The UK's Approach to Advanced Modular Reactors

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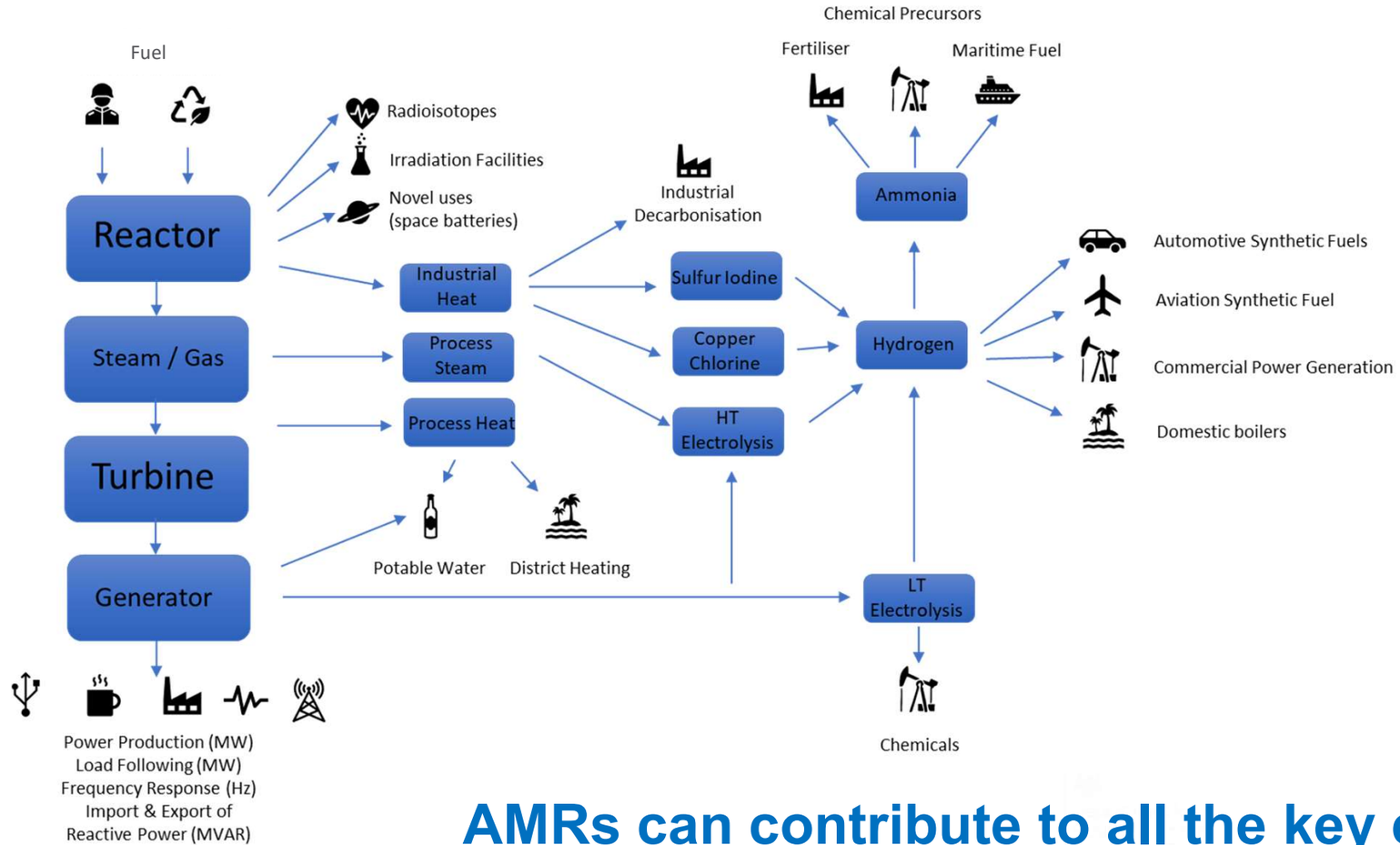
What is an AMR?

The UK classifies **A**dvanced **M**odular **R**eactors (**AMR**s) and **S**mall **M**odular **R**eactors (**SMR**s) as **A**dvanced **N**uclear **T**echnologies (**ANT**).

SMRs are near to market small modular reactors based on Light Water Reactor designs.

AMRs are reactors that use novel cooling systems or fuels and may offer new functionalities (such as industrial process heat).

The Need for AMRs



AMRs can contribute to all the key energy vectors

Net Zero by 2050

- Signed into law June 2019
- All Greenhouse Gas Emissions will be brought to Net Zero by 2050
- UK is the first major economy in the world to pass laws to end its contribution to global warming
- UK will host COP26 Summit in 2021

A Green Industrial Revolution

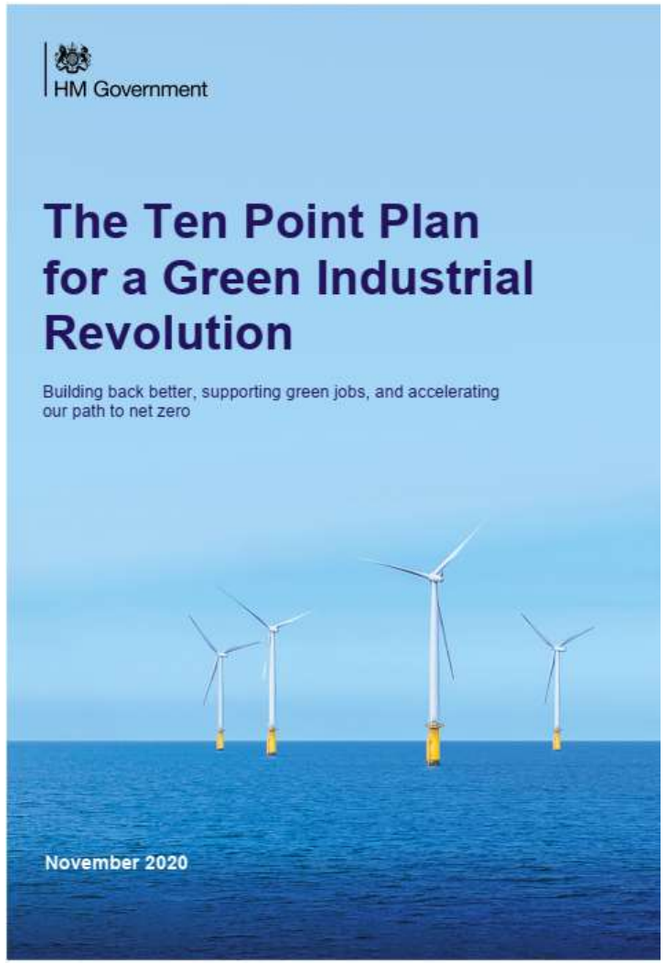
Launched November 2020
A Ten Point Plan to achieve Net Zero

- The ten point plan will mobilise £12 billion of government investment, and potentially 3 times as much from the private sector, to create and support up to 250,000 green jobs.

The Rt Hon Boris Johnson MP,
Prime Minister

The Rt Hon Alok Sharma MP,
President COP 26

The Rt Hon Kwasi Kwarteng MP,
Secretary of State for Business, Energy and Industrial Strategy



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

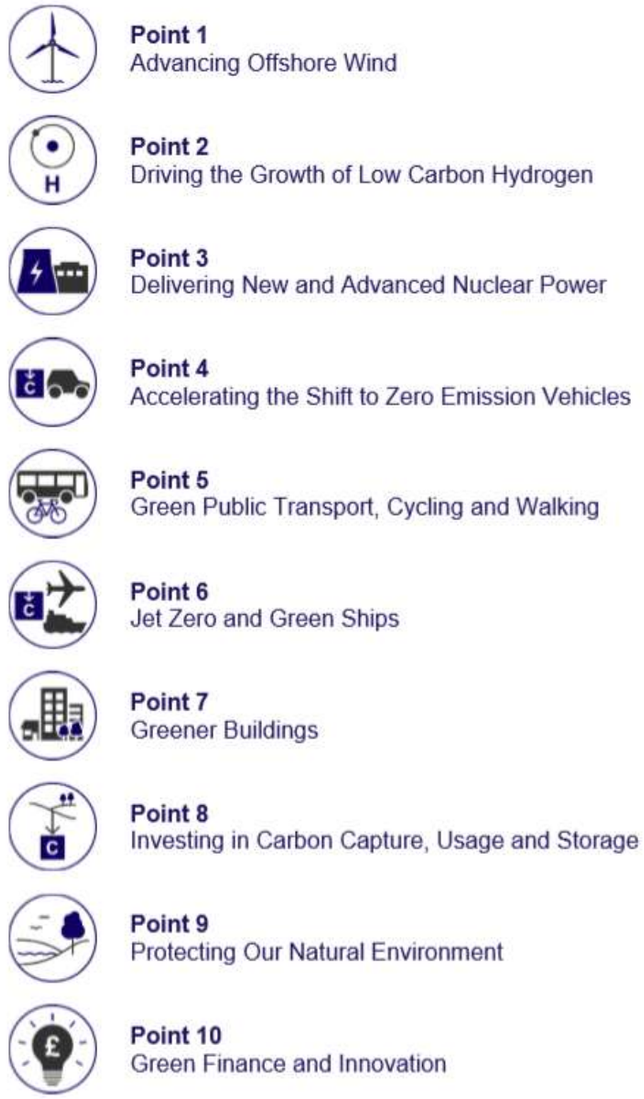
Ten Point Plan

Development of a Hydrogen Economy

Production of hydrogen and electricity from nuclear, renewables and CCS.

Key role for nuclear in delivering deep decarbonisation of electricity system, alongside renewables and other technologies

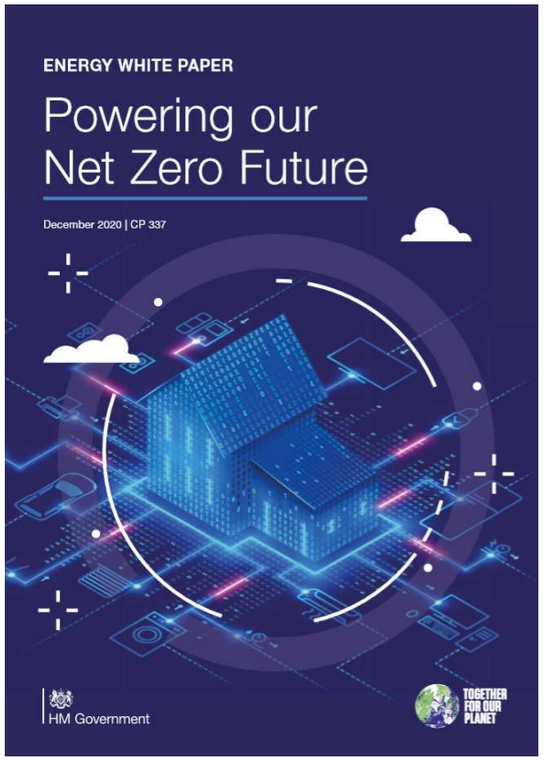
Likely role for AMRs in decarbonising industry, heat and transport



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

Energy White Paper

Open the Generic Design Assessment to SMR technologies in 2021



Bring *at least* one large scale nuclear plant to Final Investment Decision (FID) by the end of this Parliament

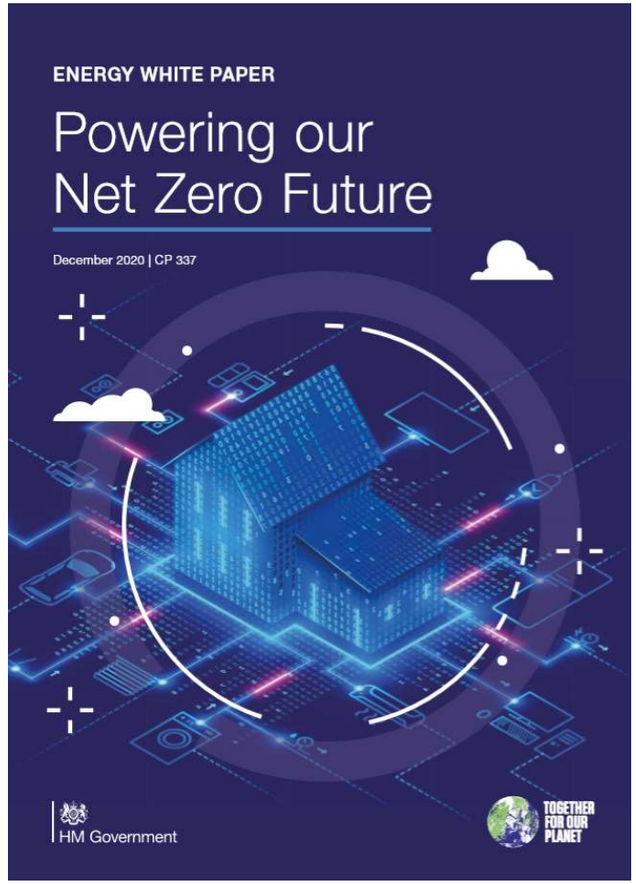
Develop a SMR design by the early 2030s

Build an AMR Demonstrator by the early 2030s

Build a commercially viable fusion power plant by 2040

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

Advanced Nuclear Fund



£385m funding for the Advanced Nuclear Fund

- £215M for developing a domestic SMR
- £170m for AMR R&D

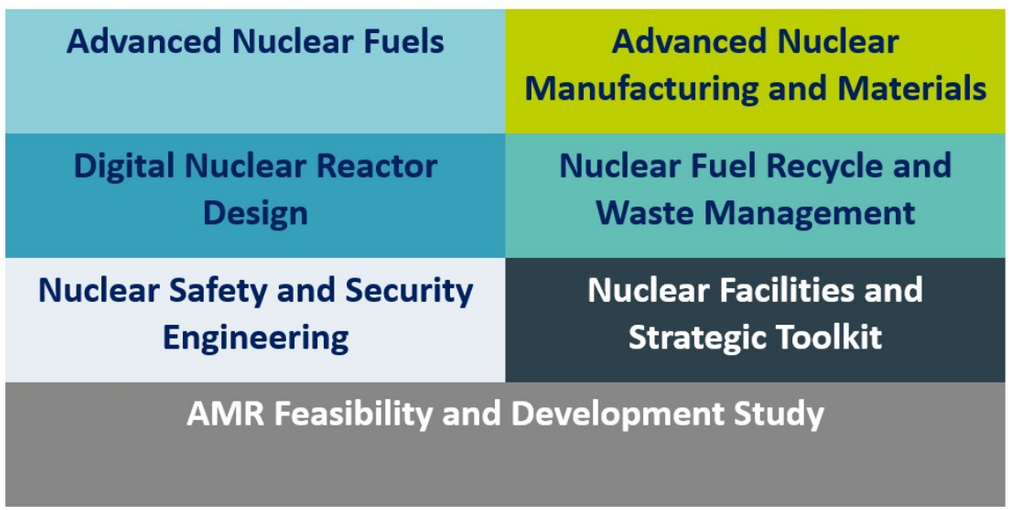
Plus £40m to develop regulatory frameworks and support UK's supply chain.

UK's Long History in Advanced Nuclear Development

- Dragon High Temperature Gas Reactor and associated research
- Dounreay Fast Reactor and associated reactors, fuel cycle and research
- Winfrith Steam Generating Heavy Water Reactor and associated research
- Development of the Advanced Gas-cooled Reactor.

Research & Development

The UK is concluding a five year £180m nuclear theme energy innovation programme which delivered R&D across a number of areas:



The UK has recently announced a £1billion programme Net Zero Innovation Portfolio – AMR is a Priority Area.

AMR Feasibility and Development Study

Two phases of the study

Phase 1 – Feasibility studies for 8 AMR Designs (completed)

Phase 2 – Development studies 3 AMR Designs (to complete in 2022)

UK continues to consider all AMR technology families that could support Net Zero

AMR Feasibility – Phase 1

Each team awarded up to £300k to produce feasibility studies:

- Advanced Reactor Concepts LLC,
- DBD Limited,
- Blykalla Reaktorer Stockholm AB (LeadCold),
- Moltex Energy Limited,
- Tokamak Energy Ltd,
- U-Battery Developments Ltd,
- Ultra Safe Nuclear Corporation,
- Westinghouse Electric Company UK.

AMR Feasibility – Phase 2

Each team awarded up to £40m to support development activities, and £5m awarded to UK regulators to support the teams

- Tokamak Energy for engineering design and development of technology for advanced modular fusion reactors,
- U-Battery for engineering design and development of technology for high temperature gas fission AMRs,
- Westinghouse Electric Company UK for engineering design and development of technology for lead cooled fission AMRs.

AMR Regulation

The UK has a goal-oriented, non-prescriptive regulatory regime – ideal for advanced technologies

ONR Office for Nuclear Regulation

Environment Agency

Cyfoeth Naturiol Cymru Natural Resources Wales

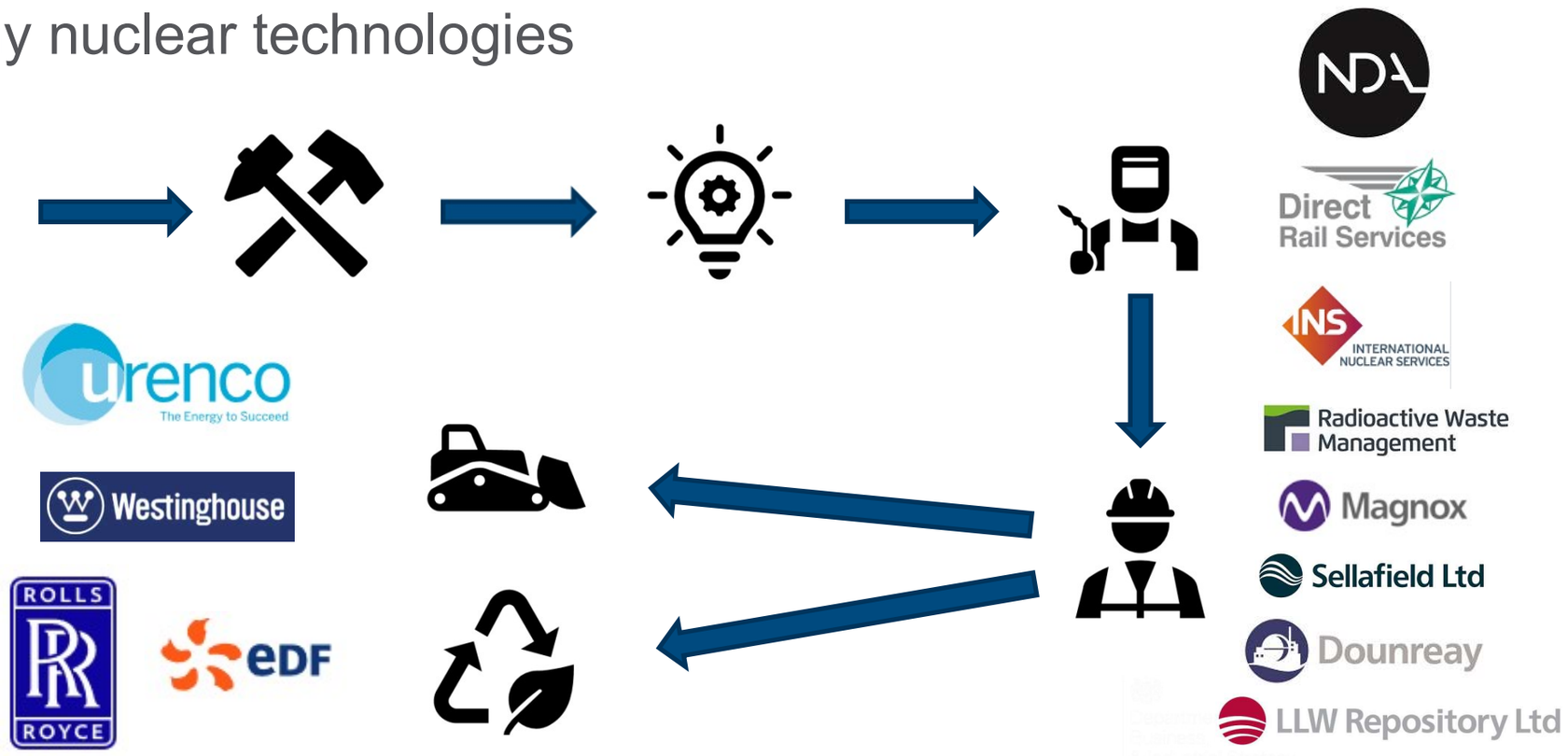
SEPA Scottish Environment Protection Agency
Buidheann Dion Àrainneachd na h-Alba

Generic Design assessed through the GDA (Generic Design Assessment):

- AP1000, EPR and ABWR have successfully completed GDA
- Hualong-1 Design in final stage
- New optimised 3 stage GDA process will open in 2021

UK's Supply Chain for AMR

The UK has a fuel nuclear lifecycle supply chain and has decades of experience across many nuclear technologies



UK Public Perception of Modular Reactors

BEIS Public Attitudes Tracker

- In 2018, BEIS introduced a question on SMR awareness to the Public Attitudes Tracker.
- In November 2020, 30% of participants had some awareness of Small Modular Reactors.

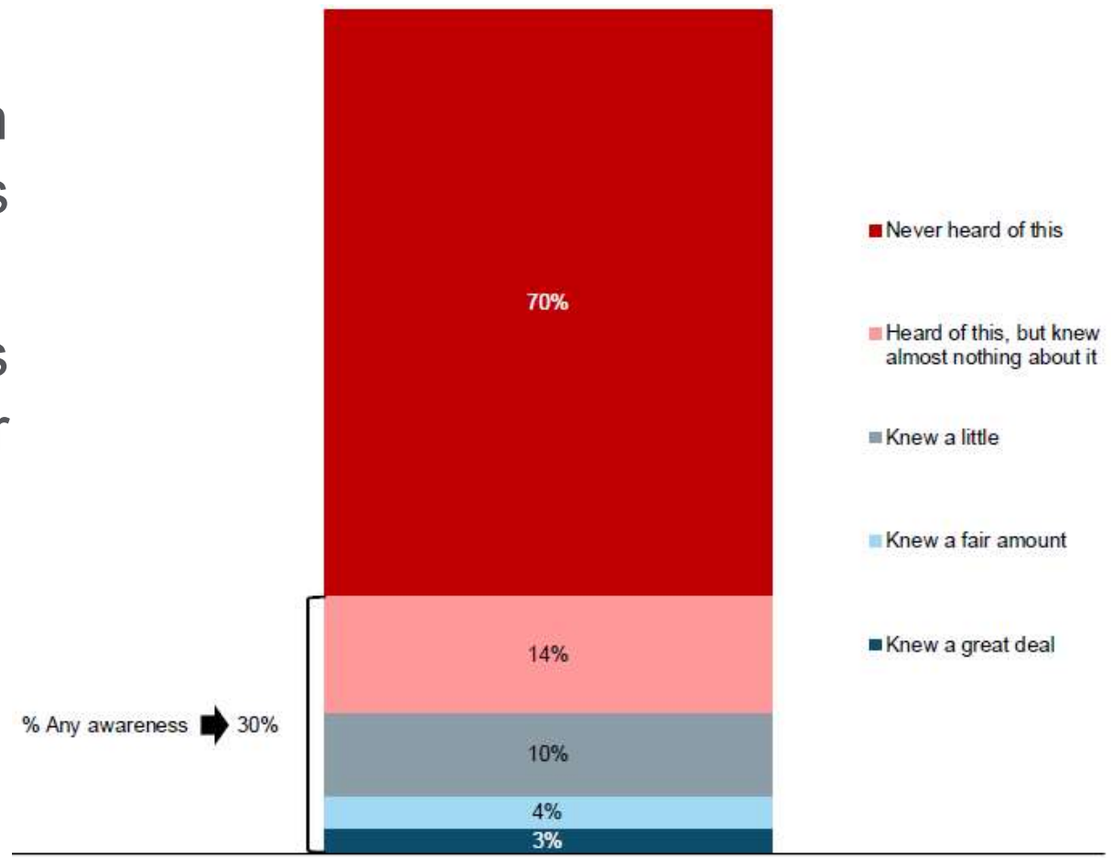


Figure: Awareness of Small Modular Reactors (BEIS PAT, November 2020)

Modular Nuclear Technologies Public Dialogue

- Sciencewise is a programme set up to assist UK Government policy-makers in conducting public dialogue to inform their decision making on science and technology issues.

- BEIS are working with Sciencewise to deliver a number of virtual ‘public dialogue’ events to explore views around modular nuclear technologies (SMR and AMR).

- Public dialogues are events where invited members of the public interact with policy makers, scientists and stakeholders to deliberate on issues relevant to future policy decisions.

- We are currently delivering 6 virtual workshops with ~76 selected members of the public from each of three communities across the UK: nuclear, industrial and non-nuclear/non-industrial.

- The outputs from this project will be published in early 2021.