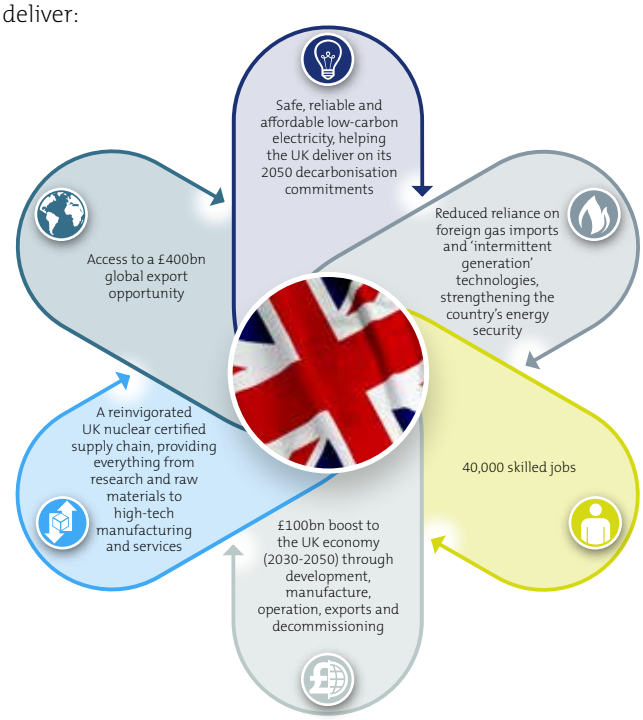
Rolls-Royce

Small Modular Reactors - once in a lifetime opportunity for the UK

A huge opportunity for the UK

A Small Modular Reactor (SMR) programme represents a once in a lifetime opportunity for UK nuclear companies to design, manufacture and build next generation reactors to meet the UK's energy needs. The UK Government has the chance to maximise British content, creating and sustaining intellectual property, high-tech, high-skills employment, a reinvigorated UK supply chain and positioning the country as a global leader in innovative nuclear technologies that present tremendous opportunities in international export markets.

Rolls-Royce believes a UK SMR programme has the potential to deliver:



A UK Consortium led by Rolls-Royce to deliver: energy security, jobs, sustainable value, a robust supply chain, exports and low carbon technology.

The UK SMR - small but perfectly formed

A UK SMR programme will create vital British intellectual property and revitalise the UK's civil nuclear expertise and ability to deploy nuclear power. Rolls-Royce is strongly placed to deliver the design and, together with a consortium of UK companies, the supply of almost all aspects of a new nuclear SMR plant re-establishing the UK supply chain to a position of global recognition. Traditional large nuclear plants are bespoke projects often relying upon state support, but small modular reactors could be made in centralised manufacturing facilities and then transported to anywhere in the country or overseas, producing benefits of scale which would drive down costs. Rolls-Royce is developing a patented modular concept which is designed specifically for factory manufacture and commissioning, speed of installation and reduced on-site construction work. This mitigates the programme risk associated with conventional nuclear plants. Our concept is the best of breed in terms of design, manufacture, cost and ownership.

Rolls-Royce believes its SMR design will:

- Provide 220MW to 440MW of power, depending on the configuration, that's the equivalent of up to 150 onshore wind turbines.
- Supply power to the grid in a timely manner at lower cost to the taxpayer and consumer, generating electricity that is at least as cheap (per MW) as power generated by today's large scale reactors – potentially even cheaper when SMRs go into volume production.
- Represent the lowest risk by using proven technology and best value by using a high degree of commercial or standardised off-the-shelf components.
- Open up opportunities for UK supply chain companies to enter into volume manufacturing as over 75% of the design (by cost) is modular.
- Appeal to a UK commercial or international utility company or power station operator.
- Be so compact (16 metres high and 4 metres in diameter) it can be transported by truck, train or even barge.

- Sit within a power station that would be roughly five and half times the size of the pitch at Wembley, which is just one-tenth the size of a typical large-scale reactor site (40,000m2 vs 400,000m2).
- Take just 5 years from the start of construction to the generation of the first electricity.
- Be up and running by 2028, maximising the UK's first-mover advantage in the race for exports.
- Minimise operating costs such as refuelling and the burden of decommissioning.
- Last for 60 years.

A UK SMR will deliver growth for the economy

A Rolls-Royce - led UK SMR solution will deliver an estimated Gross Value Added (GVA) indirect contribution of £71bn to the UK economy, according to our research.

A peak benefit of 40,000 UK jobs will be created over the new build phase (2030 – 2050), with jobs split 60:40 between direct employment in the SMR Supply Chain and indirect employment in supporting areas.

An UK SMR programme based on 7GWe in the UK and a conservative international export of 9GWe could deliver a total benefit to the UK economy of £188bn for the period 2015 to 2115, according to Rolls-Royce estimates, with the majority (£100bn) in the period 2030 to 2050. This includes a direct benefit of around £117bn, which will be created through the development, manufacture, operation, exports and decommissioning of SMR plants.

In comparison, UK Office for National Statistics (ONS) data from 2014 showed that nuclear energy provided £3.5bn to the UK.

Rolls-Royce will help deliver one of UK's largest engineering collaborations

Development of a UK SMR plant promises to be one of the largest national engineering collaborations ever undertaken and Rolls-Royce is ideally placed to champion a British consortium. We are the largest employer of nuclear engineers and scientists in the country and with our decades of experience in producing compact nuclear pressure water reactors (PWRs), we believe we can meet the needs of the SMR opportunity in the civil energy market.

Our nuclear business includes many of the key capabilities needed to undertake an SMR design and build programme. We have 3,000 highly experienced engineers working today on key nuclear island design, manufacturing, procurement and operational support covering the entire lifecycle from inception to life extension and decommissioning.

We are the only private Western reactor designer that is also a reactor plant operator, as we have responsibility for the operation of the onshore test reactor in the UK. We operate two further nuclear licensed sites: a nuclear core manufacturing facility for naval reactors and an engineering site, both situated in Derby. This combination of capabilities is matched by only a small number of organisations worldwide.

We have been a nuclear reactor plant designer since the inception of the nuclear submarine programme in the UK in the 1950s. Since then, Rolls-Royce has designed reactors for seven classes of submarine and two separate land-based prototype reactors. We have developed three separate reactor generations and each has seen significant improvements in reactor plant performance, core lifetime and safety. In addition Rolls-Royce led the development of the first integral reactor design during the 1980s and early 1990s. This reactor, designated "SIR" (Safe Integral Reactor), was 330 MWe in power, and is arguably the starting point for all subsequent integral reactor designs.

Rolls-Royce has been working on the genesis of the SMR development programme for civil nuclear applications since the early 1990s.

United Kingdom

Thurso (Submarines)
Prototyping of Royal Navy reactor plants

Faslane (Submarines)
Operational Support

Barrow (Submarines)
Buildyard, Astute class

Gateshead
Nuclear Services & Projects

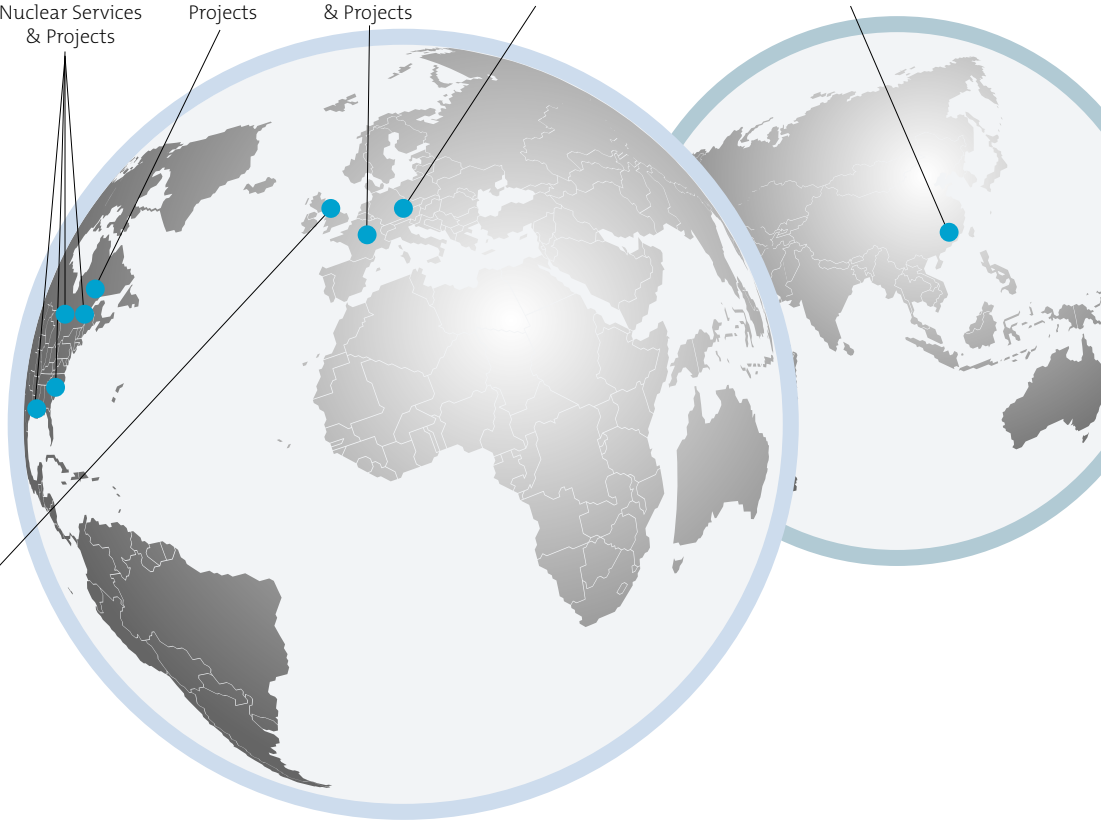
Warrington
Nuclear Services & Projects
Engineering Office

Derby (Submarines)
Core Design, Manufacture, New Build, (HQ)

Barnwood
Nuclear Services & Projects

Bristol (Submarines)
Joint Team & Customer Presence

Plymouth (Submarines)
Waterfront Support



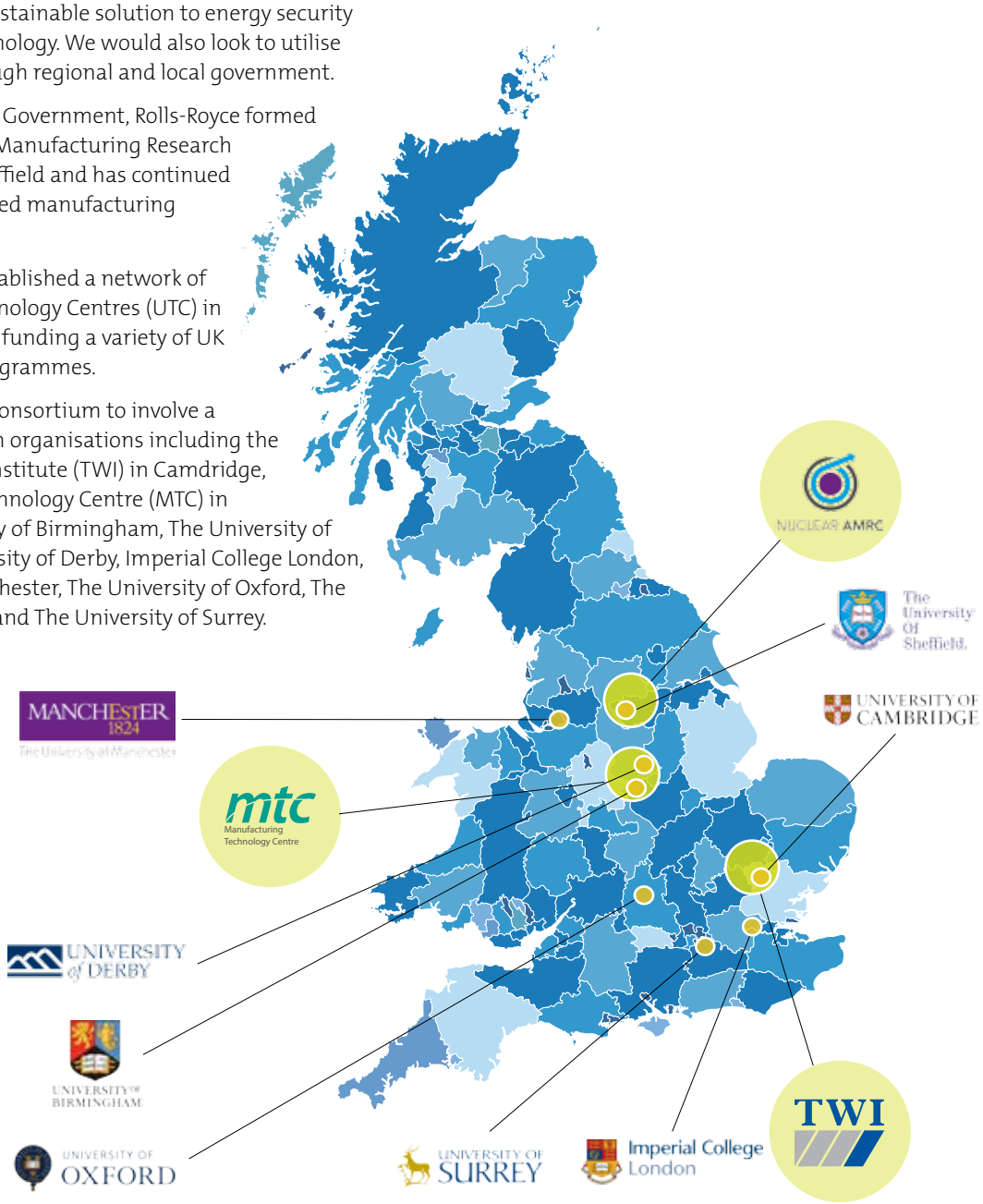
Bringing together Britain's best brains

A Rolls-Royce - led UK SMR Programme will utilise a broad range of interdisciplinary technical expertise to deliver a commercially viable, sustainable solution to energy security using low-carbon technology. We would also look to utilise support available through regional and local government.

In partnership with UK Government, Rolls-Royce formed the Nuclear Advanced Manufacturing Research Centre (NAMRC) in Sheffield and has continued to support it with funded manufacturing development activity.

Rolls-Royce has also established a network of over 25 University Technology Centres (UTC) in the UK and is currently funding a variety of UK University research programmes.

We would expect our Consortium to involve a broad range of research organisations including the NAMRC, The Welding Institute (TWI) in Camdridge, the Manufacturing Technology Centre (MTC) in Coventry, The University of Birmingham, The University of Cambridge, The University of Derby, Imperial College London, The University of Manchester, The University of Oxford, The University of Sheffield and The University of Surrey.



Broadest range of expertise deployed in UK consortium

SMR UK PLC Tier 1 Equity Partners / Investors

Reactor Island | Civil Modules | Turbine Island | Utility/ Operator | Equity Investors

Tier 2 Equity Partners / Investors

- UK Engineering consultants
- UK Manufacturing partners
- International partners (Steam Turbine and Utilities)*
- Minority investors wishing to own a stake

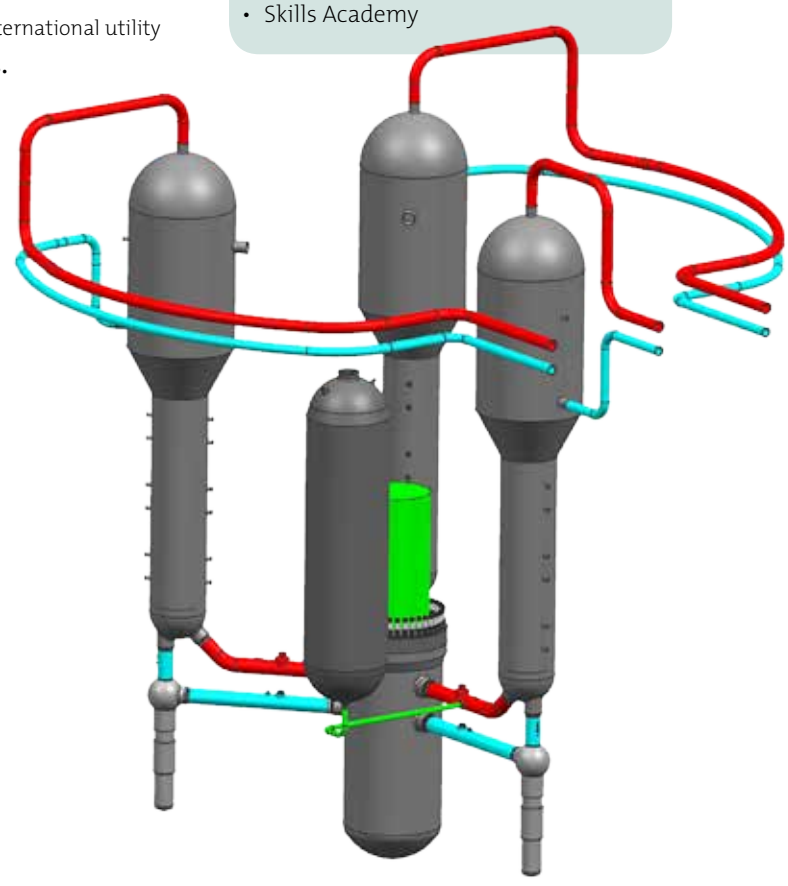
UK Supply Chain

UK Defence suppliers
UK Civil Nuclear suppliers
From large suppliers to SME's
From manufacturing to engineering

UK Academia and Research & Support
E.g.

- NAMRC
- NNL
- University network
- Welding Institute
- Skills Academy

*UK does not own Steam Turbine technology. International utility partners sought for international market access.



UK supply chain can deliver entire SMR plant

We are proposing to not just produce the optimum design solution but also lead a UK supply chain for the delivery of the entire plant.

Rolls-Royce and the UK Government have a successful track record in the aerospace sector of cooperating to maximise socio-economic benefits and create sustainable supply chain skills and jobs. There are significant parallels between what we have done in aerospace and what we will do with SMRs.

The UK already has the basis for an SMR supply chain through the existing nuclear qualified companies that support defence applications and we are the primary technical expertise resource provider for the UK supply chain development programmes undertaken by the NAMRC.

Our intent is to catalyse investment in the UK supply chain by providing a long term, sustainable programme of engineering development and production that acts as a vehicle for UK supply chain to invest in capability, equipment and capacity. This will allow 'UK Plc' to act at the top tier of the global nuclear marketplace. We believe that all of the SMR plant, with the exception of the steam turbine, is capable of being constructed in the UK by UK supply chain.

Within the nuclear sector we bring together extensive experience in managing mission-critical nuclear supply chains. We have already established a significant UK nuclear certified supply chain to support our Submarines business, consisting of 260 companies across a wide range of commodities, including raw materials, forgings, mechanical components, pumps and valves, electrical controls and systems, instrumentation, software and engineering services and we are further developing this supply chain to over 450 accredited suppliers to satisfy civil nuclear demands.

We are also engaged in two important initiatives:

F4N Fit For Nuclear

Fit for Nuclear (F4N)

Developed by the Nuclear AMRC, F4N is a unique service to help UK SMEs with 10 or more employees or with a turnover of £1.6m get ready to bid for work in the civil nuclear supply chain. The F4N programme provides a vehicle for the initial assessment and selection of prospective SMEs for incorporation into both the Rolls-Royce supplier identification programme and future phases of the Sharing in Growth initiative. To date over 300 companies have completed the online F4N assessment, with most receiving ongoing support and development. The UK SMR proposal would provide a vehicle to extend programmes such as F4N to sustain and enhance the UK nuclear supply chain.

SHARING IN GROWTH

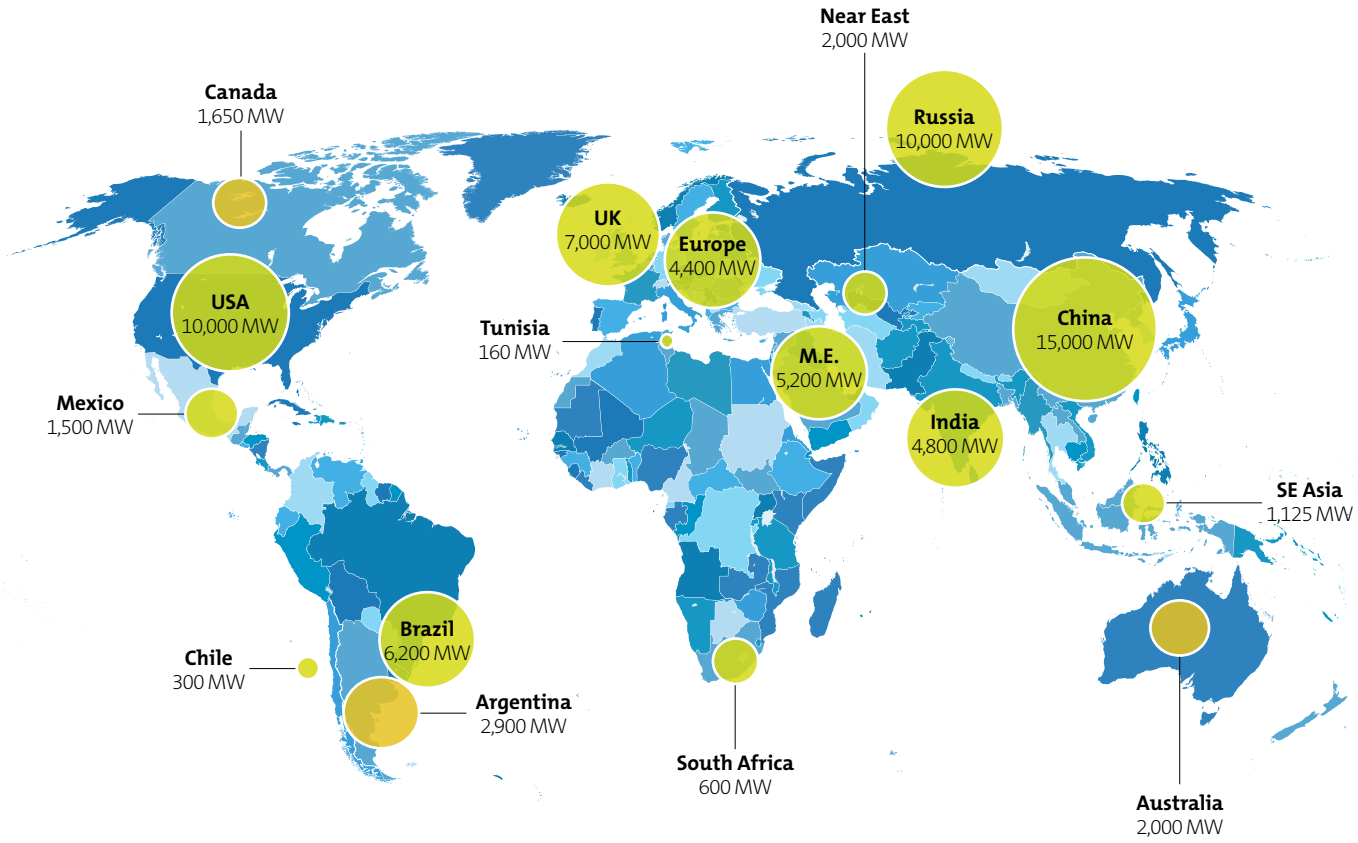
Sharing in Growth

Rolls-Royce, as the lead member for the UK Nuclear Advanced Manufacturing Research Centre (Nuclear AMRC), is the key capability and resource provider to the UK Government's Sharing in Growth (SiG) initiative, which helps SMEs in the UK nuclear supply chain increase their competiveness and compete on the global stage.

Massive global export potential for UK SMR

The potential for a UK SMR programme goes far beyond the direct benefits in terms of jobs, energy security, reduced greenhouse gas emissions and the safeguarding of skills and intellectual property. According to a feasibility study conducted by the National Nuclear Laboratory, there is a very significant global market need for energy that cannot, in all circumstances, be met by large scale nuclear reactors and so presents a real opportunity for SMRs.

The size of the potential global SMR market, is approximately 65-85GW by 2035, valued at £250-£400bn.



UK SMR needs support for right market conditions

SMRs represent a major opportunity for the UK to regain its position at the forefront of nuclear technology, but action must be taken now if the full opportunity presented by the deployment of SMRs as part of the UK's low carbon transition is to be grasped.

A number of market conditions are required:

- Selection of one preferred technology
- A UK industrial policy that supports UK intellectual property, advanced manufacturing and long term high value jobs in the UK
- Match funding until the end of the Critical Design Review
- A Generic Design Assessment (GDA) slot to ensure the process of licensing
- A suitable site to develop a First of a Kind (FOAK) power station
- A policy supporting a UK electricity market of at least 7 GWe for SMRs
- Export support to reach international markets

Rolls-Royce is committed to UK SMR programme

Rolls-Royce is committed to investing and taking the lead in a UK SMR consortium and stands ready to:

- Be the lead UK reactor technology development partner within a consortium to maximise UK commercial opportunities throughout the lifecycle of a UK SMR, delivering substantial growth to UK PLC
- Form a consortium that would comprise partners covering all primary design areas of the plant, and utilising the entire UK civil nuclear supply chain
- Invest in Intellectual Property with the aim of revitalising the UK's capability and capacity to deploy nuclear power and retain a fuel cycle capability within the UK
- Work in collaboration with academia and research & development centres to ensure that the benefits of UK SMRs are widespread and used as a foundation to support and create synergies with future Gen IV reactors and military programmes

Trusted to deliver excellence