UK SMR

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The UK SMR philosophy and approach provides differentiation in delivering a product fit for the future energy market

- Climate Change – An increasing number of governments are committing to Net Zero or similar targets
- Energy demand continues to rise and decarbonisation must address all energy vectors of Power, Heat and Transport
- There are many solutions to decarbonisation but most need more electricity (at a huge scale)
- Nuclear has to play a significant role alongside other forms of low carbon generation such as renewables – BUT not at any cost
- SMRs can provide an affordable solution by reducing / removing risk, and significantly reducing the capital and construction time against large nuclear plants
- The UK SMR consortium has adopted a market requirements driven approach, where technology innovation is introduced for benefit not for technology sake
- It is a whole power station approach, not just a nuclear reactor, adopting the principles of a modular design, standardisation and commoditisation to derive specific manufacturing and construction benefit
- As a result we have assembled a consortium of companies bringing design, manufacture, construction and operational expertise across all aspects of the power station.
- We have focused innovations in removing risk, enabling site to site continuity of design which in turn bring commonality and certainty for a fleet build approach

SMRs have been around for a while, so why now?

Large reactors have remained central to baseload duties (in certain markets) but the size, complexity, and risk profile of these large plants is causing construction to become increasingly unaffordable to some governments and private utilities.

SMRs have been around for a while in various forms. Some are based on novel reactor technologies such as sodium or lead, others on conventional light water reactor technology. The latter is the base technology that forms the majority of the world's fleet today and can utilise existing fuel and waste route infrastructure around the world.

The UK designed an SMR in the late 1980's early 1990's. This technology was one of the first so-called 'Integral Reactors'. It comprises a single vessel housing all of the primary plant.

This type of technology does not lend itself to a commercial market of electricity generation as it is not physically small, it does not allow modularisation of manufacturing (the whole vessel is a single unit), and is only the reactor part of the overall power station.

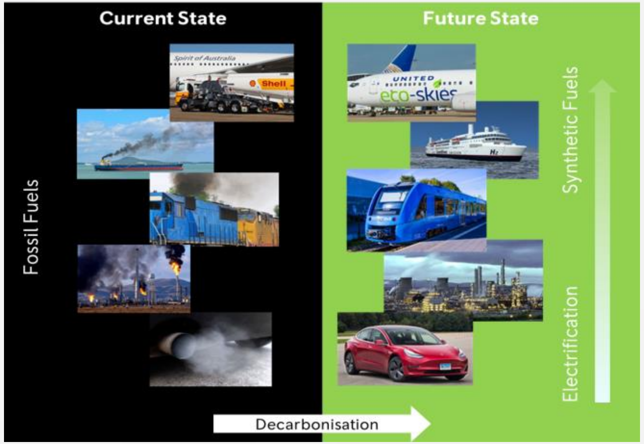
A modern SMR design must address the requirements at power station level, recognising that the reactor part is only ~25% of the total capital cost with other parts of the power station playing a large role in the economic efficiency of the power plant.

It must also adopt an approach that encompasses improvements in modern design and manufacturing methodologies across the whole power station that can reduce manufacturing and operational costs. Modularisation in our plant design is about manufacturability, constructability and economic efficiency, and not about building very large, one-off, hugely complex structures.

UK SMR - a repeatable product mindset; not one-off large infrastructure

![Rolls-Royce logo]

Our business plan reflects the growing demand for electricity driven by decarbonisation



UK Aviation fuel market would require 76 SMRs to replace fossil fuels with a synthetic equivalent

Hydrogen can serve multiple markets of electricity balancing, heat and transport and can be run through either a fuel cell, or combusted in gas turbines or domestic boilers. For extremely high energy intensive missions such as aerospace, synthetic fuels can replicate fossil equivalents and utilise existing infrastructure. Furthermore, synthetic fuels can be blended with their fossil equivalents with each incremental blend providing an emissions benefit.

All these methods require more clean electricity generation, therefore all forms of renewables and nuclear must play a part. Our SMR offers a compelling cost competitive option that can scale for multiple applications but can also operate in the vicinity of hydrogen or synthetic fuel plants avoiding the need for further expensive electricity grid infrastructure.

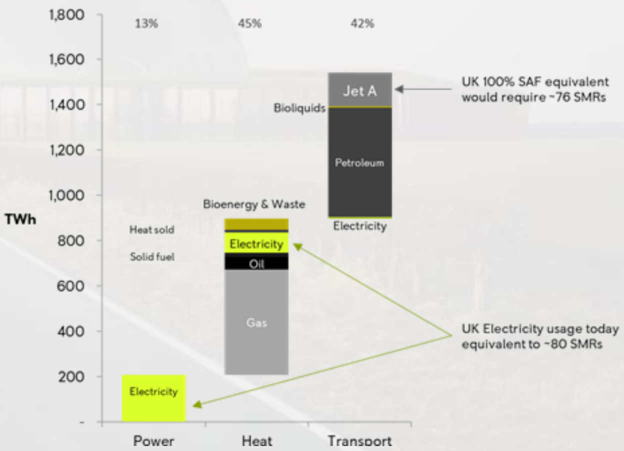
Recently, there has been a realisation that the long term objective of the energy system reaching carbon-neutrality by 2050 will not be possible if we continue to burn significant quantities of fossil-derived fuels.

Heat and Transport remain the greatest challenges in the pursuit of carbon neutrality, both technically and in scale of the demand.

There are many technologies available or under development that can improve the emissions performance across various energy vectors.

Pure electrification of light vehicles and some heat applications is already happening and will grow, but battery technology is not suitable for all forms of energy use today, particularly higher power or energy intense missions / applications.

Example: UK final energy usage by sector and fuel source



Source: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/695626/Press_Notice_March_2018.pdf

SMR can be used in a variety of critical applications to decarbonise the energy system

Hydrogen & Synth Fuel

One SMR and plant can produce 170 tonnes of H2 or 280 tonnes of net-zero synth fuel per day.
Global market by 2040 is >500 million tonnes synth fuel per year.

District Heating / Cooling

One SMR and associated infrastructure can heat or cool a city the size of Sheffield.

Annual global requirement over 10,000 TWh by 2040.

Desalination

One SMR and associated desalination plant can produce 500 million cubic metres of potable water per year.
Global demand for potable water to rise beyond 1 trillion cubic metres per year by 2040.

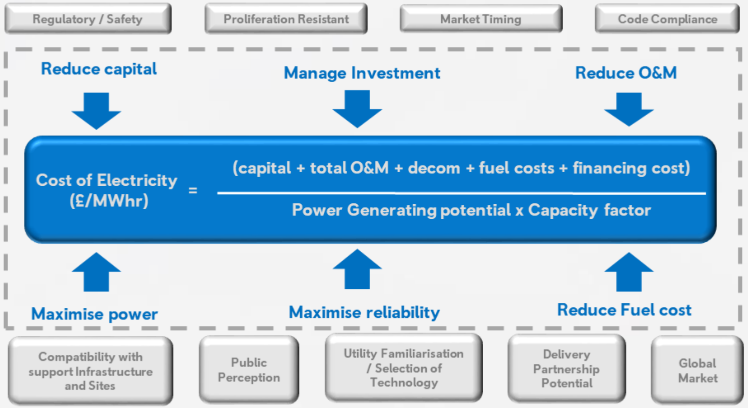
SMR

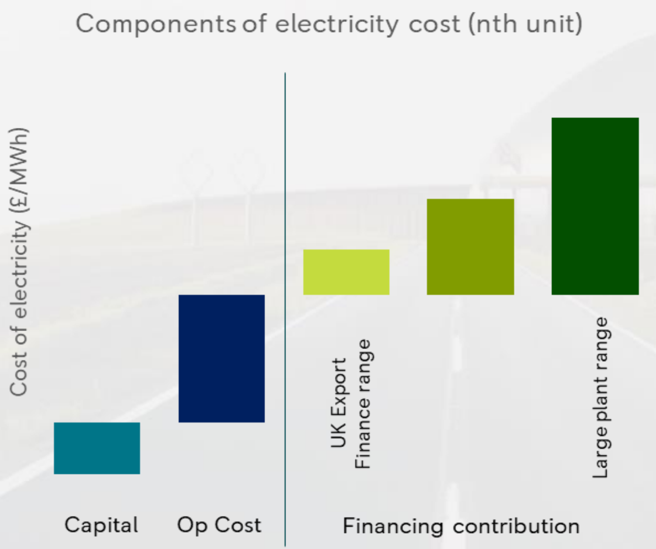
440MWe (1350MWth)
£1.8 Bn Capex
£40 / MWh
60 Year Life

Grid Electricity

One SMR can power a city the size of Leeds.
Global grid capacity demand set to exceed 79 GWe by 2040

A requirements based approach to whole power plant design





Our plant is smaller in physical size and power output to a large reactor (440MWe vs 1200-1600MWe) with a single power plant capable of providing the equivalent of ~0.5% of the UK installed capacity today.

Our consortium comprises all the capabilities required to carry out the full power station design NOT just the nuclear reactor. A requirements based approach begins with the drivers for electricity economics and includes all additional end user / customer, financier, and external stakeholder group requirements.

It is designed for all aspects of the lifecycle recognising that each phase plays a differing role in the economic efficiency of the product. From licensing through to decommissioning, our plant design encompasses innovations that will reduce / remove risk, decrease time to manufacture and build, reduce significantly the overall amounts of capital, and improve the efficiency of operation through both a reduction in costs but also maintenance periods.

The Levelised Cost of Electricity (LCOE) is driven primarily by operational cost and the financing mechanism. The latter being a function of the capital value, the risk (or perceived risk) and the time to build the plant. We have avoided introducing technology for technology sake, instead focusing on innovation for real benefit across all of these areas.

For export markets, UK export finance can support large parts of the capital financing at a rate favourable to delivering low electricity prices. We are continuing to work with the UK government to ensure we maximise the benefits of our SMR plant through new financing schemes to enable first unit build.

Plant design and layout - overview

Subject to ongoing design development and optimisation

440 MW electric output

Site area – 10 acres (40,000m^2)

Excavation – 83m diameter, 20.5m depth

500 day target build (module assembly)

Modular steel containment

Road transportable modules

3 loop standard Pressurised Water Reactor

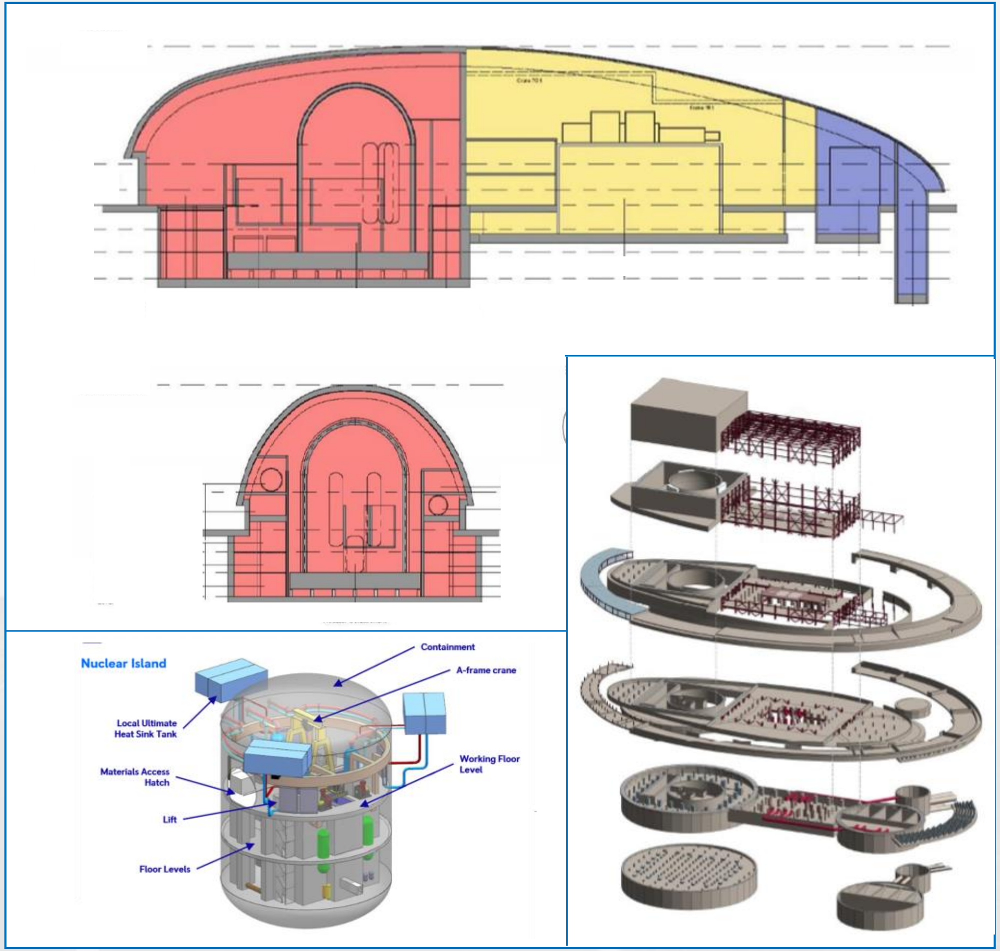
Standard civil fuel

Commercial available turbine system

Optimised civils construction and site layout

Modular design also for ease of decommissioning

Compliant with all the latest regulatory requirements



Innovations for benefit not for technology sake

Macro ‘innovation for benefit’ at the architecture level is supported by further system and component innovations

Small site footprint

Our power plant has been intentionally designed to occupy only a small site footprint. Its shape, whilst providing aesthetic benefit to the landscape, also serves multiple functional purposes in providing compliance to all latest regulatory requirements. The oval shape provides both tsunami protection and land based security defence. The raised berms around the edges provide further security whilst also housing all ancillary buildings underneath the earth. The re-use of all excavated material on site saves both capital expense and time during the site construction period. The dome itself contains the whole power plant including the nuclear island, turbine island, balance of plant systems and associated cooling systems.

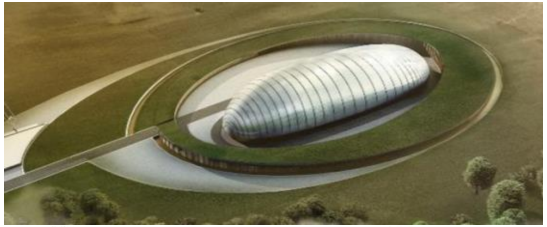
Aseismic bearing enables a product approach

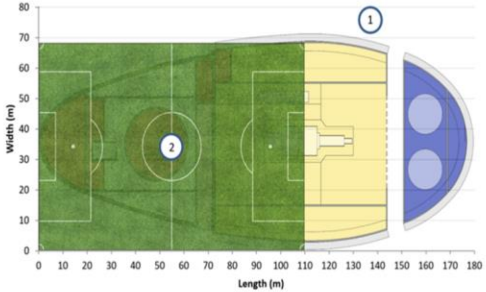
The aseismic bearing is a base plate for the plant that is tuned to the specific site conditions to ensure that all of the plant and machinery mounted on the aseismic base plate are insulated from the seismic conditions of the site. This is critically important from a fleet standardisation perspective and enables the benefits of production line factory manufacturing.

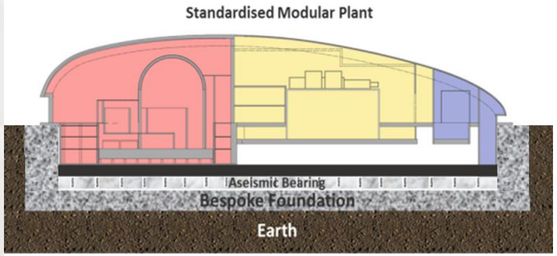
Depending on the particular site, and therefore the complexity of the aseismic bearing, the cost of the ground works and base plate will be 5-10% of the total capital. This is the only bespoke part of the build whereas the remaining 90%+ is standard factory product. Therefore, commercial separation of these two aspects of the plant build may yield further benefit in availability and cost of financing.

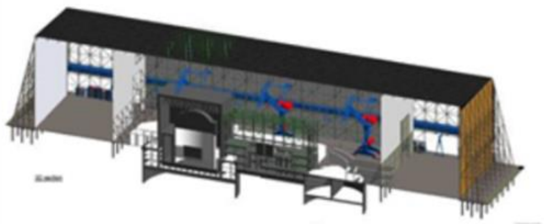
Site canopy to improve efficiency / remove weather impact

The small site footprint also allows the site to be covered and protected for the duration of the on-site build and module assembly. The risk of inactivity on site due to the weather can remove ~40% of available working hours p.a. in certain geographies. Our site canopy removes this risk and enables 24-7 working if required introducing contingency to the baseline build schedule (4 years).









Modularisation is about reducing construction time, cost, and risk and must be applied across the entire power station

It is not about designing very large, one-off structures

90%+ of the parts are standard and factory fabricated

Our approach to modularisation is driven by cost, risk, and time reductions, and is plant wide, not just related to certain aspects of the plant (e.g. Nuclear island). As a result, there are three major module facilities associated with our design: Civil modules; Nuclear Island major vessels; and Balance of Plant Systems / Mechanical and Electrical modules, resulting in 90%+ of the parts being standardised and factory fabricated. This reduces site build hours dramatically.

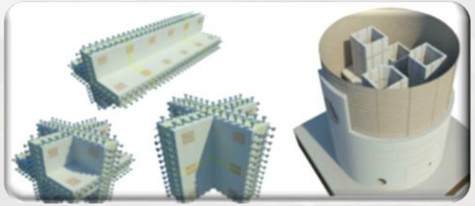
Modules are specifically designed to be road transportable and avoid the need for high and heavy manufacturing factories where costs increase exponentially with the size and weight of the largest module.

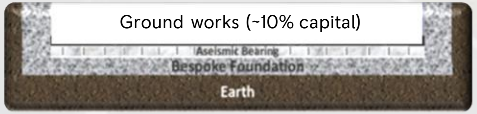
Each module facility uses a common and standard set of processes, tools, and methods to enable a production line environment and maximise the impact of learner effect. In short, our modules are designed for their manufacturing environment and vice versa.

Nuclear Island (~25% capital)

BOP & systems (~30% capital)

Civil (~35% capital)





Nuclear Island major vessels are designed to utilise common materials, machining and weld methodologies where possible to reduce one-off activities. Vessels must be road transportable and minimise on site weld demands. Our innovations to reduce production process critical path processes will significantly improve efficiency.

Mechanical and Electrical modules are all designed around a common geometric frame. This allows standardisation of module interfaces and automation of on site joining. Each module is designed around a function, containing commercially available parts (qualified to relevant standards) selected from a fixed component library to avoid one-off sub-components.

Civil modules are constructed offsite in a factory controlled environment. All civil structures can be built from a common set of civil modules. Joining together of modules at site uses proven technology. Accuracy of finished concrete pour is greatly improved within the factory and site assembly time is significantly reduced.

Minimise non-repeatable product - The ground works and aseismic bearing are the only part of the plant that are site specific. All other parts are standard, irrespective of site seismic conditions or location.

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