Made in Britain:

The Pathway to a Nuclear Renaissance

All-Party Parliamentary Group on Nuclear Energy

November 2023

Cover image — Construction at Unit 1 of Hinkley Point C, courtesy

Executive Summary

The UK has its best opportunity in 40 years to revive the nuclear sector and to provide the clean, reliable, sovereign power that this country needs. The Government has achieved a step change in policy that has transformed the prospects of nuclear energy in the UK:

- Hinkley Point C has resurrected the UK's nuclear new build industry.
- Government investment in Sizewell C, alongside the Regulated Asset Base funding model, will help secure the first true replica nuclear project in UK history.
- The formation of Great British Nuclear (GBN) has now created a "guiding mind" to deliver 24 GW of new nuclear, the most ambitious target in Europe.
  - GBN has been instructed to select the best Small Modular Reactor (SMR) technologies, assign sites to those technologies, form project development companies for those sites, and potentially invest in projects through commercial operation.

This report sets out the actions necessary to sustain this momentum, tear down remaining barriers to progress, and empower GBN even further to turn nuclear technologies into nuclear projects:

- Establish a Net Zero duty on the Planning Inspectorate and all relevant regulators and designate nuclear deployment as a Critical National Priority to ensure that planning decisions reflect the urgency of our clean energy needs.
- Publish a Nuclear Roadmap this year that outlines a full programme of projects to 2050 to enable national nuclear workforce planning and maximum UK content in future nuclear projects.
- Commit the funding to GBN necessary to build its developer capabilities and to invest directly in at least the first two SMR projects and next large-scale project.
- Select a partner for the next large-scale nuclear project beyond Sizewell C in this Parliament.
- Award funding and assign sites to SMR Technology Partners by March 2024.

These recommendations are predicated on the Government following through on its public commitments to label nuclear investment as sustainable and to bring Sizewell C to a Final Investment Decision next year. We are assured that these steps are both well in hand and look forward to announcements in the coming months.

The promise of a nuclear revival is immense. With just 6 GW of nuclear operational and 3.2 GW under construction, the industry sustains about 65,000 jobs and adds £6.1 billion directly to the UK economy. If we build 20 GW more, the industry could sustain 250,000 jobs, adding £20 billion to our new green economy each year, as well as providing a base of energy security for the rest of this century.[1]

1] The UK currently has five generating nuclear power stations, providing around 16% of the country's electricity from 5.9 GW of capacity and supporting 77,000 jobs in the sector. Based on this figure, the industry could support 250,000 jobs with 20 GW more.

1. Introduction

Nuclear energy provides irreplaceable clean, reliable, sovereign electricity. No other single technology can provide those three things. Nuclear is also the greenest of the green technologies: according to the United Nations, it has the lowest lifecycle carbon use, lowest land footprint, and lowest impact on ecosystems of any electricity generating source.[2] Nuclear's unique strength makes it ideally placed to promote energy security, environmental sustainability, and broad-based economic prosperity in Britain.

The Government and the Opposition both agree that achieving these three goals therefore requires major investment in new nuclear capacity. They have also recognised that the previous developer-led model has failed. Nuclear projects are capital intensive and long-term, so they need strong direction from government and sustained partnership between the public and private sector to share risk and deliver projects.

The Government's decision to take a major equity stake in the Sizewell C project, the first such investment for 35 years, marked a watershed in UK nuclear policy. That decision demonstrated that the UK Government recognised its strategic role in nuclear deployment and was serious about delivering the next big nuclear project. The formation of Great British Nuclear as a publicly owned company with the mandate to choose the best SMR Technologies, assign sites to those technologies, and award funding to develop those technologies and bring projects through construction to commercial operation has given further confidence to the private sector that the UK Government intends to deliver a programme of new nuclear projects, and not settle for one project at a time. That confidence is essential for the nuclear industry to invest in the industrial capabilities and workforce skills required to deliver new power stations quickly and efficiently, while maximising the scope for UK content.

The UK, however, is not operating in isolation. Countries all over Europe are launching major new nuclear programmes, designed by state bodies, backed by state financing, and enabled by sensible planning reforms. France intends to build up to fourteen new large-scale reactors as well as developing SMRs. Poland decided to launch its first ever nuclear programme three years ago and is already close to signing off a major large-scale project. Sweden, the Netherlands, Czech Republic, Slovakia, Slovenia, Hungary, Bulgaria, Romania and Ukraine are all seeking to build more nuclear. Canada has started construction on the first commercial SMR, while the United States is pumping unprecedented funding into the development of advanced reactors and fuels.

The UK is thus facing stiff competition for skills, investment and supply chain opportunities. This report is designed to examine what we must do as a country to convert unprecedented policy support for new nuclear into a programme of new projects. The principles which underly our recommendations are based on the experience of successful nuclear programmes worldwide: strategic clarity from Government, swift planning, cheap financing, replication of designs, and continuous supply chain activation to capture opportunities for UK companies and their people.

2] Carbon Neutrality in the UNECE Region: Integrated Life-cycle Assessment of Electricity Sources, United Nations Economic Commission for Europe, 2022 (Accessed: 24 August 2023) https://unece.org/sites/default/files/202208/LCA_0708_correction.pdf

2. Strategic Enablers: Planning

Planning has become a critical source of uncertainty for nuclear new build that undermines the investment case for these projects just when the speedy delivery of new nuclear is most essential. To meet the 24 GW target, the planning system must approve 50% more capacity per year for the next 30 years than it has done in the past 15 years.

The single most important thing the UK Government can do to facilitate the deployment of new nuclear is to place a Net Zero duty on all relevant regulators involved in the planning process, particularly the Planning Inspectorate, to ensure regulation is proportionate to the urgent need for more clean energy to fight climate change.

In the past, the Planning Inspectorate has recommended against Development Consent Orders (DCOs) for both Wylfa Newydd and Sizewell C on minor environmental grounds despite acknowledging that these projects would make huge contributions to our clean power needs. Thankfully, the Secretary of State overruled the Planning Inspectorate on Sizewell C, but the regulators must be instructed explicitly to make more sensible and proportionate decisions from the start.

The Government should take three further steps to get the planning system moving again:

- New nuclear development should be designated a Critical National Priority, on par with offshore wind, to create the strongest possible policy presumption in favour of development.
- Regulatory bodies involved in the planning, permitting, licensing and consenting processes must be properly resourced to make timely and proportionate decisions on new build projects.
- National Policy Statements relevant to nuclear should be updated and adopted with as much speed as possible to provide certainty in the planning process and drive investment in nuclear projects.

The proposed National Policy Statement EN-7 should renew the list of designated sites that were identified within EN-6 for large-scale nuclear. This will provide developers and investors with confidence in where new nuclear projects, including GW scale projects, can be constructed.

Urenco's UK enrichment facility at Capenhurst

To fully meet the UK's nuclear ambitions, our siting policy must enable the identification of additional sites through robust siting criteria that developers can use for site selection.

Small and advanced modular reactors will potentially require dozens of sites, especially to support the decarbonisation of industry. It is not practical to try to list of all of these. Moreover, technology vendors cannot wait years for a Strategic Siting Assessment to take place, as other countries are already surging ahead of the UK in advanced nuclear technologies. An approach based on clear, objective criteria can offer rapid certainty to developers while offering the flexibility to support an emerging market in new applications of nuclear technology.

Our goal must be to create a planning system that enables the full promise of nuclear energy, not a blocker that drowns our hope of net zero and energy security in paperwork.

3. Strategic Enablers: Programme Clarity

The launch of Great British Nuclear (GBN) in July 2023 should start a new era for nuclear deployment in the UK. To maintain this momentum, the Government should set out the details of our new nuclear programme beyond the initial SMR selection process. These include a roadmap of specific projects to get us to 25% of our power needs (24 GW by 2050), the preferred funding arrangements to get us there, the resources and powers of GBN, and the route to market for technologies that are not selected by GBN.

The Nuclear Roadmap

The forthcoming Nuclear Roadmap from DESNZ should set out a detailed timeline of the projects required to reach the 24 GW ambition set by Government. We can only attract investment, attract new people, and build new capabilities in nuclear if we have new projects.

Current Government policy targets getting Sizewell C to a Final Investment Decision (FID) in this Parliament, which will get us to 7.7 GW. The next target is for two projects to reach FID in the subsequent Parliament (2024-2029). However, we do not yet know where those projects will be built. We also do not know for certain how these projects will be funded. At best, these targets would leave us 21 years, 12 GW, and billions of pounds short of our ambition.

The Nuclear Roadmap should fill in that gap by setting out the following:

- Government support for lifetime extensions for the existing generating fleet.
  - Following major investment, EDF has been able to extend the lifetimes of the existing fleet by several years and more may be possible, given the medium-term outlook on energy security.
  - Operating the existing fleet for as long as possible plays a key role in maintaining nuclear skills, reducing emissions, and cutting gas imports.
- The sites on which we can build, how much capacity we can build on each site and the order in which we would build on each site.
  - GBN's siting work should be incorporated into this work as quickly and comprehensively as possible.
- Targets for the numbers of projects reaching FID in each of the projected Parliaments between 2029 and 2050 and interim targets for capacity deployment in 2035, 2040 and 2045.
- The preferred funding model and financing arrangements for future nuclear projects.
- To date, the UK has pursued ad hoc and bespoke funding and financing arrangements for nuclear projects, which creates a large amount of uncertainty for the industry. While each project will have its own specific requirements, a published standard structure would be immensely valuable for developers and investors.

Powers and Resources of GBN

The Government should make a comprehensive statement of GBN's remit, operational model and budget, and its role in relation to relevant government departments to provide clarity to industry, investors and the public. The SMR tender document published in July 2023, for instance, states that "GBN intends to establish Project Development Company(s) (Project Devco), which will provide developer capabilities." The Government should offer swift clarification on the following points:

- Will GBN own sites?
- Will GBN be responsible for securing planning consent and other permissions for nuclear projects?
- Will GBN hold Nuclear Site Licences?
- Will GBN operate nuclear reactors once complete?

These answers will tell Technology Partners and potential investors how much the public sector will do for each project and how much the private sector must do itself.

The tender document for SMR Technology Partners published in July 2023 also specified a contract value of up to £20 billion, which was very welcome, although it was heavily hedged. The Government should establish the following funding parameters, even if it cannot commit money at this stage:

- GBN will have the resources to take equity shares in future SMR and GW scale projects as required.
  - The Government has taken a cornerstone stake in Sizewell C, which has had a significant benefit for investor confidence.
- The Regulated Asset Base (RAB) model combined with direct public sector equity investment is the Government's preferred funding model for future nuclear projects.
  - This model cuts the cost of capital, which cuts substantially the ultimate price of electricity paid by the consumer. NIA analysis has found that a 1% reduction in the cost of capital would reduce consumer prices by £8-9/MWh.

These steps will provide long-term clarity and certainty for all participants in the UK nuclear industry about the Government's intentions, which is essential for successful nuclear deployment.

4. Delivering further large-scale nuclear

The UK Government must remain committed to large-scale nuclear projects and determine swiftly how best to deliver further large-scale after Sizewell C.

It is of the upmost importance that the UK Government ensures Sizewell C reaches FID in 2024 and "green labels" nuclear investment to help facilitate that. The project is essential to the vitality of the UK supply chain and the future of the nuclear industry in this country. A speedy decision will also ensure a more efficient transfer of the skilled workforce from Hinkley Point C to Sizewell C to capture the benefits of replication.

After Sizewell C reaches FID and GBN selects its chosen SMR partners, however, the UK will still need a minimum of 16GW more nuclear capacity to meet the 24 GW target. Large-scale reactors as well as SMRs will be required to meet this target. Large-scale reactors are proven, reliable technology that produce huge amounts of power with limited land use. Hinkley Point C, for instance, will power six million homes from less than a quarter of a square mile.

A number of Western large-scale reactor designs are running now and their supply chains active. In the past six months, the Westinghouse AP1000 at Vogtle in the USA, the EPR at Olkiluoto in Finland, and the KEPCO APR-1400s at Barakah in the UAE and Shin Hanul in Korea have all entered commercial operation. Another AP1000 will be finished shortly, and 3 EPRs and 4 APR-1400s are currently under construction.

The UK should seize this opportunity to start a negotiated process to determine which reactor technology is best placed to deliver a further large-scale project at Wylfa, while maximising British supply chain expertise:

UK EPR, AP1000, or APR1400. Wylfa is the best site in Europe for large-scale nuclear and thus ideal for realising the fleet effect of multi-unit replication.

The UK Government should offer the following support:

- Government purchase of the land and IP of Horizon Nuclear Power from Hitachi.
- Access to the RAB funding model.
- A Government "cornerstone" equity stake to increase investor confidence.
- Support from GBN to secure planning consent and other permissions.
- Expedited site licensing with an appropriate level of resources for the Office for Nuclear Regulation

From top: Aerial view of Olkiluoto 3, Finland (©TVO); Vogtle Units 3 and 4, USA)©Georgia Power Company); Shin-Hanul 1 and 2, South Korea (©KHNP)

The Government should establish what each of the three partners can bring to the project and choose one by the end of this Parliament.

Fundamentally, large-scale nuclear power plants can be built quickly and competitively. France and Korea each built large-scale reactors in five to seven years, when they applied a rigorous fleet mentality to nuclear construction.[3] Replicating reactor designs, utilising an existing supply chain and keeping the skilled workforce engaged within the sector will reduce costs and build new reactors more efficiently. If we adopt this approach, combined with cheaper financing costs from the application of the RAB model, we can achieve cheaper, faster large-scale nuclear to help meet our energy security and net zero needs.

5. Establishing market leadership on SMRs

Great British Nuclear should utilise its powers to set out a clear roadmap using down-selected technologies by Spring 2024.

GBN should provide long-term policy and funding commitments to chosen technologies from its down selection in 2023 with the following steps:

- The UK Government should guarantee a site suitable for multiple SMRs from each chosen vendor.
  - Orders for a fleet of SMRs in the UK will justify investment in SMR factories from the selected vendor, increasing the efficiency of construction and building up UK industrial capabilities. This must be guaranteed in GBN's development contract.
- The UK Government should offer the prospect of further orders for SMRs if initial work is successful, as Ontario Power Generation has done with its orders for the first grid-scale commercial SMRs.
- The UK Government should ensure that existing nuclear sites suitable for SMR deployment, including, for example, but not limited to, Oldbury, Trawsfynydd, and Heysham, are immediately available to selected vendors for early site surveying and preparatory works.
- The UK Government must invest in the capacity of the UK supply chain to serve domestic and foreign SMR orders.
  - The UK Government should focus on reinstating the UK's capability to manufacture components for SMRs such as reactor pressure vessels, steam generator and turbines. This will stimulate economic growth and bringing high-value jobs to local communities.

SMRs of course also present an enormous export opportunity. We refer the Government to the recommendations we made in our September 2022 report, "Resisting Russia's Energy War: UK Nuclear Investment for Allied Energy Security", about placing orders with Rolls Royce SMR to establish a viable UK alternative to Russian reactor exports, expanding UK export finance for nuclear new build projects, and increasing regulatory support for UK nuclear exports.

Rolls Royce SMR, as a UK-flagged reactor design, is a strong option for driving UK reactor exports. We appreciate that the Government has gone with an open, competitive selection process, so we urge them to develop UK manufacturing capabilities to build whatever designs are chosen, UK or foreign. That way, the UK supply chain can not only provide UK content for UK projects, but also potentially win orders for SMR projects globally. We outline the strategy required in the next section, and we are firmly convinced that this "high-value" approach to SMR deployment should be our goal.

3] Nuclear Power in South Korea, World Nuclear Association (Accessed 24 August 2023) https://world-nuclear.org/information-library/country-profiles/countries-o-s/south-korea.aspx
Nuclear Power in France, World Nuclear Association (Accessed 24 August 2023) https://world-nuclear.org/information-library/country-profiles/countries-a-f/france.aspx

6. Skills and supply chain

The UK should use a major programme of nuclear construction to increase our nuclear skills base and rebuild the heavy industrial capabilities that we have lost. We should insist that our nuclear renaissance benefits UK companies as far as possible and that it provides as many good jobs as possible to communities in all parts of the country.

Workforce

Our nuclear workforce must grow swiftly and dramatically. There are approximately 65,000 people in the civil workforce today: a 24 GW programme would require in the order of 250,000 people. Once the Nuclear Roadmap has set out our plan to deliver this full programme, new recruits will see that they have a stable, long-term future in nuclear. In addition, businesses will have the certainty to invest years in training new workers. We have to start training construction workers today for projects that reach FID in 2029, so the Roadmap should be published as swiftly as possible.

Once this is done, the Nuclear Skills Taskforce should be charged with producing a workforce plan from now to 2050 integrating the civil nuclear construction pipeline with the nuclear submarine construction programme. This integration is essential to maximise supply chain activation and efficiency and minimise the cannibalisation of skills in one part of the nuclear sector by the other. Crucially, this plan should say what we need to do to get the people to deliver 24 GW of on-grid nuclear and new submarines, and not whether we can get the people. Our approach must be led by our project requirements and not by our current skills constraints.

▲ Since 1950 Sheffield Forgemasters has manufactured cast and forged nuclear components for multiple applications

Supply Chain Capabilities

The Government should also plan to maximise the UK content of any new nuclear programme to rebuild the UK's heavy industrial capabilities in the nuclear sector. The UK could once make reactor pressure vessels, coolant circulators, boilers and turbines for nuclear power stations. We cannot do any of that today, but we could again. Companies like Sheffield Forgemasters, for instance, now owned by the Ministry of Defence, could make reactor pressure vessels for civilian SMRs.

To justify the major investment in plant and equipment required, the UK Government must insist that UK content, including UK front-end fuel cycle services, is maximised and then place orders to facilitate that.

We recommend that the UK Government follow the Korean model for the indigenisation of nuclear projects and the creation of a world-class nuclear industry. This way, the UK can increase how much of our nuclear power stations are made in Britain even if foreign designs are chosen in the SMR selection.

In the 1970s, South Korea had no nuclear power stations. Today, South Korea has 24 GW of nuclear domestically, 4 GW more under construction, and 5 GW exported successfully to the UAE.

The country followed a clear pathway that the UK should emulate. First, the Korean Government made a strategic decision to deploy nuclear power for energy security. The country then ordered American, French and Canadian-designed reactors, insisting that Korean industry work closely with foreign partners to build up their skills and experience. They chose to standardise on the American design and, with a technology transfer agreement, adapted it into their own Korean design. At the same time, they meticulously developed the capability of Korean industry to make every critical component required in their reactor design, to fabricate their own nuclear fuel, and to maintain the workforce necessary to do so. Korea always built multi-unit projects to capture the benefits of replication, and their nuclear industry has not stopped building in 50 years.

The UK should replicate the most successful aspects of this approach. If GBN selects multiple SMR technologies, it should order multiple units of all of them. GBN should consult with the supply chain and order enough units in total to justify UK companies investing in capital intensive capabilities such as the fabrication of reactor pressure vessels. As a condition for contracting with GBN, vendors should be required to maximise UK content, starting where possible with the use of UK nuclear fuel, which is our most mature supply chain capability. Where it is not realistic to achieve UK content in a particular area, GBN and its technology partners should publish medium-term localisation strategies, involving joint ventures and other partnerships between foreign suppliers and UK industry. To aid this, GBN should standardise on the single most successful SMR design after the initial deployment phase. This will concentrate investment efficiently on the required capabilities, allowing swifter introduction of UK content and more competitive exports.

Establishing sovereign supply chain capabilities is the highest value approach - breathing new life into Britain's industrial heartlands and creating high-quality and long-term jobs with cutting-edge engineering and science. Energy security, industrial development and decarbonisation will all come from such an approach.

7. Conclusion

The UK should execute a programme of 24 GW of nuclear on three principles:

- Sustained strategic direction from central Government and Great British Nuclear on financing, planning and programme structure.
- Continuous fleet deployment of large and small nuclear reactors.
- Maximisation of opportunities for the UK workforce and industry.

The Government can set that strategic direction if it is minded to do so. It can impose a Net Zero duty on all planning regulators and designate nuclear as a Critical National Priority. These swift and simple reforms will prevent the planning system from inappropriately delaying or frustrating the Government's own agenda. The Treasury can grant GBN the funding it needs to stand up credible development companies to get projects to FID, and DESNZ can publish a Roadmap that sets out where, when, and how we will build new reactors to get to 24 GW by 2050.

From there, GBN should choose its SMR Technology Partners within months and agree co-funding arrangements by spring 2024, alongside the relevant departments. The Government must be willing to take equity shares in the first SMR projects and to order enough units in the first wave to get the programme off the ground.

Concurrently, a cross-departmental taskforce should choose a partner to deliver a major, multi-reactor, large-scale nuclear project at Wylfa before the Parliament is out. 2023 has been a banner year for Western large-scale nuclear: KEPCO, EDF and Westinghouse have all brought their reactor designs to full commercial operation. Costs are available, risks are understood, and supply chains are active in a way that they have never been before. The Government should take full advantage and start negotiating with KEPCO, EDF and Westinghouse as soon as possible.

All of these steps will in turn create the pipeline of projects necessary for companies to invest in skills and in capabilities to make this a "made in Britain" nuclear renaissance. The Government already has the vehicle for national workforce planning across civil and defence nuclear in the Nuclear Skills Taskforce. The policy choice it needs to make is how much British nuclear it wants to be made in Britain. Again, the Government has the levers to insist that all projects maximise UK content and revive long lost industrial capabilities. We have recommended following the path that vaulted South Korea from a developing economy to the front rank of nuclear nations.

We believe the UK Government should choose this high-value pathway for the UK's nuclear development because this new nuclear construction programme should be the author not just of energy security and net zero, but of good green jobs and industrial revival in every corner of Britain. We hope they will make that choice.

8. About the APPG

The APPG on Nuclear Energy provides a forum for MPs and Peers to engage with leading businesses and organisations that are working to enable the UK to meet its energy security and decarbonisation targets through the implementation of civil nuclear projects, and to discuss policy options to support these.

The Group was established in July 2015.

Contact the APPG on Nuclear Energy

Jon Woodburn
Public Affairs Executive
Nuclear Industry Association

5th Floor, Tower House,
10 Southampton Street,
London WC2E 7HA

Tel: 07803 696 786

Email: jon.woodburn@niauk.org