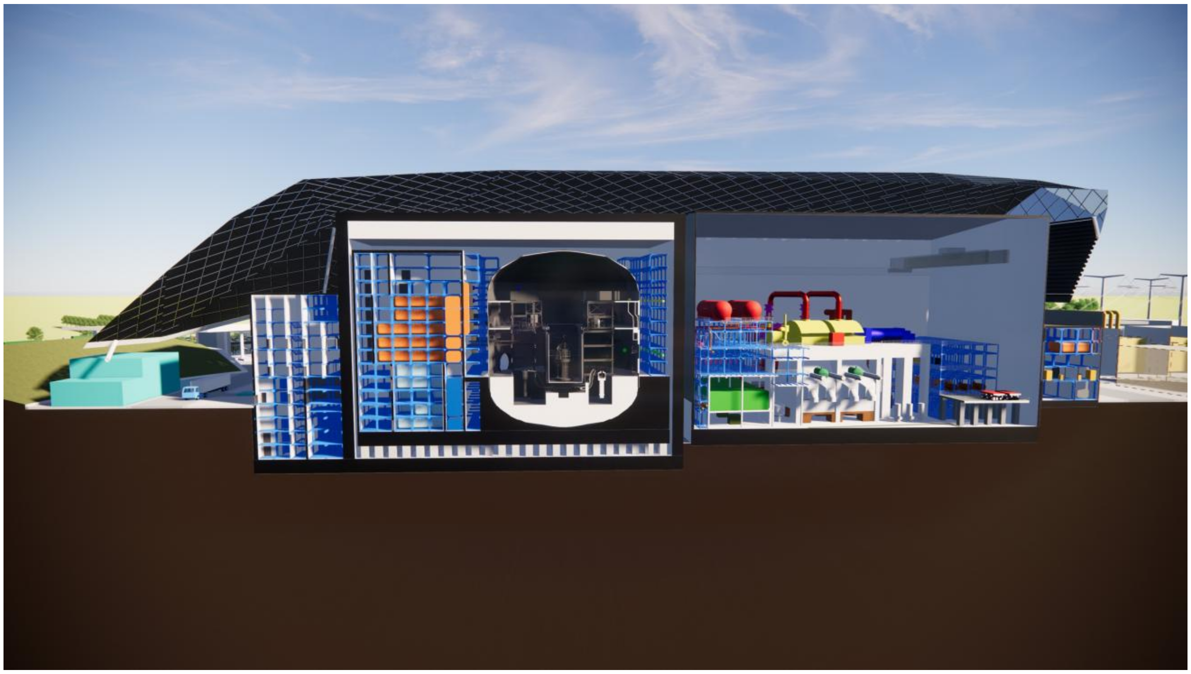
gda.rolls-royce-smr.com

Our technology

12–16 minutes

The Rolls-Royce SMR draws upon standard Pressurised Water Reactor (PWR) technology that has been used in hundreds of reactors around the world.

The Rolls-Royce SMR power station will have the capacity to generate up to 470MWe of low carbon energy, equivalent to more than 150 onshore wind turbines and enough to power a million homes for 60 years.



The marketplace

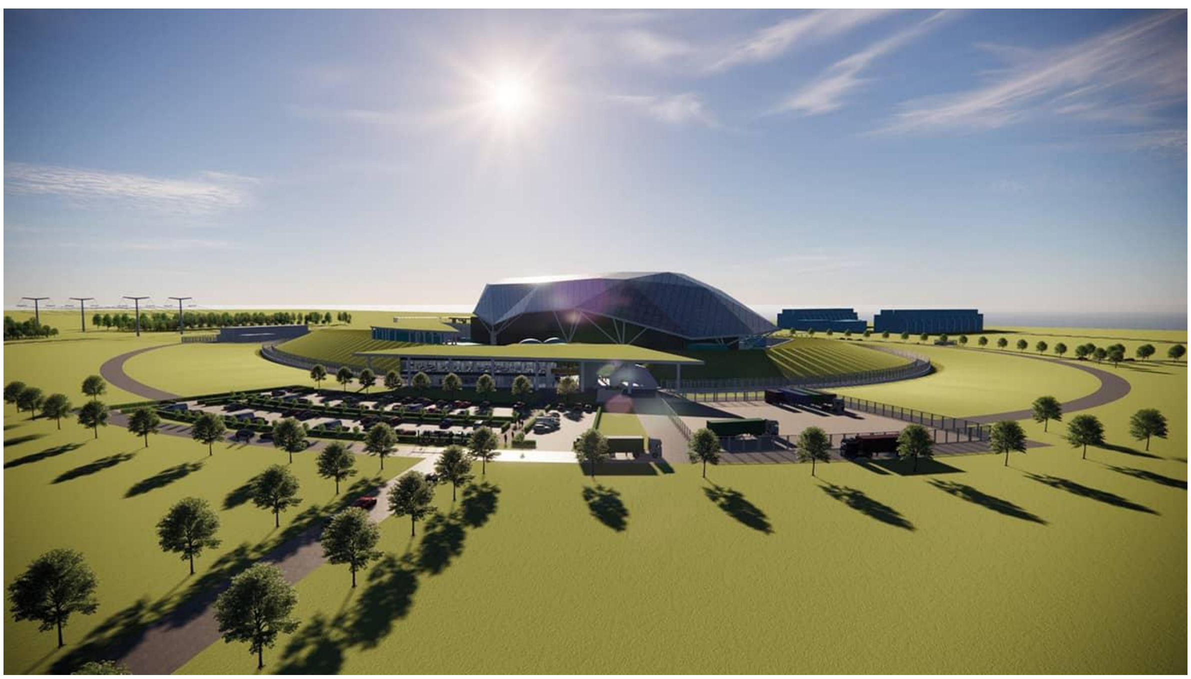
The Rolls-Royce SMR is designed for success in the global marketplace:

Low cost: A highly competitive source of ‘always on’ clean energy

Deliverable: Reducing risk and providing certainty with a factory-built product

Investable: Designed to attract traditional forms of capital through a low-risk solution

Global and scalable: Meeting unprecedented demand for clean energy

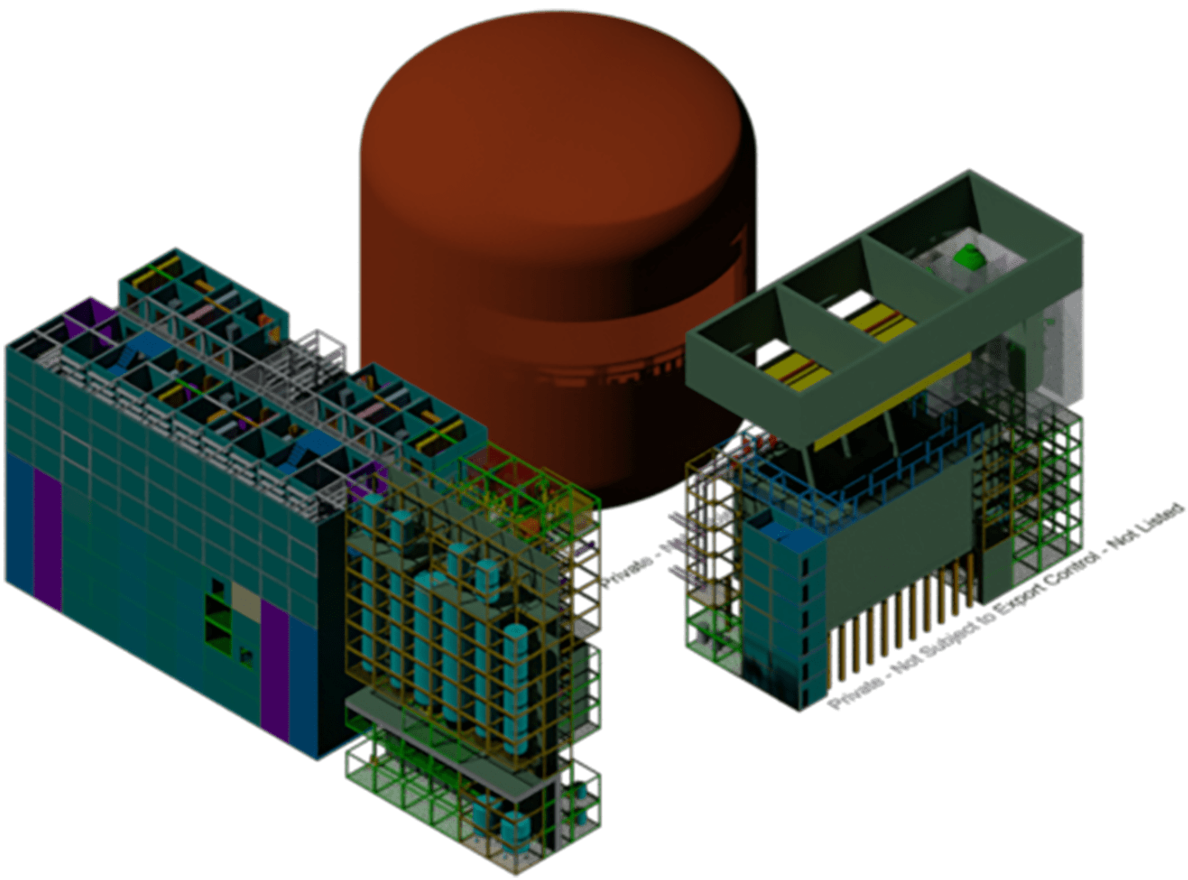


Modularisation

The whole power station is constructed using around 1,500 standard transportable modules manufactured and tested in off-site factories to minimise activity on site.

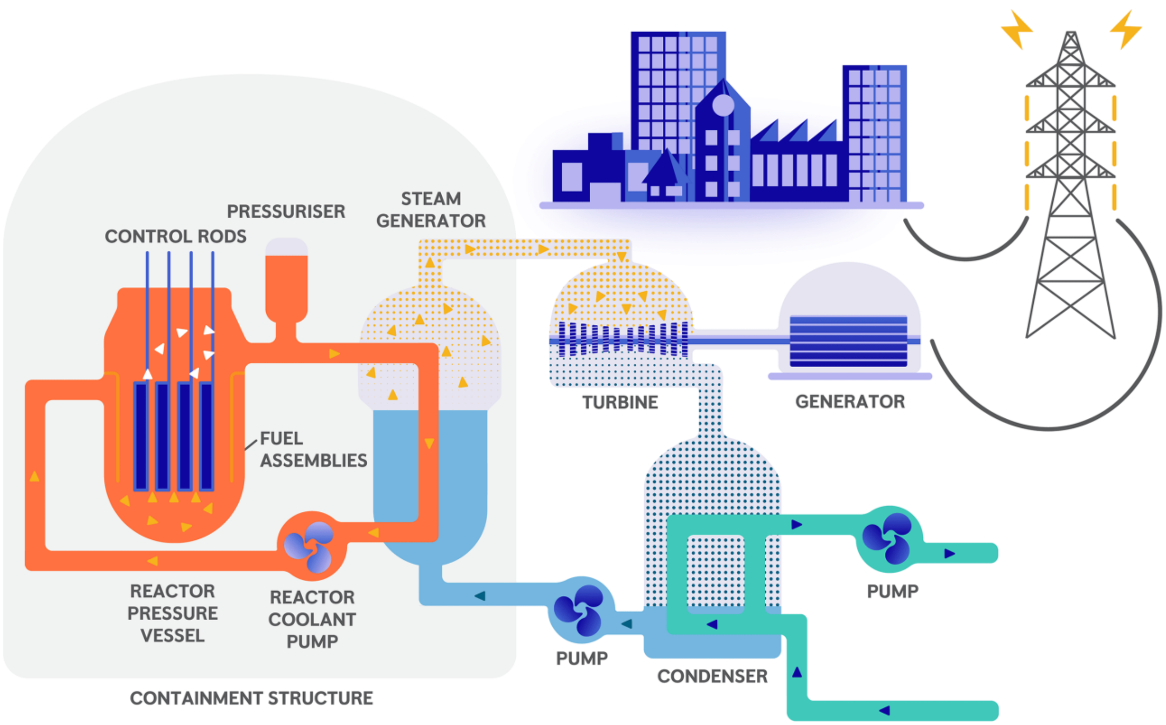
The modules will fall within three categories or 'types':
Heavy pressure vessels, mechanical electrical and plumbing and civil engineering:

The modules will be assembled on location within a compact site footprint. Each SMR unit will fit within a site 'canopy' measuring 21,500m² or 5.3 acres.



How a Rolls-Royce SMR works

Our technology is a Pressurised Water Reactor (PWR) and at the heart of our power station is its fuel. The Rolls-Royce SMR uses industry standard fuel which has a proven track record. The fuel itself is uranium dioxide powder. Uranium is a naturally abundant element and, for a Rolls-Royce SMR, is enriched to no greater than 4.95 % Uranium-235. You can find out more about uranium and its isotopes here:



The uranium is in the form of a black powder which is pressed and inserted into a pellet. The pellets are loaded into tubes with the ends welded shut to form a rod. These rods are placed into lattice arrays with spacer grids and top and bottom end plates to form a fuel assembly. You will be able to read more about our fuel in the relevant chapter of our Environment Safety Security and Safeguards (E3S) Case.

The fuel assemblies are loaded into a Reactor Pressure Vessel – a forged steel structure with very thick walls to withstand the pressure that will be created inside. Power in the reactor is controlled routinely using control rods and other methods described in the Fuel and Core Chapter of our E3S Case. Unlike other PWRs, the Rolls-Royce SMR does not use boron for routine reactivity control, simplifying operations and reducing waste.

Control rods are withdrawn to start the nuclear fission chain reaction. As a result of fission in the fuel, heat is produced which is used to heat the surrounding water in the reactor pressure vessel. This raises the temperature in the reactor coolant circuit (also known as the primary circuit) to around 300°C.

To stop the water boiling, the pressure in the primary circuit is maintained using a pressuriser which keeps the pressure at around 15.5 MPa – that's around 155 times atmospheric pressure. The pressuriser works by allowing a little water to boil inside creating a steam bubble which exerts pressure on the rest of the water in the primary circuit much like a piston would. The water is circulated around the reactor core and into one of three loops using reactor coolant pumps. These pumps pump the hot water from the reactor into one of three steam generators.

Each steam generator contains thousands of inverted U-tubes, through which the hot water passes. On the other side of these tubes is cooler water from the secondary or steam circuit which is at a lower pressure. The hot water from the primary circuit gives up its heat through the steam generator tubes to the colder water on the secondary circuit and is passed back to the reactor for reheating.

On the secondary circuit side of the steam generator tubes, water at a lower pressure (typically around 6 – 7 MPa) is allowed to boil. This boiling water turns to steam and passes through special drying equipment to remove any moisture droplets. Steam from the three steam generators is combined and sent to the main turbine where the steam pushes against the blades. Like any conventional power station, the steam passes across the steam turbine blades from an area of high pressure to an area below the turbine of very low pressure, known as the condenser.

As the steam passes the turbine blades, it causes the turbine to spin on its bearings. Spinning at up to 3000 revolutions per minute (in the UK), the turbines are connected via a shaft to an electrical generator. The generator contains a large electro-magnet which is spun by the turbines inside a coil of copper wire. The turning of the magnet inside the copper wire generates an electrical current in the copper which is drawn off and fed into the electrical grid to provide clean, abundant energy for the electricity grid and industry.

The steam, once it has finished doing its work in the steam turbine, expands in volume by about 30,000 times. It is turned back to water in the condenser by passing it over thousands of small tubes fed with cooling water. When the steam hits these tubes it condenses back to water and is pumped back into the secondary circuit and onward to the steam generators for reuse. On its way, the water is preheated to ensure the plant is operating most efficiently.

Cooling water is supplied to the condenser from a third, separate circuit. Here, cool water is supplied from a basin and pumped through the tubes in the condenser where it picks up heat from the steam in the condenser. The warm water is pumped to the cooling towers where it is allowed to fall over packing material with air passed upwards through it using large fans to cool the water before returning to the basin for reuse. There is some evaporation of this water, which may, on some days show as a plume of clean water vapour.

E3S case

Rolls-Royce SMR is pursuing a new approach in the UK and presenting a holistic approach to licensing of the plant itself. Rolls-Royce SMR has developed an integrated E3S (Environment, Safety, Security and Safeguards) Case. The case is formed from a traditional Pre-Construction Safety Report (PCSR which is broadly analogous to a Safety Analysis Report in some jurisdictions), Environment Report, Security Report and a Safeguards Report (which is technically part of Rolls-Royce SMR's PCSR). We have aligned the E3S Case with international standards such as IAEA SSG61 and NUREG-0800 to increase our licensing flexibility when exporting Rolls-Royce SMRs outside of the UK. We will transition our E3S Case to a digital platform which enables us to be flexible and agile with our licensing approach. Our generic E3S Case is produced in revisions, reflecting the design of the Rolls-Royce SMR and is presented to our regulators for assessment throughout the UK GDA. The E3S Case adopts a Claims, Arguments and Evidence approach, to demonstrate that the plant is safe to people and the environment.

Our generic E3S Case is produced by our expert team and presented to the regulators for assessment as part of the UK GDA process. Once this has been presented and discussed with the regulators, we will publish our E3S case on this website, which you can find by clicking here. Prior to publishing on the website, we will remove any material that is subject to security or export controls or which is commercially proprietary in nature. Rolls-Royce SMR aims to be as transparent and open as possible in all our dealings and with the publication of our E3S Case.

Following GDA, the generic E3S Case will be developed as required to form the site specific PCSR and Environmental Permits required for our customers to build and operate the power station. For overseas customers, the generic E3S Case is very easily modified for different jurisdictions enabling a speedy deployment of Rolls-Royce SMR power stations elsewhere.

The E3S Case provides the key information to demonstrate the safety and security of the plant, both to people and the environment, and is designed to connect seamlessly with the Limits and Conditions of Operation of the Rolls-Royce SMR which will be further described in an E3S integrated suite of Technical Specifications, which themselves lead onto the operating procedures for our future customers. Using our agile and digital E3S Case in this way we can ensure that not only are Rolls-Royce SMR power stations designed with safety, security and environmental protection in mind, they can be easily operated by customers to such high standards of protection too.

Waste management

Unlike power stations that burn fossil fuels, such as coal and natural gas, nuclear power stations do not release harmful emissions into the atmosphere when they produce energy.

As with all industrial processes, there are some authorised discharges to the environment. These will be kept as low as possible, closely monitored and reported by our independent regulators to ensure they fall within extremely stringent guidelines.

Like any process, the operation of a nuclear power station does create a small amount of waste, which is currently safely stored and managed at the nuclear licensed site. The UK has a world leading record in safely handling and storing the waste that is generated whilst providing sustainable, zero-carbon power.

The cost of decommissioning and waste management is built into the cost of an SMR through a scheme called the 'funded decommissioning programme' to ensure the taxpayer won't face the bill for decommissioning and clean-up.

The Rolls-Royce SMR is being designed with waste minimisation in mind so during its construction, operation and decommissioning, we will generate as little conventional and radioactive waste as possible.

Detailed information about the management of spent nuclear fuel and radioactive waste will be published in the Documents section of this website. How we manage radioactive waste is one of the most common questions we face:

How much radioactive waste does an SMR create over its lifetime?

Over its 60-year lifetime, an SMR generates around **285m³** of spent nuclear fuel (about the size of a tennis court). The spent fuel contains more than 99% of the radioactivity. More detail about how we will manage our waste can be found in the Integrated Waste Management Strategy.

What type of waste is it?

In addition to the spent fuel, the Rolls-Royce SMR produces gaseous, liquid and solid wastes including chemical wastes, waste oil, solvents, ion exchange resins, filters, sludges, waste metal and general waste (such as bags, packaging, tissues and gloves that might also come from a hospital X-Ray or radiotherapy department). Not all waste is radioactive however and a SMR power station will also produce waste such as cardboard, paper, glass, cans and other materials. The Rolls-Royce SMR is being designed with sustainability in mind and preventing waste production in the first place is a key goal for Rolls-Royce SMR.

How long will it be radioactive?

The nuclear fission process produces a wide range of fission products, with radioactive half-lives that range from extremely short to very long timescales. There is rapid decay over the first few hours, days and weeks following irradiation, with increasingly slower decay as time progresses. The overall activity level falls from intense levels, immediately following irradiation, to increasingly low levels with time. The overall radioactivity falls below that of natural uranium after about 10,000 years.

What will you do with it?

Deep geological disposal, in a specifically designed and engineered vault constructed kilometres underground, is internationally recognised as the best solution for the disposal of higher activity waste.

The Government is progressing well towards finding a location for the UK's geological disposal facility (GDF) and is already in discussions with several communities across the UK about the possibility of hosting the GDF in their area. Well established waste disposal routes already exist for low-level radioactive waste, which is created in a range of industries.

Find out more about the Geological Disposal Facility, a permanent solution for the UK's higher-activity radioactive waste.

Find out more about the strategy for the management of solid low level radioactive wastes arising from the nuclear industry