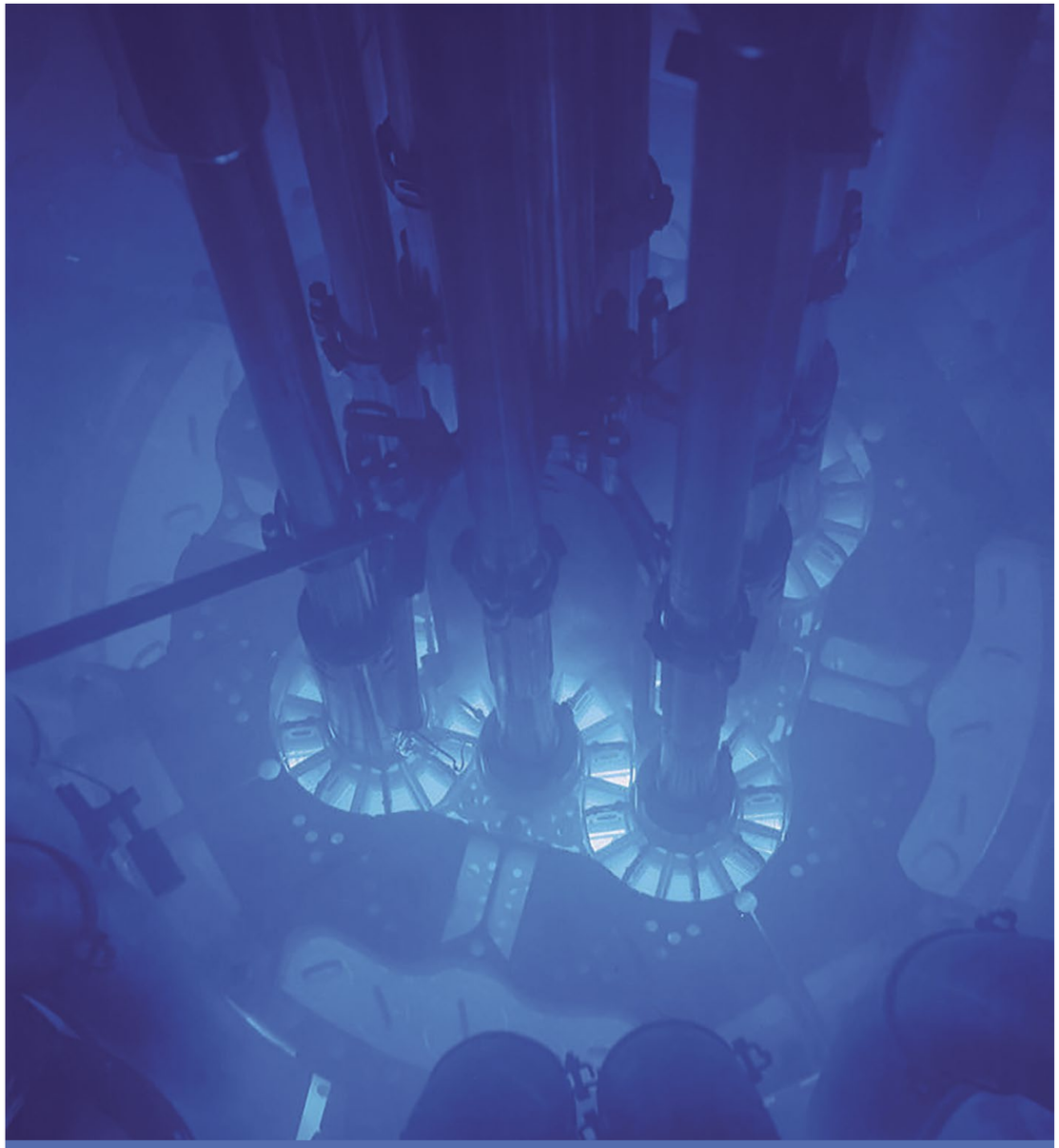
MIDLANDS ENGINE

REVIEW OF NUCLEAR & RELATED INDUSTRIES IN THE MIDLANDS

JANUARY 2023

ERA ENERGY RESEARCH ACCELERATOR



ACKNOWLEDGEMENTS

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Cover pictures – Top: GE-Hitachi BWRX-300 Small Modular Reactor (illustration).

Lower picture: Rolls-Royce SMR reactor (illustration).

Image left: Courtesy of Idaho National Lab.

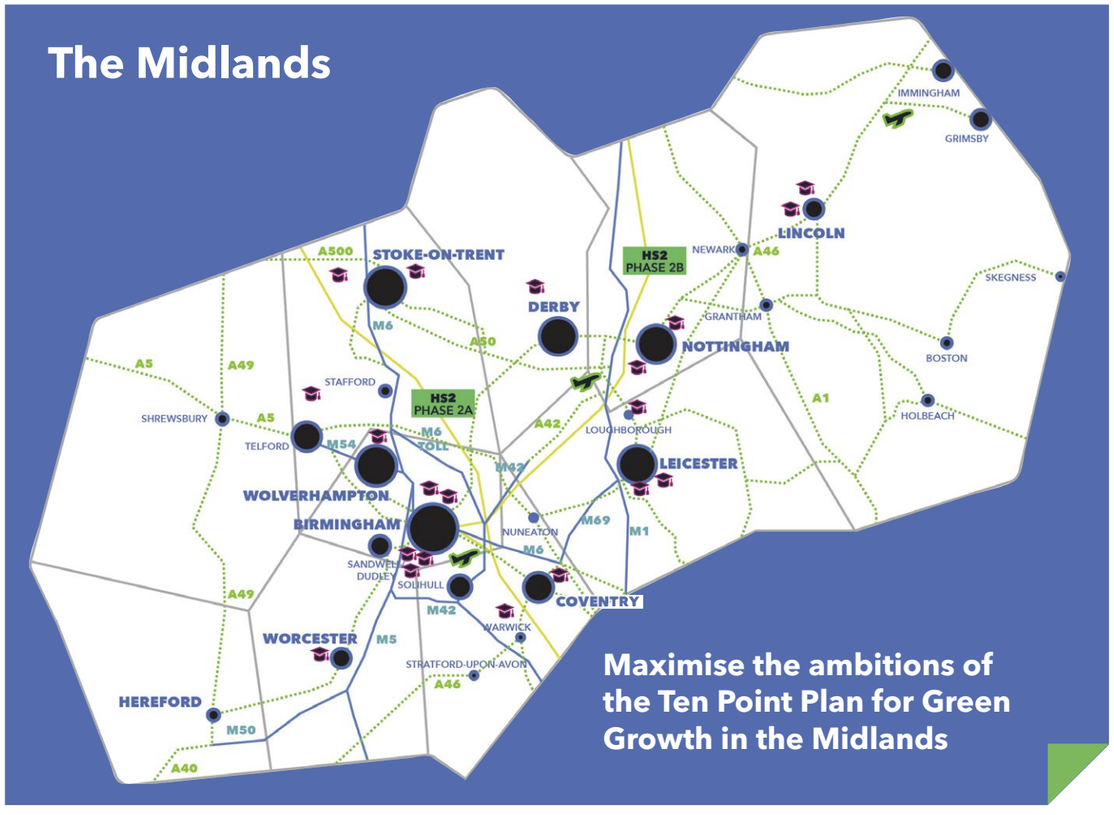
1 EXECUTIVE SUMMARY

The drive towards net zero by 2050 and the increasing need for energy security requires a massive transformation in the UK energy sector. The UK government is signalling the need for a five-fold increase in the generation of electricity by nuclear energy. Aligned with this there is a need to consider next generation nuclear technologies such as small modular reactors, advanced modular reactors and fusion. The Midlands has not historically been a site for the location for nuclear energy generation, but the development of these new technologies is likely to change this.

Within the Midlands region, there are a number of leading companies who have a significant role in the nuclear sector with Rolls-Royce being the largest. Moreover, national investment in nuclear energy is likely to generate opportunities for both small and large businesses with a need to develop supply chains and the skills to underpin the growth of these sectors in the region.

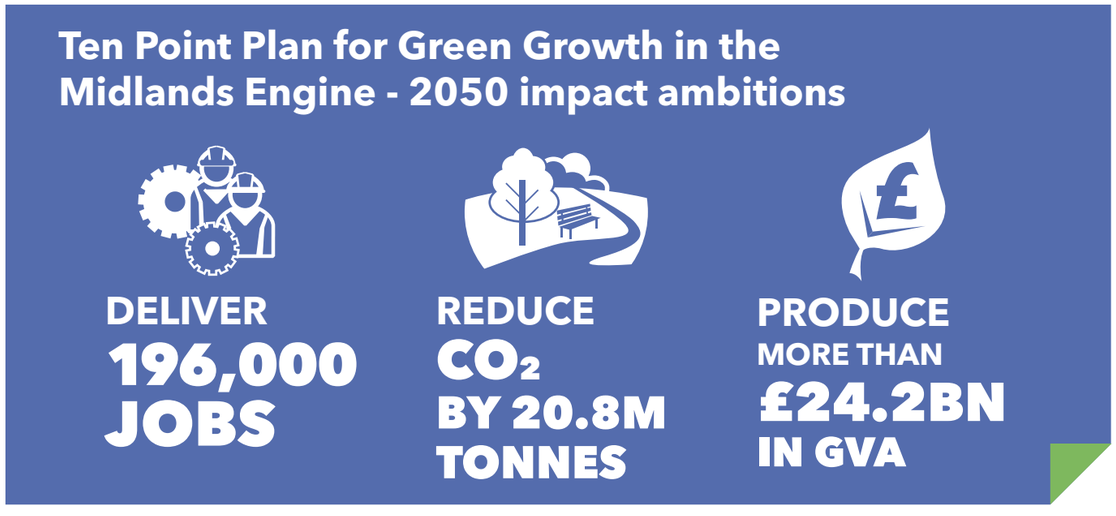
The present report builds on the Midlands Engine Ten Point Plan for Green Growth[1] launched in 2021. It reviews national developments within nuclear and related industries as well as the existing regional expertise and opportunities for growth. This report recommends seven actions which would help ensure that the Midlands Engine benefits maximally from investment and growth in nuclear and related industries over the next two decades.

[1] Midlands Engine, Ten Point Plan for Green Growth in the Midlands Engine, July 2021



The seven recommended actions are:

1.	**Support bids for nuclear manufacturing sites.** There is the potential for a number of nuclear manufacturing facilities to be sited in the region building on the Midlands' strong manufacturing base.
2.	**Support the development of new nuclear generation in the Midlands and propose potential Midlands sites.** The Midlands is unique as it has no current nuclear generation sites. Whilst the first phase of new nuclear is focused on re-purposing older nuclear sites there are opportunities for new sites to be put forward in the future.
3.	**Support the development of the fusion energy sector.** The government's announcement that the new STEP Fusion plant will be built at West Burton A in north Nottinghamshire will enable a significant Midlands-based fusion technology sector to develop and will strengthen the local supply chain.
4.	**Establish a Midlands nuclear consortium to coordinate nuclear energy activities across the region.** This would bring together the supply chain, developers, generators, researchers and skills providers interested or already operating in the region.
5.	**Support nuclear skills development to meet Midlands and national demand.** Develop a Midlands nuclear skills roadmap and encourage universities and colleges to scale up skills provision to meet planned nuclear activity, especially given the scaling up in construction and deployment involved.
6.	**Support creation of nuclear test, validation and R&D facilities.** The Midlands has potential to become a leading cluster for the nuclear and fusion sectors but requires facilities to support the development of next generation nuclear to enable this.
7.	**Support the siting assessment of the UK's long-term Geological Disposal Facility (for example at Theddlethorpe).** Work with communities through the established Community Partnership to better understand what hosting a geological disposal facility entails, providing expertise where required.



2 CONTEXT

In 2021 the Midlands Engine launched the Ten Point Plan for Green Growth. This was a major regional initiative to demonstrate the Midland's leadership in the net zero transition. The plan mirrored the Government's own Ten Point Plan for a Green Industrial Revolution.[2] It set out how the Midlands Engine partnership could collaborate to accelerate the region and UK towards net zero and become a leading location for low carbon investment.

Figure 1: The Ten Points of the Ten Point Plan for Green Growth in the Midlands Engine. Theme 6 Focus: Clean Energy

6 CLEAN ENERGY

Sustainable energy generation and storage

The way we generate and store energy is at the heart of our region's path to net zero. The Midlands has phenomenal capability in renewable energy, bio-energy and energy storage, and ambitious plans to grow this sector. We will support our region and people to move away from fossil fuels, securing the renewable, sustainable and reliable sources of power we need for future economic prosperity and unlocking major new opportunities for business and industry.

AIMS

- **Reduce greenhouse gas emissions**
- **Coordinate development of energy systems**
- **Reduce energy costs and imports**
- **Improve energy security**
- **Create high-value jobs**
- **Increase regional innovation**

Green Buildings

Net Zero Transport

Nature's Recovery

Blue-Green Places

Low Carbon Hydrogen

Clean Energy

Smart Energy

Green Innovation

Energy Workforce

Green Finance

[2] HM Government, Ten Point Plan for a Green Industrial Revolution, November 2020

Nuclear energy's current contribution to the grid is

AROUND 6.5 GW 15% of annual electricity production

UK government proposed support for nuclear

24 GW of nuclear energy generation - 25% of future electricity production

Both the Midlands Engine's and UK Government's ten point plans recognised that a key feature in the UK's energy system has been nuclear energy. For the UK, nuclear energy dates back to the 1950s with the development of the first civil nuclear power station at Calder Hall in the North West of England. Since those times, a fleet of nuclear power plants have been developed, ranging from the early Magnox designs, through to advanced gas cooled reactors (AGRs) and the pressurised water reactor (PWR) which was built at Sizewell in the 1990s. These are gradually reaching the end of their lives.

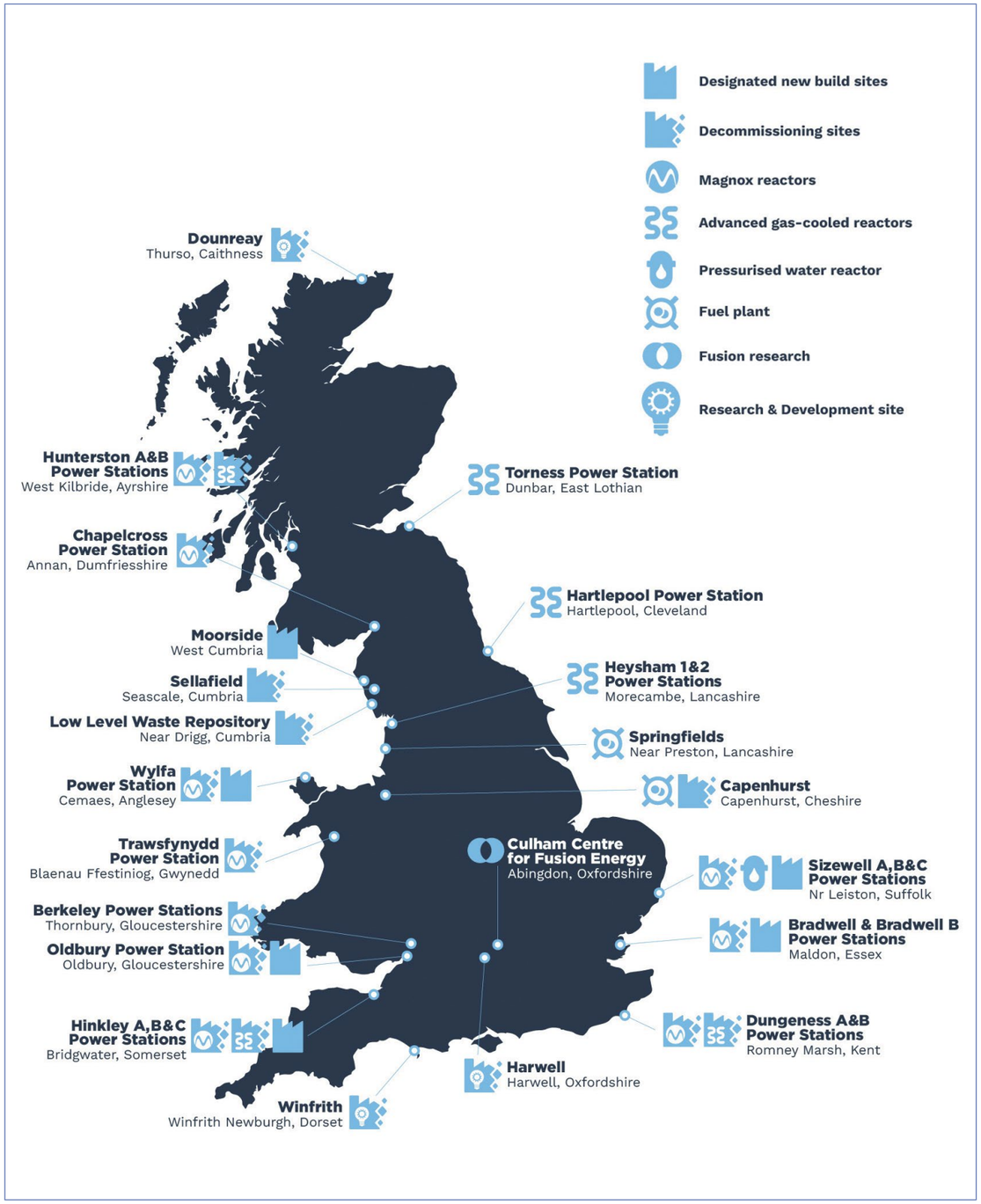
Currently nuclear energy's contribution to the grid is 6.5 GW and accounts for about 15% of annual electricity production. However, the UK government has recently signalled its intention to support a nuclear renaissance with 24 GW of nuclear energy generation planned for by 2050.[3] Historically, new nuclear generation has been located in coastal areas, recognising that traditional large-scale nuclear generation requires reliable access to cooling water usually from the sea. Much of the Midlands Engine area is inland and has therefore not been considered a suitable location for nuclear power plant development.

However, the recent diversification of the nuclear sector from large-scale reactors to advanced reactor technologies, small modular reactors (SMRs) and potentially fusion, changes the landscape and the opportunities for nuclear technology to play a role in the Midlands energy mix. The decarbonisation transition of the Midlands Engine's coal power station sites and the availability of their associated grid infrastructure provides the opportunity to consider the development of nuclear energy sources to power industrial clusters providing access to clean nuclear electricity, heat and potentially hydrogen. The Midlands also has a strong industrial heritage and features a number of companies, such as Rolls-Royce, which play a significant role in the nuclear sector. There is therefore potential to use the development of new nuclear technologies as a platform for regional economic growth.

The present review picks up a thread of the Ten Point Plan for Green Growth in the Midlands Engine, which identified the potential importance of the nuclear sector in the Midlands. It recommends a series of interventions which the Midlands Engine partnership could collaborate to develop the sector within the region. This includes the examination of potential sites, support for nuclear and related industry sectors and supply chains, and the coordination of skills to support the sector's growth in the Midlands.

[3] Department for Business, Energy & Industrial Strategy, British Energy Security Strategy, April 2022

Figure 2: Map of UK Nuclear sites (NIA 2023)[4]



[4] UK civil nuclear facilities, Nuclear Industry Association, 2023.

3 NATIONAL FUNDING AND SUPPORT FOR NUCLEAR DEVELOPMENT

There have been a flurry of government strategies and white papers in the past 18 months. These include the UK Net Zero Strategy,[5] the Ten Point Plan for a Green Industrial Revolution, an Energy White Paper[6] and the recent British Energy Security Strategy.

The April 2022 British Energy Security Strategy enhanced earlier ambitions to increase the nuclear energy component of the UK energy mix from 15% to 25% by 2050, representing 24 GW of nuclear capacity. The aim was to bring one project (Sizewell C) to Final Investment Decision (FID) in this parliamentary period (by January 2025 at the latest), and at least another two FIDs in the next parliamentary period (by 2029/30).[7]

The development of SMRs and advanced modular reactors (AMRs) were planned to be accelerated to help reach the 24 GW target. The importance of this sector is reflected in the investment government is making to support its development. In total, programmes are injecting funding of over £1billion into the sector's development, which is also attracting private sector funding:

- The Department for Business, Energy & Industrial Strategy (BEIS) has made a **£222 million commitment to the fusion-related Spherical Tokamak** for Energy Production (STEP) programme, which is in addition to the government's **investment of £184 million** for new fusion facilities.
- Through a consortium led by Rolls-Royce, the UK is investing in the development of SMRs. This has been **backed by £210 million of BEIS funding**. This is matched by **private sector funding of over £250 million**.
- AMRs are next generation reactor technologies which utilise fast rather than thermal neutrons. UK government is **investing £170 million** through the Advanced Nuclear Fund to support an AMR demonstration by the early 2030s.
- These programmes require underpinning R&D facilities and these have been funded through the National Nuclear User Facility programme, **funded £84 million from BEIS,** to create a suite of facilities. The University of Birmingham was successful in securing two of the more major components which are the High Flux Accelerator-Driven Neutron Facility and a materials in situ corrosion facility for irradiated nuclear materials.

[5] Department for Business, Energy and Industrial Strategy, Net Zero Strategy: Build Back Greener, October 2021
[6] Department for Business, Energy & Industrial Strategy, Energy White Paper: Powering Our Net Zero Future, December 2020
[7] In the 2022 Autumn Statement, UK Government pledged £700m investment in Sizewell C, becoming a 50% shareholder in the project's development with EDF Energy. Read more here.

Figure 3: Key nuclear ambitions (Source: British Energy Security Strategy, April 2022)

Nuclear ambition: Deliver Great British Nuclear with high ambition, expertise and backed to support projects

Key measures:

- **Up to 8 reactors progressed across the next series of projects**
- **Reaching up to 24 GW by 2050 (up to 25% of demand)**
- **Start scoping out Great British Nuclear development vehicle from 2022**

By end 2022	2023 ambition	2024 ambition	2030 ambition	2050 ambition
• **Great British Nuclear (GBN)** vehicle set-up • **Future Nuclear Enabling Fund** funding awarded	• Initiate the **selection process** for further nuclear projects	• **FID on one nuclear project** by the end of this parliament	• Up to **8 new reactors** progressed across the next series of projects	• **Up to 24GW** nuclear installed **(up to 25% of total GB demand)**

To support these ambitions, a £120 million Future Nuclear Enabling Fund was also launched by the government in May 2022. This was designed to unlock and accelerate new nuclear technologies while encouraging new players into the market. It provides targeted, competitively-allocated government grants to enable nuclear construction projects, including SMRs, to attract private investment. This Fund is designed to accelerate the development of new nuclear projects, from SMRs to larger scale generation projects, and bring fresh innovation into the market. It is expected to offer opportunities to initiatives in every region of the UK and create high-skilled jobs, as well as boosting the resilience and capability of UK nuclear supply chains.

Alongside these initiatives, a new organisation, Great British Nuclear, is now charged with helping nuclear projects through the development process and realising the government's ambition of generating up to 24GW of additional nuclear-sourced energy by 2050. This has now been initiated with the appointment of a new Industry Adviser to BEIS tasked with leading and helping to drive forward government proposals for nuclear.

The SMR consortium led by Rolls-Royce is targeting a delivery price of £40–£60/MWh for its power station, a similar price to offshore wind generation. SMRs could be much more affordable to build than large power stations, avoiding the huge upfront costs and decade-long development times of current reactors. An initial SMR power station would be a fraction of the cost of a gigawatt-scale new build, could be built in four or five years, and, once operational, will generate revenue to help finance additional units. In addition, the UK government is also investing £170 million through the Advanced Nuclear Fund to support an AMR demonstration by the early 2030s.

SMRs will be important for the Midlands for several reasons. Firstly, the significant industrial programme for the manufacture of the reactors will build on the core capability of Rolls-Royce, who have been producing the nuclear reactors which power the UK's fleet of submarines and who are based in the region. Second, the region has a number of old coal power station sites which, once decommissioned, become the ideal location for the development of new industrial clusters where a small nuclear power plant could generate clean electrical and thermal energy.

In fusion energy, BEIS has made a commitment to the STEP programme. The West Burton A former coal power station site in north Nottinghamshire was recently successful in being selected to host the STEP fusion power plant. This offers a major opportunity for fusion and related nuclear industries in the region.

The STEP programme aims to:

- Build on the UK's global leadership in fusion as established through the JET (Joint European Torus) project near Oxford which has been the flagship programme for fusion development globally.
- Demonstrate the commercial viability of fusion by building a prototype plant at West Burton in Nottinghamshire.
- Enable the development of a world-leading fusion industry, capable of exporting fusion expertise and technology around the world.

Nuclear Waste Services (NWS) is the national organisation working with communities to find a suitable site and a willing community to host the UK's first Geological Disposal Facility (GDF). The process of finding a site within the UK will take a number of years, but the GDF will be a multi-billion-pound infrastructure project of national importance hence will attract jobs and investment in the local community. Theddlethorpe, near Mablethorpe in Lincolnshire, is currently one of the communities that has engaged in this process.

Pictures: Top Images
(Source: University of Birmingham)

Top left – experimental graphite stack

Top right – positron emission tomography work

Bottom image – West Burton A site selected for STEP fusion programme.

4 NUCLEAR ENERGY AND THE MIDLANDS

Large-scale plant development

Despite its reputation, nuclear energy is one of the safest low carbon energy generation technologies which can be deployed as the UK seeks to decarbonise its grid.[8] The government has signalled its ambition to develop 24 GW of nuclear energy generation by 2050. However, the UK presently has a fleet of ageing AGRs constructed mainly in the 1970s. These have had their operational life extended through a series programmes overseen by the Office for Nuclear Regulation (ONR) but will all be decommissioned within the next few years. This will leave one operational plant, which is a more modern designed PWR, at Sizewell B[9] in Suffolk. At present, the Hinkley Point C European pressurised water reactor (EPR), a Franco-German design, is the only new nuclear power plant under construction in the UK. Located on the North Somerset Coast it has two reactors of 1.6GW (3.2GW total).

The PWR design is one of two main reactor types which are used worldwide at present, the other being Boiling Water Reactors (BWR). Both designs have been through major design revisions as the technologies have developed and present designs are referred to as Generation III+. These new reactors have enhanced safety features which have taken learning from operation of reactors over 70 years and a detailed understanding of what works and what does not. Operation and approval is overseen by the ONR and the Environment Agency (EA). Regulatory timescales have been improved by introducing a Generic Design Assessment (GDA) which is a once-only assessment of a technology's security, safety and environmental acceptability, allowing for shorter subsequent site specific licencing processes.

The UK has examined a number of different designs including the EPR:

- **Framatome/EDF/Siemens 1.6 GW EPR** – a Franco-German design based on the next generation of the PWR fleet operational in France. Being constructed at Hinkley Point C and potentially at Sizewell.
- **Westinghouse AP1000** – US origin design which is a 1 GW PWR reactor. Potentially would be built first at the Wylfa site in Anglesey.
- **Advanced Boiling Water Reactor (ABWR)** – a Japanese reactor from Hitachi which was to be built in Wylfa, but investment was not secured.
- **China General Nuclear (CGN) HPR1000** – a Chinese-designed PWR reactor, already built in China with 1 GW generation. This design is not currently progressing on any UK nuclear projects.

These large-scale plants will still need coastal sites for their operation and hence will not feature in the Midlands Engine's energy generation mix, but they will provide manufacturing, construction and service opportunities for Midlands industry. Each reactor costs approximately £10 billion to construct (though Hinkley Point C is now in excess of £20 billion for two reactors producing 3.2 GW) and 24 GW of generation would require 10 to 15 new large-scale reactors requiring in excess of £100 billion of investment. Even if only 50% of this were to be spent within the UK on construction and supply chains, this is a significant growth opportunity for the Midlands.

Small modular reactors

Beyond the ambitions of large-scale nuclear energy generation, there are a series of next generation nuclear opportunities developing. The most advanced of these are SMRs. Historically, these are reactors which have an output of less than 300 MW and have a long history of deployment in remote locations powering ships and submarines. The UKs fleet of submarines are powered by small PWR type reactors produced by Rolls-Royce in Derby. The modular element of the SMR is based on the principles of modular design and production line approaches of manufacturing, assembly and installation. In principle, with the modular approach and a volume market, the cost of SMR production could come down to such an extent that cost-savings in production of SMR designs outweigh the advantages large nuclear power plants have in producing more energy at scale. This approach was discussed in a Department of Energy and Climate Change commissioned report issued in 2016. This found that SMRs could achieve levelized cost parity (which considers all elements of the cost of an energy technology) with large reactors by building 10 units per annum and a total deployment of greater than 5 GW.[10] SMRs are potentially more flexible than large scale reactors, can be operated more readily in a load following mode with variable generation, can supply high grade heat for industrial applications, and can be located away from coastal sites meaning in principle they could be deployed in sites across the Midlands.

Deployment of SMRs will initially focus on existing nuclear sites, however, there are opportunities for other locations to be subsequently brought into a site selection process. The ideal utilisation of an SMR would be in an industrial cluster in which the electricity and heat is deployed into energy intensive manufacturing rather than being distributed, particularly heat, over networks. Nuclear reactors generate electricity through the fission process which heats water, generating steam which in turn drives a turbine. This process currently often results in waste heat which could be exploited for industrial processes.

Access to low carbon heat and electricity would help make a case for reshoring manufacturing back to the region and is a principle that several areas are considering, including the Black Country in the West Midlands. SMRs also provide the opportunity for large scale hydrogen production, principally via electrolysis, but other methods are possible which may be used to displace natural gas from energy intensive industry associated with decarbonisation plans.

The SMRs being developed by Rolls-Royce in the UK will be slightly larger than the traditional definition at approximately 400 MW, and will be part of a range of international SMR designs which are being advanced. The US has, for example, also put significant investment into this sector. The Rolls-Royce SMR will, if it becomes commercially successful, require a series of specialist manufacturing plants for which the national siting

[8] Our World In Data, What are the Safest and Cleanest Sources of Energy?, February 2020

[9] The Sizewell site contains two nuclear power stations: Sizewell A (decommissioned) and Sizewell B (still operational). A third power station is planned on the site at Sizewell C.

[10] Department of Energy and Climate Change, Small Modular Reactors: Can Building Nuclear Power Become More Cost-Effective?, March 2016

Large scale reactors

Each reactor costs approximately £10 billion to construct and 24 GW of generation would require 10 to 15 new large-scale reactors requiring in excess of £100 billion of investment.

Small modular reactors

SMRs are potentially more flexible than large scale reactors, can be operated more readily in a load following mode with variable generation, can supply high grade heat for industrial applications, and can be located away from coastal sites.

Generation IV reactors

Next generation alternate reactors designs, which will require low enrichment of uranium or will reuse spent fuel and burn waste products from reactors, are being developed globally.

REVIEW OF NUCLEAR AND RELATED INDUSTRIES IN THE MIDLANDS

process has already started. The opportunity for jobs and skills development is very significant, as per the example of large nuclear power plants. The first deployment of the Rolls-Royce SMR will be 2030+ and the Rolls-Royce consortium believes each plant could power up to 450,000 homes and the multi-plant SMR programme itself could support up to 40,000 jobs.[11]

In 2015 a study was performed by Atkins, on behalf of the Energy Technologies Institute (ETI), to identify potential new sites for nuclear energy generation. This took into consideration a number of constraints, such as military activity, ecological sensitivity, flooding as well as sites currently or previously having been used or in consideration for either thermal (coal) or nuclear power generation. A number of potential brownfield and greenfield sites in the Midlands were identified (see the map in Figure 3).

Figure 3: Nuclear power plant siting study - England & Wales.[12]

It is clear from this study that the Midlands does have the potential to consider hosting SMRs. As discussed above, the first phase of the SMR programme has focused on current or recently decommissioned nuclear sites. However, Midlands sites may be worth considering in a future round of SMR and other plant development activity. To be successful in attracting the development and construction of SMRs in the region, significant groundwork is required to engage with site owners, understand the development plans for sites, understand the potential for integration of an SMR and determine if the site has the right characteristics (for example water supply) to host an SMR. As with the STEP fusion siting process, Midlands Engine partners can work together and with government once locations are identified to promote potential Midlands locations.

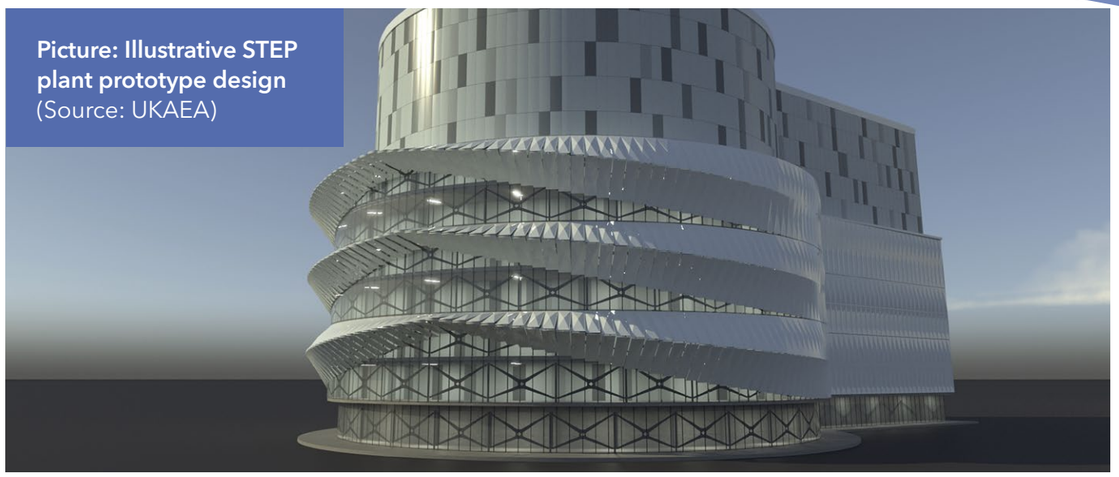
Generation IV reactors

Beyond the present generation of nuclear power plants, which are likely to operate for 60 years, if nuclear energy is to contribute to energy generation in the future, next generation (Generation IV) reactors will be required. This development is partly in recognition that uranium resources are finite and, depending on utilisation, could only last between 60-100 years. As such, alternate reactor designs which require low enrichment of uranium or which can even reuse spent fuel and burn waste products from reactors are being developed globally.

With its history of developing AGRs, the UK is engaging with a programme of high temperature gas cooled reactor development. Generation IV could also include molten salt or sodium/lead cooled fast reactors. These advanced reactor developments present opportunities for the close alignment of industry and the regional university research base as well as the development of research facilities to support this sector development. The development of a molten lead facility by Ansaldo Nuclear (Wolverhampton) is a good example. Rolls-Royce is also investigating the opportunity for the new Generation IV reactors to use heat generated in the hydrogen-creating process through the thermal splitting of water.

The UK's commitment to support the development of Generation IV reactors provides an opportunity for the Midlands to take a leading role in this sector recognising the industrial base in the region and the R&D expertise in our universities.

[11] Department for Business, Energy & Industrial Strategy, Policy Paper: Advanced Nuclear Technologies, March 2022
[12] Atkins Power Plant Siting Study - Project presentation, ETI, 2015



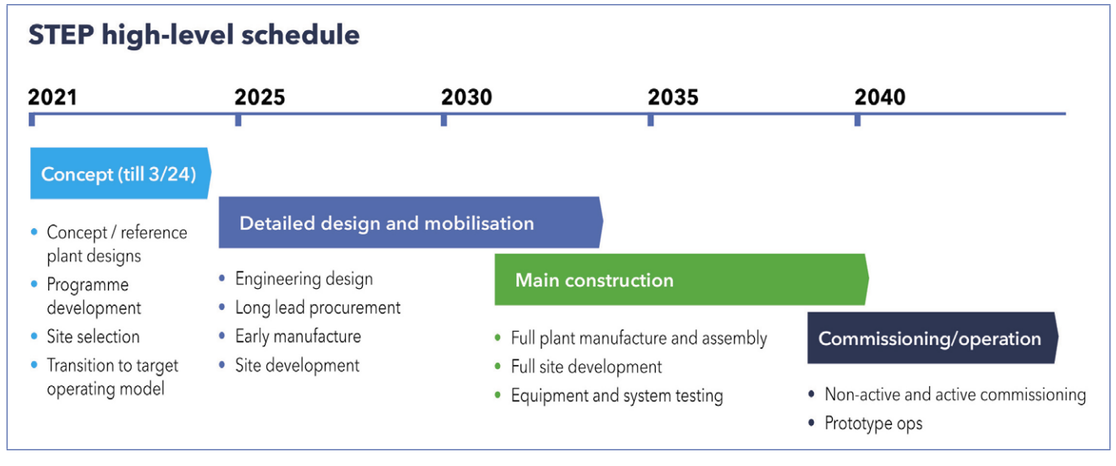
Picture: Illustrative STEP plant prototype design (Source: UKAEA)

Fusion energy

Fusion power has for generations been the dream of next generation nuclear. Rather than relying on fission, which splits heavy nuclei, fusion produces energy through the fusion of hydrogen isotopes (deuterium and tritium). This more or less mirrors the reactions that take place in the sun. The UK has historically led the development of fusion with initiatives like the JET project at Culham near Oxford, and now has an important role in the International Thermonuclear Experimental Reactor (ITER) project in France which is leading a global drive towards commercial scale fusion.

In parallel, the UK has developed a spherical tokamak power plant design called a mega ampere spherical tokamak (MAST). Funded by UK government, the STEP programme is driving the construction of a UK fusion power plant at a scale which would deliver a few hundred MW. The aim is to have it operational from around 2040. Though the power plant design itself may be reasonably well-developed, there are significant research and development needs associated with construction materials and energy production. This alone could provide a significant opportunity for researchers in the Midlands.

Figure 4: Proposed plan for development of the STEP fusion power plant (Source: UKAEA)



The UK Atomic Energy Authority (UKAEA) has now been through a national siting programme for the construction and development of the STEP power plant. In October 2022, West Burton in Nottinghamshire was announced by BEIS as the successful site. The siting of this key fusion facility in the Midlands Engine is an outstanding opportunity for growth as well as high-value jobs and skills and will almost certainly be a magnet for inward investment.

Figure 5: Holtech International SMR-160 Small Modular Reactor (illustration)

Nuclear waste management and utilisation

The previous, present and next generation of nuclear reactors produce waste which includes spent fuel taken out of the reactors plus other long-lived radioisotopes created as part of the reactor operation. This waste presents both challenges and opportunities. For example, academics at the University of Leicester have found uses for radioactive material and isotopes in medical applications. They have also found a way to capture energy from the decay process to produce energy for small, nuclear-powered batteries.

Despite these alternative uses, the majority of the waste needs to be disposed. The UK is presently going through a process to site a national Geological Disposal Facility (GDF). This will comprise a small surface receiving facility plus a disposal area constructed deep underground where the geological environment is suitable and well characterised. The aim is to have a GDF operational from 2050 onwards.

The national siting process involves interested parties coming forward to find out more about the process of finding a site to host the facility and engaging in a process with Nuclear Waste Services, who are leading the process on behalf of the UK government. One of the potential sites is Theddlethorpe on the East Midlands Coast. Such developments will attract investment from UK government into a variety of related facilities, but will also be an opportunity to cluster thematic industrial activities and hence create local jobs and skills. Indeed, NWS predicts the GDF will create more than 4,000 jobs within the first 25 years of operation and around 2,000 on-going jobs during the 175-year lifetime of the facility.[13]

[13] Nuclear Waste Services, Geological Disposal Facility: Creating Jobs & Skills, September 2022

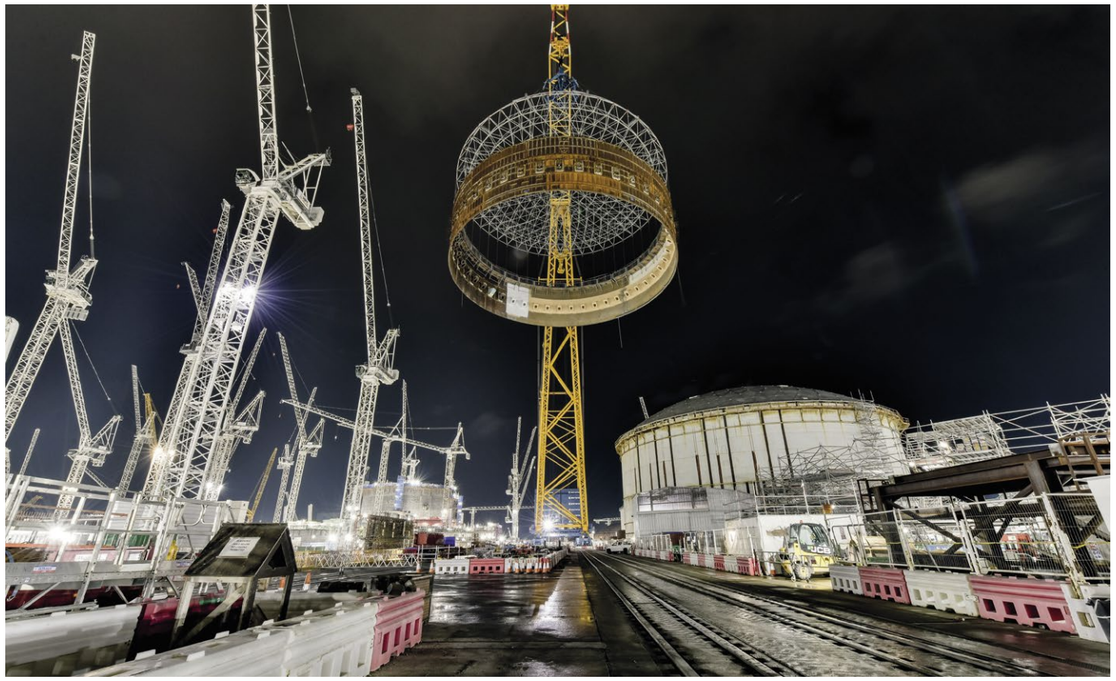


Figure 6: Hinkley Point C construction – UK's first new nuclear power station in 20 years (Source: EDF).

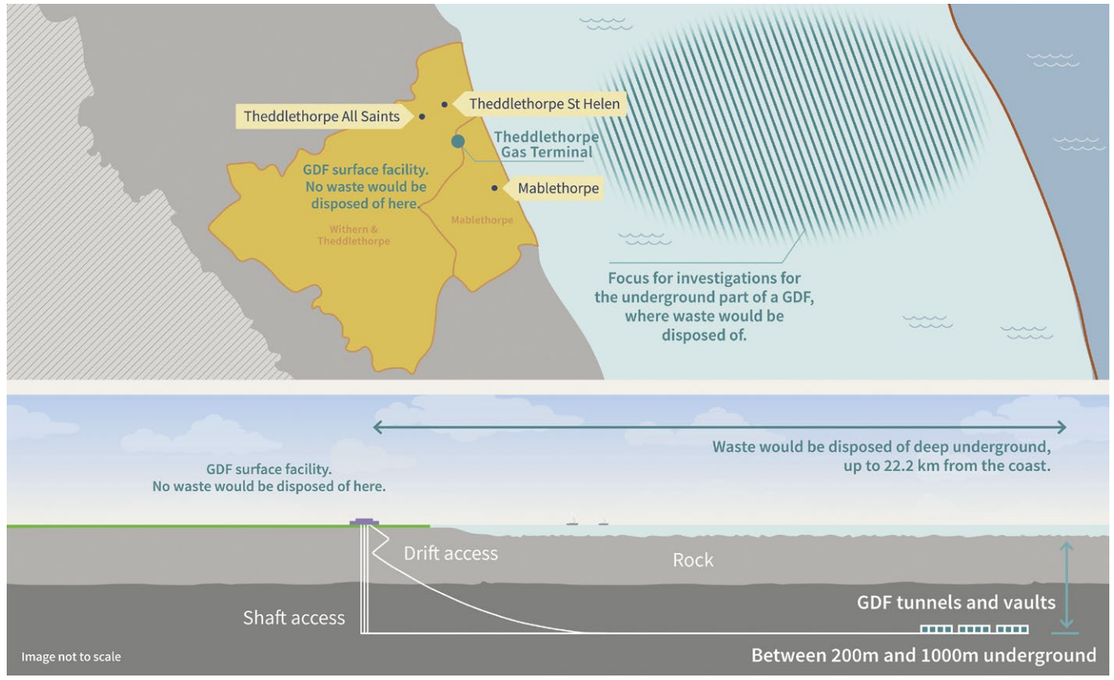


Figure 7: Identified Theddlethorpe Search Area for further consideration in search for suitable GDF site (Image courtesy of Nuclear Waste Services).

5 MIDLANDS NUCLEAR INDUSTRY AND RESEARCH BASE

A recent Midlands Net Zero Hub (formerly 'Midlands Energy Hub') report[14] provides an analysis of investment for the region's low carbon and environmental sub-sectors. The report identifies that investment in the Midlands nuclear sector grew between 2017/18 and 2019/20 from £639m to £789m for private equity, £696m to £859m for venture capital and £753m to £929m for other investment equating to a 23% increase over the two year period. This is broken down as illustrated in figure 8 below.

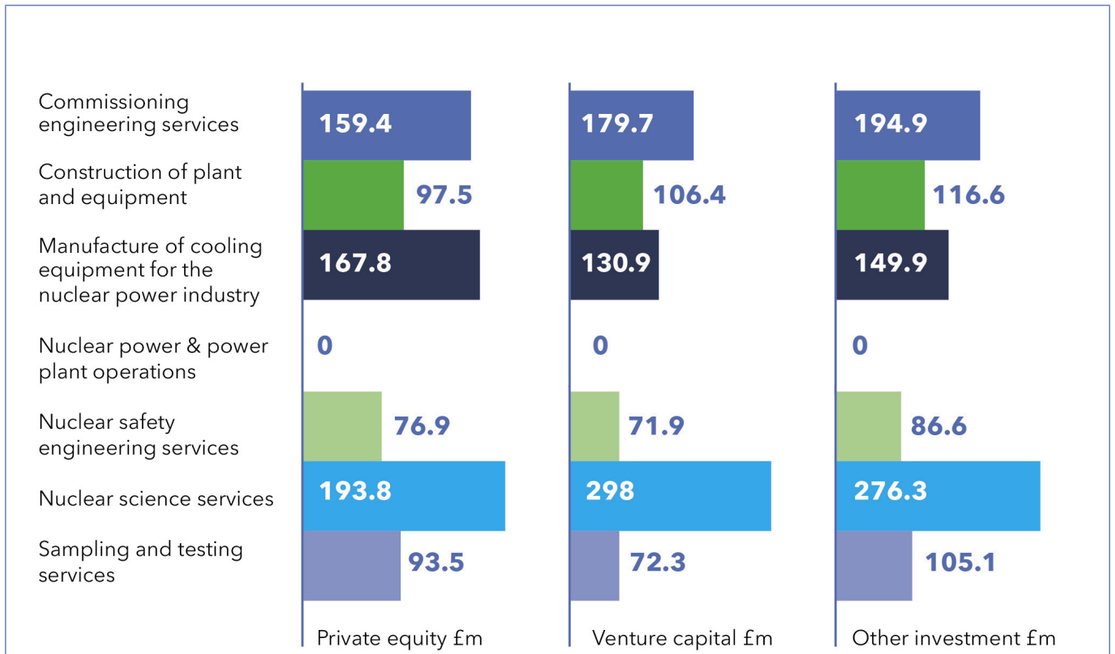


Figure 8: Investment in R&D 2019/20 in the nuclear sector (Source: Midlands Net Zero Hub Regional Report 2021)

The report identified twenty-three companies in the Midlands nuclear sector. Regional growth in the nuclear sector was identified to have been 29%, compared with 2.9% nationally, making it the fastest growing low carbon and environmental sector in the Midlands.

[14] Midlands Energy Hub, Midland Energy Hub Regional Report: Low Carbon Environmental Goods and Services Market Snapshot, March 2021

Table 1: Major nuclear companies in the Midlands[15]

Organisation	Location	Jobs	Activity
Rolls-Royce	Derby	**Over 3,200 jobs**	Leading an established consortium for the development of SMRs.
Cavendish Nuclear	Leicestershire	**Over 300 jobs**	Supporting new nuclear projects with project development, project management, site commissioning, etc.
Goodwin International	Stoke-on-Trent	**Over 300 jobs**	A precision product engineering company who provide a variety of nuclear components for both defence and civil nuclear applications.
Ansaldo Nuclear	Wolverhampton	**Over 200 jobs**	Design, manufacture, assembly, test, installation and commissioning of customised solutions for the nuclear decommissioning, defence, and nuclear new build markets.
Assystem	Derby	**Over 200 jobs**	Company supporting construction and commissioning of nuclear projects and facilities.
Kuka Systems UK	Greater Birmingham	**Nearly 150 jobs**	Design robotic systems for safe nuclear decommissioning.
Atkins	Derby & Birmingham	**~75 jobs**	Engineering consultancy with significant nuclear energy activity.
Nuclear Advanced Manufacturing Research Centre (NAMRC)	Derby	**Up to 70 jobs[16]**	NAMRC recently opened a new research facility in Derby to help small manufacturers win work in the nuclear sector.
EDF	West Burton A, Nottinghamshire	**Potentially thousands of new jobs at West Burton A STEP site[17]**	Major nuclear generator and owner of West Burton site successfully chosen to host STEP fusion programme.

[15] Nuclear Industry Association, NIA Jobs Map 2022, September 2022
[16] TheBusinessDesk.com, 70 jobs to be created at £20m nuclear manufacturing facility, September 2022
[17] Business Live, Billions in investment and thousands of new jobs expected after site revealed for world's first fusion energy reactor, October 2022

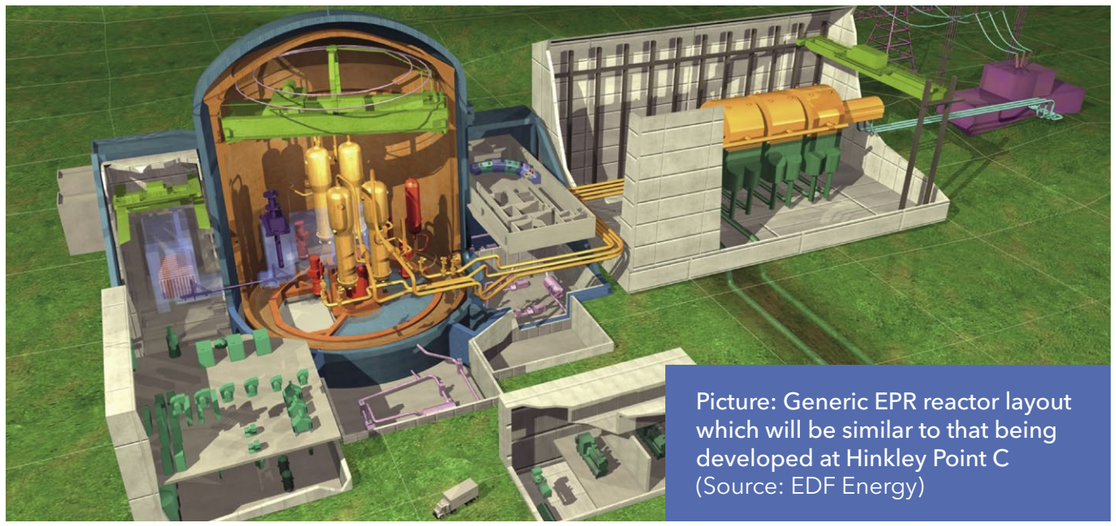
Key nuclear related organisations with a presence in the Midlands

Atkins, with their office based in the nuclear business cluster around Derby, have a long history in the nuclear power sector which dates back to the 1950s and their involvement in the engineering of the Berkeley nuclear power station. Globally, they have a team of 2,000 working across nuclear power. During the first phase of the SMR development programme, Atkins led the modular design of the SMR power station. This design work means that 90% of the manufacturing and assembly will be carried out in factory conditions, significantly reducing cost and build time. The company has projects working across topics such as nuclear enrichment, nuclear design, nuclear new build and decommissioning and nuclear generation.

The **Rolls-Royce** site at Raynesway, Derby, is the location for the support of the Royal Navy submarine reactor plant linked to the Barrow-in-Furness shipyard. Their reactors have powered all of the Royal Navy's submarines since HMS Valiant was launched in 1963. Rolls-Royce Submarines employs over 1,500 engineers associated with design, manufacture and support. Rolls-Royce Submarines has launched a Nuclear Skills Academy to train 200 apprentice engineers every year. This is supported by the Nuclear Advanced Manufacturing Research Centre, the National College for Nuclear, the University of Derby and Derby City Council. To support the development of the SMR programme, Rolls-Royce are recruiting 400 people, including design engineers, supply chain specialists and experts in nuclear fuels. It is estimated that SMR manufacturing and operation could create 40,000 UK jobs and generate £52 billion in economic benefits.

Ansaldo Nuclear has its head office in Wolverhampton. It specialises in the design, manufacture, assembly, test, installation and commissioning of customised solutions for the nuclear decommissioning, defence, and nuclear new build markets. The involvement in the nuclear industry began with the construction of the first nuclear reactor in the UK, the Dounreay Plant. Since then, Ansaldo Nuclear Ltd has supplied an extensive range of equipment and solutions to most UK nuclear power stations, including fuel route, remote handling, inspection equipment, encapsulation, waste handling solutions, gloveboxes, shielded containments, and reprocessing equipment. They have projects across the sector from current generation III and III+ reactors, Generation IV and SMRs through to fusion including JET and ITER with major contracts for the latter.

Cavendish Nuclear work across the nuclear sector and have an office in Leicester. The company work on projects ranging from decommissioning, through to new build and the nuclear submarine programme. It is a key component of the Babcock International Group's Nuclear Sector. It has over 40 years of working within the sector with 5,000 employees. Key projects included the decommissioning of the Dounreay site, waste retrieval from Sellafield's Pile Fuel Cladding Silo, and its contribution to the Hinkley Point C project. In recent times, Cavendish Nuclear has been growing its activities and has been recruiting 400 new staff across its UK offices.



Picture: Generic EPR reactor layout which will be similar to that being developed at Hinkley Point C (Source: EDF Energy)

EDF is an energy company presently constructing the Hinkley Point C twin-EPR reactor in North Somerset. This is the largest UK construction programme. It has created over 25,000 new jobs, up to 1,000 apprenticeships and 64% of the project's construction value is predicted to go to UK companies. The company has extensive experience in the nuclear sector and operates the UK's AGR reactors and Sizewell B's PWR. The company is also owner and operator of the coal power station at West Burton in Nottinghamshire. This site has successfully been selected for the STEP fusion power plant. This will bring potentially thousands of new, high-quality jobs to the Midlands Engine area and benefit surrounding nuclear-related supply chains.

Assystem is a global nuclear engineering company aiming to make nuclear energy safer and more competitive. They support clients from conception to decommissioning stages of their nuclear infrastructure and also assist newcomers in developing their nuclear programmes. Their Defence Platform office is based in Derby, specialising in management and design functions of submarine and nuclear projects in the UK.

Goodwin International was established in 1949 and specialises in heavy project engineering. It produces a variety of nuclear components for both defence and civil nuclear applications. These range from primary pump casings for nuclear reactors to the complete supply of sub-assembled components. The company employs over 300 people at their main UK facility at Stoke-on-Trent.

Kuka Systems International is a supplier of automated production and assembly solutions who are specialists in designing robotic systems for the nuclear environment. They have a number of different applications for the nuclear decommissioning industry including handling and sorting waste products, size reduction, box encapsulation, lidding and swabbing, and general housekeeping operations. They have operations in both Wolverhampton and Sandwell in the Black Country.

The **Nuclear Institute** is the only professional membership body dedicated to the nuclear sector. Its **Midlands branch** is run by Midlands nuclear stakeholders and organises educational, networking and social events for regional stakeholders.

The **Nuclear Advanced Manufacturing Research Centre (NAMRC)** is an 8,000 sqm. research factory on the Advanced Manufacturing Park in Rotherham, linked to University of

Picture: The design for the NAMRC facility in Derby (Source: NAMRC)

Sheffield AMRC and AMRC Training Centre, and a host of high-value manufacturing companies.

The Nuclear AMRC Midlands is a new industrial R&D centre at Infinity Park, Derby. The new centre will focus on later-stage development in technology areas which will create an initial 70 jobs. The building also provides a new base for the University of Derby's Institute for Innovation in Sustainable Engineering. NAMRC's role is to support the development of the nuclear sector with a focus on manufacturing. Its Fit4Nuclear programme assesses and supports businesses, often from non-nuclear sectors, to enter the nuclear supply chain.

16 of the 62 UK companies currently supported by Fit4Nuclear are in the Midlands Engine (25% of total), highlighting the strong industrial base in the region to support the growth of nuclear and related industries. The 16 Midlands companies highlighted by Fit4Nuclear can be seen in Table 2 below.

Table 2: Fit4Nuclear companies in the Midlands Engine (as of January 2023)[18]

Organisation	Location	Jobs	Activity
Arrowsmith Engineering	Coventry	**67 jobs**	Specialists in machining full certified and bonded components in titanium, nimonics, stainless steel, exotic metal and engineering plastic.
Brown and Holmes	Tamworth	**62 jobs**	Design and manufacture of workholding, assembly tooling, automated solutions, robot/cobot integration, standard workholding, extraction systems, material handling.
Certex Lifting	Nottinghamshire	**128 jobs**	Provides lifting products and services like cranes to diverse range of markets including nuclear.
Capula	Staffordshire	**243 jobs**	Capula provide material tracking systems, control systems, radiological surveillance systems, building management systems, IT systems, and real-time data historian solutions.
CE Turner	Melton Mowbray	**82 jobs**	Manufacturer specialising in complete project management, precision fabrication, machined components, complex integration and testing and wide-range of subcontracted solutions.
ECS Engineering Services	Nottinghamshire	**140 jobs**	Provide engineering and steel fabrication services up to Execution Class 4 in mild and stainless steel.
Heathyards Engineering	Staffordshire	**65 jobs**	Provide tube manipulation, fabrication and high integrity welding to a range of industries.
Hydrobolt	Wolverhampton	**232 jobs**	Specialists in manufacturing high integrity fasteners for the energy industries.
Joseph Ash Galvanising	Telford	**563 jobs**	Provides steel finishing services including galvanizing, spin galvanizing, shot blasting and powder coating, as well as packing export containerisation and steel bundling.
KGD Industrial Services	Hereford	**90 jobs**	KGD is a package manufacturer with in-house design, manufacturing, inspecting, painting and testing facilities with experience working on global engineering projects.
Lestercast	Leicester	**37 jobs**	Manufacturer of precision investment castings, offering bespoke components in range of metals including high temperature and specialist alloys.
Nuclear Energy Components	Derbyshire	**14 jobs**	Engineering and component manufacturing for nuclear industry.
Penny Nuclear	Chesterfield	**87 jobs**	Designs and manufactures lifting equipment, mechanical handling solutions and hydraulic systems for all stages of nuclear plant and lifecycle and nuclear fuel cycle.
SL Engineering	Lincolnshire	**51 jobs**	Manufacture specialised rigid tube assemblies, fabricated & welded pipes, complex tube manifolds, ducting, conduits, flexi-rigid metallic hose assemblies, and CNC precision machined pipe fittings.
Somers Forge	Birmingham	**120 jobs**	Provide a wide range of open die forgings for both civil and military applications worldwide.
Syspal	Telford	**165 jobs**	Specialists in high quality, high performance stainless steel and aluminium fabricated products.

Expertise and facilities

A number of universities across the Midlands have been active in nuclear energy research and innovation both supporting the region and wider national activities. This research capability dates back to the dawn of the civil nuclear programme in the UK in the 1950s. The universities also have extensive training programmes which provide graduates into the nuclear energy and nuclear decommissioning sectors.

The Energy Research Accelerator (ERA) has nuclear research and innovation facilities which support the development, utilisation and decommissioning of nuclear power plants. This includes current nuclear sites outside the Midlands as well as future Midlands sites like the STEP programme and potentially modern reactors like SMRs and AMRs.

Most recently, funded by BEIS and managed through EPSRC, the National Nuclear User Facility (NNUF) programme has provided £84 million to create a suite of UK research facilities to support the evolving nuclear sector. This is to ensure that the requisite R&D capability and infrastructure exists to successfully deliver and support the operation of a new generation of nuclear power plants in the UK. As part of the NNUF, the University of Birmingham successfully secured and has now launched the High Flux Accelerator Driven Neutron Facility and a materials in situ corrosion facility for irradiated nuclear

[18] NAMRC, F4N Company Directory. Company list filtered by 'East Midlands' and 'West Midlands' (Accessed January 2023)

materials. These capabilities provide a platform for collaborative R&D with the nuclear industry. Rolls-Royce has also recently opened new offices at Space Park at the University of Leicester to develop its expertise in nuclear power applications for space. This will enable the university to work closely with engineers at Rolls-Royce, which has developed a concept for a micro-reactor that can be used in space exploration.

Left – interior of High Flux Accelerator-Driven Neutron Facility at University of Birmingham.

Below – High Flux Accelerator-Driven Neutron Facility at University of Birmingham.

Source: University of Birmingham

As part of the NNUF, the University of Birmingham successfully secured and has now launched the High Flux Accelerator Driven Neutron Facility and a materials in situ corrosion facility for irradiated nuclear materials. These capabilities provide a platform for collaborative R&D with the nuclear industry.

6 NATIONAL WORKFORCE, JOBS AND SKILLS

Aligning Midlands training programmes with the growth opportunities in the nuclear sector is vital otherwise growth will stall due to a lack of talent. Indeed the lack of available talent has often curtailed business investment plans and is often a bottleneck for business development.

Data from the Nuclear Industry Association (NIA)[19] reports that in 2022 over 64,000 people were employed in the UK's nuclear industry. However, with 39% of the workforce aged 50 or over and only 15% under 30, there are growing pressures on recruitment.[20] The Nuclear Skills Strategy Group forecasted in 2019 that between 3,200 and 4,800 new workers would be needed every year until 2025 to meet the demand from new projects.[21] There are risks of skills shortages if current trends continue.

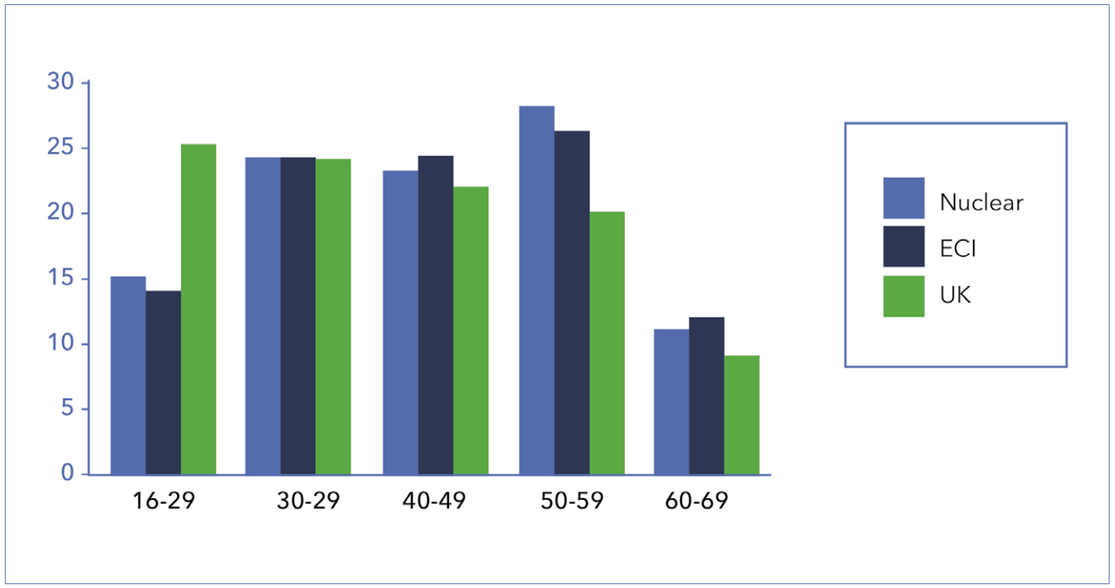


Figure 9: Age profile in the nuclear sector compared to the wider ECI and active UK population (Source: ECITB, 2021)

The gender profile of the nuclear sector does not differ significantly from sectors such as oil and gas with around 19% being women, and importantly, the nuclear sector deal includes a target to reach 40% women by 2030. Furthermore 94% of workers in the survey identified as being white.[22] These factors combined together with the ambition to increase nuclear capacity make a clear case for new skills being developed focused across a more diverse group.

19 Nuclear Industry Association, NIA Jobs Map 2022, September 2022
20 ECITB, ECITB Workforce Census 2021: Nuclear, 2021
21 Nuclear Skills Strategy Group, Nuclear Workforce Assessment 2019, November 2019
22 ECITB, ECITB Workforce Census 2021: Nuclear, 2021

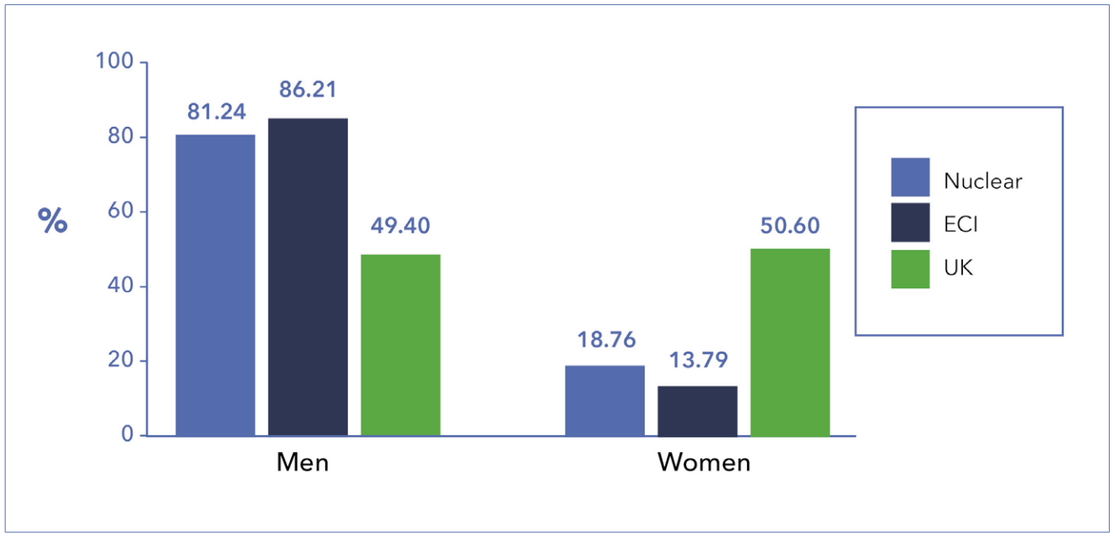


Figure 10: Gender profile in the nuclear sector compared to the wider ECI and active UK population (Source: ECITB, 2021)

The Nuclear Skills Strategy Group's Nuclear Workforce Assessment suggests there is increased demand in the following skills areas:

- Chemistry
- Commissioning engineering
- Electrical engineering
- Emergency planning
- Project planning and control
- Reactor operation

A number of universities in the region are already active in skills development to support the sector. For example, the University of Birmingham has both undergraduate and postgraduate nuclear programmes in nuclear engineering, reactor physics and technology and nuclear waste management and decommissioning.

However, given the future needs of the sector the regional skills provision will need to increase to support both the region and the wider sector. In addition to university activity, Rolls-Royce Submarines Ltd has committed to 200 new apprenticeships every year for 10 years and has launched its own nuclear skills academy supported by the NAMRC, the National College for Nuclear, the University of Derby and Derby City Council. There are also possibilities for a new skills centre to be created in north Nottinghamshire, near the West Burton STEP fusion site, to train apprentices for the UKAEA programme.

Picture: Training using the 1MW process plant for early career professionals at Aston University.

7 IDENTIFYING OPPORTUNITIES AND DEVELOPING RECOMMENDATIONS

The starting point for developing this list of recommended actions was a workshop with key individuals in the sector followed up by 1:1 interviews. This process was used to probe opportunities and challenges perceived in the Midlands in relation to the current state of the nuclear sector and future opportunities.

Table 3: Organisations interviewed

Organisations interviewed	Interview questions
• **Ansaldo** • **Atkins** • **EDF** • **Lincolnshire County Council** • **Lodestone** • **NNL** • **Nuclear AMRC** • **Rolls-Royce**	• What role should the Midlands play with respect to different technologies coming forward? • What should the Midlands being doing to position itself better? • What are the future skills needs? • Are there supporting facilities that are needed? • What are the supply chain opportunities?

Following the interviews, a set of recommendations were developed which were then tested at a workshop held in July 2022. It is proposed that these actions are integrated into the delivery of the Ten Point Plan for Green Growth in the Midlands Engine.

Picture: Spent fuel storage pool.

8 PROPOSED ACTIONS AND RECOMMENDATIONS

This report makes seven recommendations for pan-regional, collaborative action. These recommendations reflect the opportunities and challenges the nuclear and fusion sectors face in the Midlands.

1. Support bids for nuclear manufacturing sites

There is the potential for a number of nuclear manufacturing facilities to be sited in the region building on the Midlands' strong manufacturing base. These include facilities such as pressurised vessel production and heavy engineering, and nuclear welding and manufacturing expertise. One example of this is the heavy vessel manufacturing facility for SMRs being considered by Rolls-Royce. Although neither site made the final selection, two sites in Lincolnshire (Associated British Ports site in Grimsby and Pioneer Park in Stallingborough),[23] were among eight sites originally shortlisted for the SMR manufacturing facility, highlighting regional manufacturing opportunities emerging from the scale-up of nuclear in the UK.

Action: Use the network to draw up a priority list of opportunities and lead companies and develop an investment case which gives the greatest chance of regional success.	**Outcome:** Potential new industrial manufacturing providing jobs and investment.

2. Support the development of new nuclear generation in the Midlands and propose potential Midlands sites.

The Midlands has no current nuclear generation sites. Whilst the first phase of new nuclear is focused on re-purposing older nuclear sites, there are opportunities for new sites to be put forward in the future. The Midlands could therefore place itself at the forefront of the development and siting of advanced reactors such as SMRs and AMRs. A number of sites, such as former fossil fuel power stations sites like Cottam, High Marnham, Drakelow or other brownfield sites, could be suggested for siting SMRs or AMRs depending on grid connectivity and water availability. Nationally, sixteen SMRs are being targeted for development, but only eight sites have been identified so far. Hence, there is a potential to advance new sites in the Midlands for a future phase. SMRs and AMRs have a potential wider role too supporting heat, hydrogen and jet fuel production, and providing heat and power to industrial clusters if alignment can be identified. They also have the advantage that they could be linked to energy storage and are compact in size.

Action: In collaboration with local and combined authorities and industry, advocate for a regional siting evaluation for AMRs and SMRs in the region, which takes in to account regional industrial energy use and potential for clustering industry around new nuclear developments.	**Outcome:** Potential plans for new nuclear energy generation sites in the Midlands which will act as focal points for industrial activity in the region, but also provide low carbon energy for the region, replacing former coal-fired power stations.

[23] eLINCOLNITE, Two Lincolnshire sites shortlisted for new Rolls-Royce factory, July 2022

3. Support the development of the fusion energy sector

The new STEP fusion power plant at West Burton, Nottinghamshire, provides a significant opportunity for the Midlands-based fusion sector and associated supply chains. There is a significant R&D programme needed to support fusion development, particularly in areas such as energy generation, tritium management and materials development.

Action: Establish a fusion working group involving universities, industry and local authorities to ensure benefits from engaging with this new sector are maximised.	**Outcome:** An active ecosystem supporting the major development of fusion in the region and beyond.

4. Establish a Midlands nuclear consortium to coordinate nuclear energy activities across the Midlands.

This would bring together the supply chain, developers, generators, researchers and skills providers interested or already operating in the region. The forum would be neutrally moderated, without a bias towards any particular sector. An exemplar activity currently doing this is in the South West focused around Hinckley Point C[24] which enables organisation to get involved in the project activity.

Action: Establish the Midlands Nuclear Forum to update on activity and explore opportunities, such as funding opportunities.	**Outcome:** A well-coordinated sector able to maximise on opportunities both for the region and for individual organisations.

5. Support nuclear skills development to meet Midlands and national demand

Skills needed include broad engineering, project management and materials.

Actions: This recommendation includes: • Develop a Midlands nuclear skills roadmap. • Encourage universities and colleges to scale up nuclear skills provision to meet planned regional and national activity. • Advocate for nuclear apprenticeship programmes like the Rolls-Royce Nuclear Academy and the proposed UKAEA fusion school. • Advocate for an EPSRC nuclear-focused Centre for Doctoral Training to provide around 50 relevant PhD studentships.	**Outcome:** Provision of skilled employees to match needs for the region and wider nation,, making it attractive for industry to locate in the Midlands.

[24] Hinkley Supply Chain - Engaging South West Businesses

6. Support creation of nuclear test, validation and R&D facilities

To allow the Midlands to establish itself as a lead in the sector for the development of next generation nuclear requires facilities to support it, such as fusion (including hydrogen/tritium, materials), energy systems for nuclear applications (for example storage) and advanced manufacturing for next generation nuclear.

Actions: Identify and evidence key facilities that the Midlands should host and has leading capability to support.	**Outcome:** Facilities in the region to support the sector, attract R&D funding and collaboration between universities and industry.

7. Support siting assessment of the UK's long-term Geological Disposal Facility, for example at Theddlethorpe

Work with communities such as Theddlethorpe in Lincolnshire to provide information, where required, about any future application. Draw in academic and technical expertise from the region to help inform discussions. Examine the skills, community, and infrastructure needs and employment opportunities. Link to the wider network or activities in nuclear in the Midlands.

Action: Support discussions with local leaders working on the Theddlethorpe GDF Programme.	**Outcome:** Support the development of an informed case for the site, utilising the wider regional strengths and linked into other relevant regional activity.

Picture: The Sizewell B nuclear power station was the last operational power station built in the UK. (Source: EDF)

CONTACTS

For more information about the Energy Research Accelerator, please contact either:

Professor Martin Freer
Director of the Energy Research Accelerator
M.Freer@bham.ac.uk

Faye McAnulla
Programme Director of the Energy Research Accelerator
Faye.McAnulla@era.ac.uk

ERA is a collaboration of Midlands-based energy research institutions that work with industry and the public sector to support energy innovation.

The eight university partners and the British Geological Survey has extensive experience and skills in the nuclear sector which range from training and education through to state-of-the-art research facilities.

The partners have been supporting the nuclear industry since the 1950s and the development of the first civil nuclear power plant in the UK.

Find out more at:
www.era.ac.uk

For more information about the Midlands Engine, please contact:

Jacob Vivian
Project Manager
Jacob.Vivian@midlandsengine.org

The Midlands Engine partnership is a pan-regional, apolitical partnership that convenes and acts as a focal point for our region's local authorities and government, local enterprise partnerships, universities and businesses to work together, with government, in pursuit of our shared aim – greater economic prosperity.

The Partnership acts to amplify partners' efforts to sustainably grow the Midland economy and is supported and enabled via a small secretariat.

The Midlands Engine Green Growth Board coordinates the partnership's strategic direction around the clean growth agenda, including around nuclear and related industries.

Find out more at:
www.midlandsengine.org

MIDLANDS ENGINE

www.midlandsengine.org
green.growth@midlandsengine.org
@Midsengine
midlands-engine

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