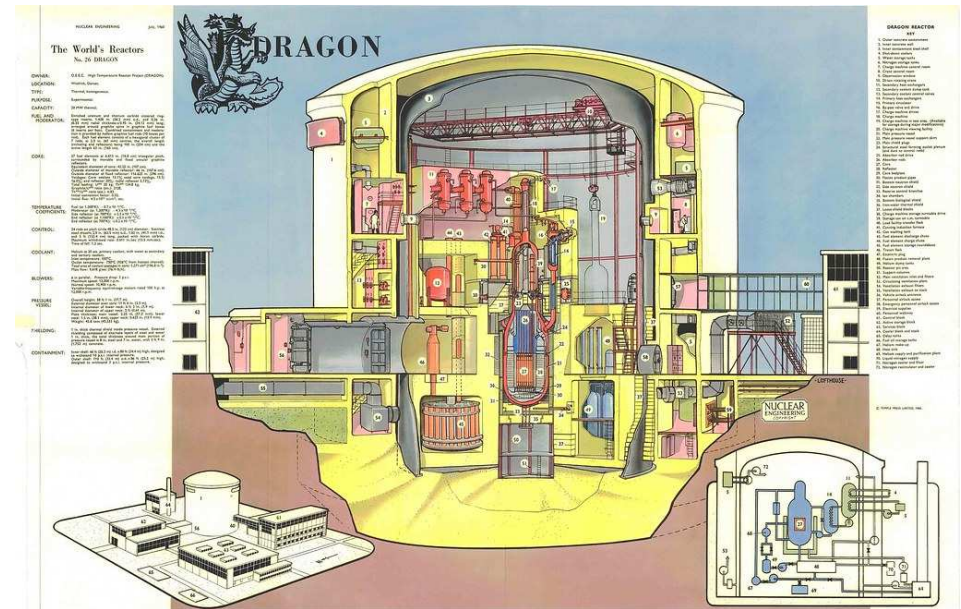
Head of International Engagement

NNL



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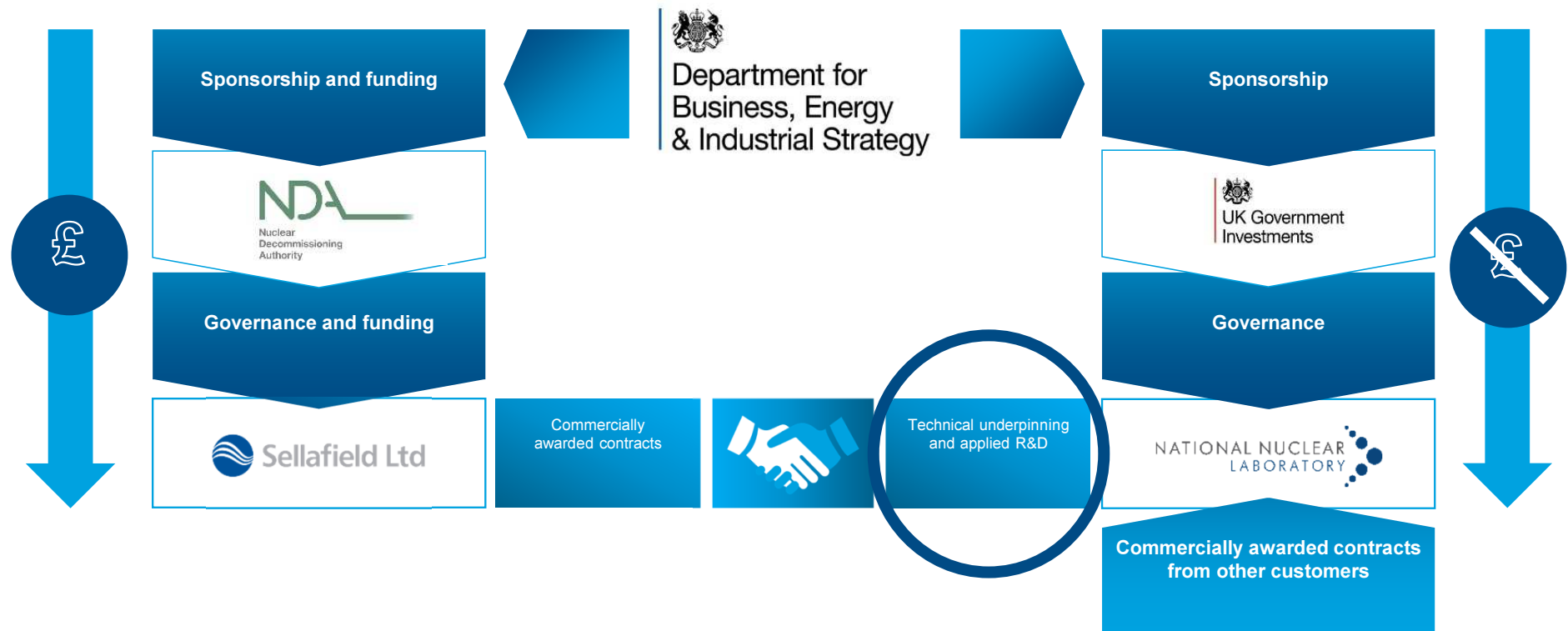


## Who are NNL (1)

- NNL is the UK's national nuclear laboratory which operates on an autonomous commercial basis
- NNL is owned by the UK Government and has three roles given to it by the Government



## Who are NNL (2) - NNL's position in the UK



## NIRO and NIRAB

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The Nuclear Innovation and Research Advisory Board (NIRAB) in partnership with the Nuclear Innovation and Research Office (NIRO) provides independent, expert advice to Government on the research and innovation needed for nuclear energy to play a significant role in the UK's future low carbon and secure energy mix and to create the environment in which the UK nuclear industry can contribute significantly to the economy ([www.nirab.org.uk](http://www.nirab.org.uk))

NIRAB consists of experts that are called upon periodically to address specific issues and challenges facing Government and the UK nuclear sector, feeding its advice into a broad range of bodies including the Nuclear Industry Council.



NIRO is operated by NNL on an independent arms-length basis and is currently staffed by secondees from NNL and industry, and consists of nuclear experts seconded on a full-time basis from NNL, UKAEA, BEIS, and the UK Supply Chain.

NIRO and NIRAB are the Governments nuclear advisors, and are staffed by people with nuclear expertise.



## History of Gas Cooled Reactors in the UK (1)

Calder Hall – a CO<sub>2</sub> cooled Magnox Reactor - the World's first Nuclear Power Station was opened in 1956



## History of Gas Cooled Reactors in the UK (2) - Magnox Reactors

Power Station	Capacity	Lifetime
Calder Hall	220	1956-2003 (47y)
Chapelcross	196	1959-2004 (45y)
Berkeley	276	1962-1989 (27y)
Bradwell	242	1962-2002 (40y)
Hunterston A	180	1964-1989 (35y)
Dungeness A	450	1965-2006 (41y)
Trawsfynydd	470	1965-1991 (26y)
Hinkley Point A	500	1965-2000 (35y)
Sizewell A	420	1966-2006 (40y)
Oldbury	434	1967-2012 (45y)
Wylfa	980	1971-2015 (44y)



## History of Gas Cooled Reactors in the UK (2) - AGRs

AGRs – Advanced Gas Cooled Reactors

Power Station	Capacity	Opened
Hinkley Point B	1061	1976
Hunterston B	1074	1976
Hartlepool	1207	1983
Heysham I	1179	1983
Dungeness B	1120	1983
Heysham II	1254	1988
Torness	1250	1988

(and one PWR)

Sizewell B	1216	1995
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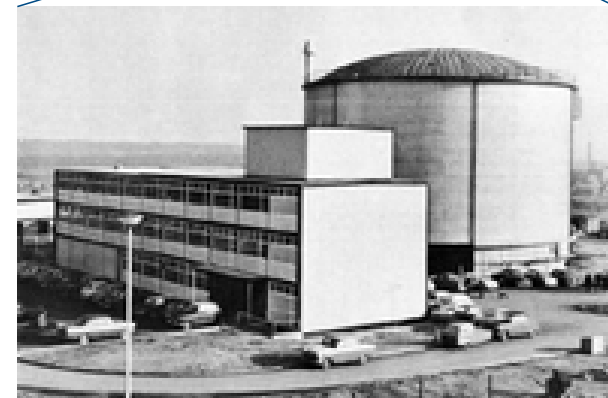
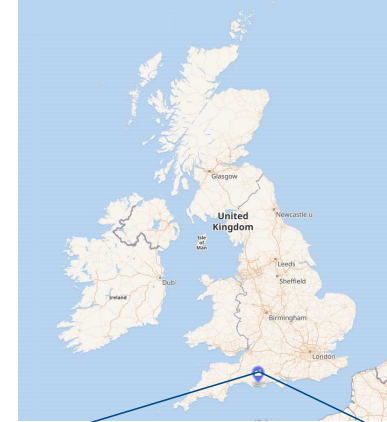


## AGR Expected Closure Dates



## History of Gas Cooled Reactors in the UK (3) - HTGR - Dragon

- 20MW He-cooled test reactor
- Outlet temperature of 750°C
- Operated from 1964-1975
- Currently being decommissioned



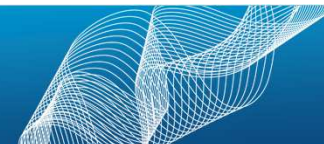
# UK Government Policy in relation to HTGRs (1) - Key Documents

- At the end of 2020, two documents were published which were relevant to HTGRs
  - [2020 Ten Point Plan for a Green Industrial Revolution](#)
    - [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/936567/10\\_POINT\\_PLAN\\_BOOKLET.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/936567/10_POINT_PLAN_BOOKLET.pdf)
  - [Energy White Paper](#)
    - [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/945893/201215\\_BEIS\\_EWP\\_Command\\_Paper\\_Large\\_Print\\_Web.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/945893/201215_BEIS_EWP_Command_Paper_Large_Print_Web.pdf)
- These included the development of large scale, Small Modular Reactors (SMRs) and *Advanced Modular Reactor (AMR)* technologies.
- The Energy White Paper created a Advanced Nuclear Fund, including funding for a Research and Development Programme in Advanced Modular Reactors which “...includes reactors that can operate at 800°C and the high grade heat could unlock efficient heat production of hydrogen and synthetic fuels”.



## UK Government Policy in Relation to HTGRs (2) - Call for Evidence

- The UK Government will often issue public consultations on matters of policy
- In the summer of 2021, the UK Government issued a “Call for Evidence” on the “Potential of high temperature gas reactors to support the Advanced Modular Reactor Research Development & Demonstration (AMR RD&D) Programme.”
  - **This call was issued by BEIS, the Department for Business, Energy and Industrial Strategy (equivalent of METI)**
    - [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/1008813/advanced-modular-reactors-demo-call-for-evidence.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1008813/advanced-modular-reactors-demo-call-for-evidence.pdf)
  - **The questions were**
    - **1. Do you agree with the government’s preference to explore the potential of high temperature gas reactors (HTGRs) to meet the key objective of the Programme?**
    - **2. Whether there is any new, additional evidence on other AMR technologies that could meet the key objective of the Programme?**
    - **3. How the capability of the UK supply chain could support the Programme?**
- BEIS stated that their preferred option was HTGRs, and published the NIRO report containing the evidence for this.
  - [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/1006752/niro-217-r-01-issue-1-technical-assessment-of-amrs.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1006752/niro-217-r-01-issue-1-technical-assessment-of-amrs.pdf)



## UK Government Policy in Relation to HTGRs (3) - Call for Evidence - Summary

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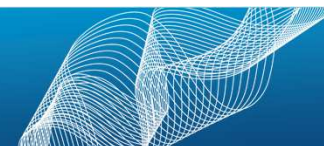
The consultation closed in August, and last month, BEIS published a summary of the submissions on their website.

<https://www.gov.uk/government/consultations/potential-of-high-temperature-gas-reactors-to-support-the-amr-rd-demonstration-programme-call-for-evidence>

They received 60 responses from a range of supply chain companies, academic institutions, regional bodies, industry organisations and private individuals.

Of these responses:

- 38 were in favour of the government's preference to support HTGRs for the AMR RD&D programme
- 16 were not in favour
- 6 were neither for nor against



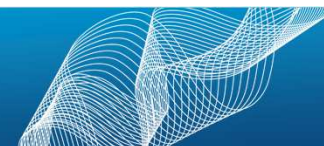


## UK Government Policy in Relation to HTGRs (4) - Call for Evidence - Summary

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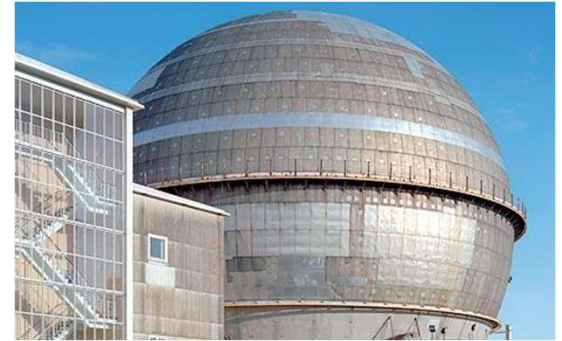
The following key themes were identified in the submission:

- Support for HTGRs as the best AMR technology solution to help support Net Zero by 2050
- Important characteristics of HTGRs including; high temperature heat for industrial processes, high technical maturity, UK's experience with gas-cooled reactors
- UK supply chain's capability to support the AMR RD&D Programme to deliver an AMR demonstration by the early 2030s (responses varied on whether the UK supply chain was immediately able to support the programme or would need support and development)
- The use of Multi Criteria Decision Analysis (MCDA) as a quantitative tool for AMR assessment
- The capability of other non-HTGR technologies and specific AMR designs
- Technical topics including: fuel cycle, waste management, high temperature material behaviour and hydrogen production



## UK Government Policy in Relation to HTGRs (5) - Historical Perspective

- The UK has not built any Demonstration or Research Reactor since the 1960s
- Funding of new nuclear build has been seen as something for private industry, and left to the market.
- Therefore, the UK Government committing to investing in the demonstration of new nuclear technology is a huge step in UK energy policy.
- It has been driven by Climate Change and Energy Security
- Japan has a much more recent history in the construction of nuclear plants and of Government investment in new technologies
- The UK government has recognised that the Nuclear Industry provides high quality jobs in different areas of the country (i.e. not just big cities). This fits with its “Levelling-up” policy. Trying to ensure that economic prosperity is shared equally across the country, and not just in certain areas such as the South East of England

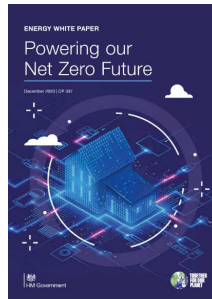


# UK Government Policy in relation to HTGRs (6) - Further Key Documents

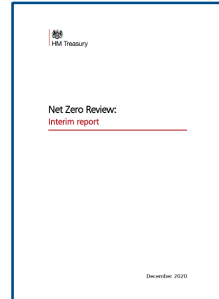
- Nuclear in 'non-nuclear' policies



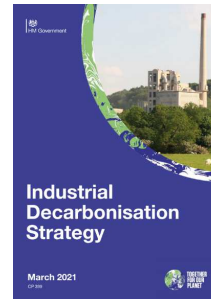
<https://www.gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution>



<https://www.gov.uk/government/publications/energy-white-paper-powering-our-net-zero-future>



<https://www.gov.uk/government/news/net-zero-review-publishes-initial-analysis-of-green-transition>



<https://www.gov.uk/government/publications/industrial-decarbonisation-strategy>



[https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/1030656/uk-net-zero-research-innovation-framework.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1030656/uk-net-zero-research-innovation-framework.pdf)

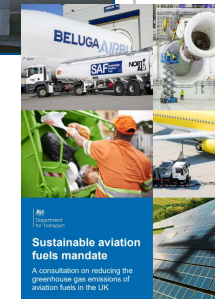


<https://www.gov.uk/government/publications/transport-decarbonisation-plan>



<https://www.gov.uk/government/news/uk-government-launches-plan-for-a-world-leading-hydrogen-economy>

<https://www.gov.uk/government/publications/heat-and-buildings-strategy>



<https://www.gov.uk/government/consultations/mandating-the-use-of-sustainable-aviation-fuels-in-the-uk>

## NNL and HTGRs: The Advanced Fuel Cycle Programme

For an AMR programme to be a success. There needs to be successful demonstration of:

- Reactor Technology
- Fuel Cycle
- Applications

NNL has interests in all of these areas.

For example NNL is hosting the Advanced Fuel Cycle Programme, a UK Government funded initiative on fuel R&D. As part of this NNL intends to demonstrate the production of the first Coated Particle Fuel at active scale in the UK.

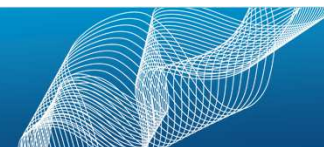


UK Energy Minister Greg Hands and NNL CEO Paul Howarth with a CPF uranium fuel kernel in the NNL's Advanced Fuel Cycle laboratories last month

## (Personal Experience) Differences between the UK and Japan

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- Japan has large reactor constructors with recent experience (メーカー), and a related supply chain
- Government decision making processes are different
- Business decision making processes are different





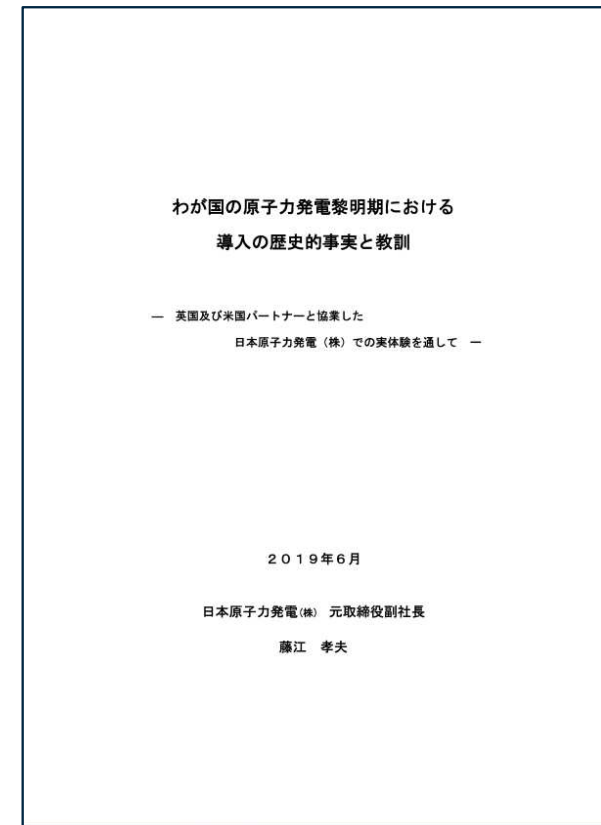
# Experience of Working Together

Historical Facts and Lessons Learned from the  
Establishment of Nuclear Power Generation at Its Dawn in  
Japan

Actual Experiences of the Japan Atomic Power Company,  
Working with UK and US Partners

Takao Fujie Former executive vice-president, Japan Atomic  
Power Company

[https://inis.iaea.org/search/search.aspx?search-option=everywhere&orig\\_q=%E8%97%A4%E6%B1%9F%20Historical%20Facts](https://inis.iaea.org/search/search.aspx?search-option=everywhere&orig_q=%E8%97%A4%E6%B1%9F%20Historical%20Facts)



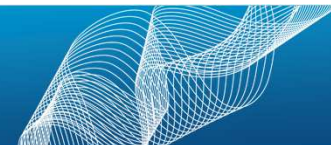
## Next Steps

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The UK Government is considering next steps of the programme and expect to share further information, likely in Spring this year.



Department for  
Business, Energy  
& Industrial Strategy



## Summary

- The UK has a long history in developing and operating gas-cooled reactors
  - **We developed, built and operated the Dragon reactor in the 1960s**
- UK Government has made commitments to demonstrating advanced nuclear technologies, particularly those which can generate high temperature heat
- Their preferred option is for HTGRs, which has been confirmed by the Call for Evidence.
- We expect to hear the next steps in the process sometime in the next few months

