It is time to expose the Great British Nuclear Fantasy once and for all

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Contents

1. Introduction

In April 2022, the then UK Prime Minister, Boris Johnson, set a target of 24GW (equivalent to eight stations like Hinkley Point C) of new nuclear capacity[1] to be completed in Great Britain by 2050. At the heart of the proposal was the creation of a new government owned entity, Great British Nuclear (GBN), with a mission of 'helping projects through every stage of the development process and developing a resilient pipeline of new builds'[2] designed to ensure energy security and to meet the UK's commitment to achieving net zero. The new Labour Government, elected in July 2024, has been emphatic about the scaling up of renewables, and has confirmed that nuclear power 'will play an important role in helping the UK achieve energy security and clean power'[3]. While not explicitly committing to the 24GW target, the new Government expressed its belief that a scale expansion of new nuclear projects was a necessary part of the energy mix for the transition to achieving net zero carbon by 2050. The Government is expected to continue with GBN but in a clearly subordinate role to its new creation, Great British Energy, its vehicle for driving development and investment into projects that will enable the energy transition to achieve net zero by 2050.[4]

There has, so far, been little government recognition of the sheer difficulty of achieving a vast expansion of nuclear energy. As so often in the past, the nuclear programme has barely got off the ground and the flagship project of the new nuclear programme, Sizewell C, had, by October 2024, yet to receive a Final Investment Decision (FID) apparently because of the lack of interested investors. In an attempt to keep the project from collapsing while it tries to find investors, Government has chosen to invest £8bn in the project, in addition to Electricité de France's (EDF's) contribution of about £700m, just to get it to FID,[5] a process budgeted by EDF in 2016 to cost only £458m.[6] Small Modular Reactors in which much hope is vested barely exist beyond the drawing boards and by the time they could be deployed, if all goes to plan, it will be too late for SMRs and Sizewell C to make any significant contribution to achieving 'Net Zero'.[7]

The recipe for expanding nuclear and overcoming the problems that have meant previous large nuclear programmes came to little remains the same as that of the previous government: create a flow of large nuclear projects starting with an FID for Sizewell C; bring Small Modular Reactors to commercial availability by 2029 and start ordering them then; and streamline the planning and regulatory processes.

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[1] In addition to the still incomplete Hinkley Point C.
[2] https://www.gov.uk/government/publications/british-energy-security-strategy/british-energy-security-strategy
[3] Change, Labour Party Manifesto 2024, p.52 https://labour.org.uk/wp-content/uploads/2024/06/Labour-Party-manifesto-2024.pdfis
[4] The new Labour secretary of state for Energy Security and Net Zero said: 'We are exploring how Great British Energy and Great British Nuclear can best work together, including considering how Great British Nuclear functions can be aligned with Great British Energy.' https://www.gov.uk/government/publications/introducing-great-british-energy/great-british-energy-founding-statement
[5] https://www.gov.uk/government/publications/sizewell-c-development-expenditure-subsidy-scheme/sizewell-c-development-expenditure-devex-subsidy-scheme
[6] https://www.edf.fr/sites/groupe/files/contrib/groupe-edf/espaces-dedies/espace-finance-en/financial-information/regulated-information/urd/edf-urd-annual-financial-report-2020-en-hd.pdf p 72
[7] The Johnson government set a target of decarbonising the electricity sector by 2035, while the Starmer administration has brought forward this target to 2030. New nuclear capacity cannot come online before 2035 much less before 2030.

Achieving these objectives in whole or in part will be impossible. In addition, the nuclear programme remains encumbered by its traditional ethical and sustainability problems, if anything, more so. The prevailing fear of nuclear accidents and radiation risks has intensified as nuclear is increasingly exposed to cyber-attack and the palpable threats from terrorism and warfare. The accidents at Chernobyl and Fukushima, and the threats to Zaporizhzhia in Ukraine and Russia's Kursk plant at the heart of the Russo-Ukraine war provide chilling evidence of dangers that are likely to materialise sometime somewhere. With its embedded relationship to the bomb, nuclear energy is implicated in existential catastrophe. The other existential threat comes from accelerating Climate Change which will inundate some coastal sites, create problems of cooling water and, render the legacy of wastes scattered at vulnerable sites an unmanageable problem for generations far into the future.

We may well ask why, in the face of such deficiencies and dangers and with evidence of flagging momentum, this fantastical project is still proceeding? The answer lies in a powerful combination of political ambition, nuclear industry and trade union lobbying purveying the promise of skills, jobs investment, export markets and wealth associated with nuclear development and its supply chain. A mainstream discourse of nuclear as a mainstay of base load supply, energy security and the goal of net zero has been nurtured, to which powerful interests unthinkingly subscribe. Inertia ensures the persistence of the fantasy.

Yet, all the evidence in terms of renewables competition, the opportunity costs and long term economic and security risks of a swerve to new nuclear indicates a vast gulf between rhetoric and reality. In this paper it is our purpose to address the realities and to demonstrate why new nuclear expansion is not only impossible but acts as a barrier to achieve a rapid energy transition powered by renewable technology, storage and energy efficiency.

In the face of the evidence, we consider it reasonable to conclude that any expansion of civil nuclear power in the UK beyond that already committed is unachievable.

2. Why the expansion of new nuclear is doomed

The Government faces two immediate decisions to get the nuclear programme up and running. The first is whether to take a Final Investment Decision (FID) on the Sizewell C nuclear power plant project and the second is whether to award contracts to the winning companies in the Government's competition to identify and fund the best Small Modular Reactors (SMRs) for deployment in the UK. Decisions to go ahead will, in both cases, commit sums of public money in excess of £20bn and will pre-empt other options for achieving the government's target of achieving 'Net Zero' by 2050. If such a large programme were to go ahead it would only produce about 20% of the notional 24GW target and would be unlikely to start generating before about 2040, long after the previous and the current administration claimed the electricity system would have been decarbonised. Meeting the 24GW target will require substantial additional decisions.

2.1. The large reactor programme, Hinkley Point C, Sizewell C and beyond

Hinkley Point C comprising two 1600MW reactors using the French EPR design and owned initially by a consortium of EDF with 66.5% and China General Nuclear (CGN) 33.5%,[8] is the only surviving project of the previous nuclear programme, which, in 2008, was expected to bring 16GW of new nuclear online by 2025 (later revised to 2030)[9]. The Government's implausible promise of 2008 that this programme could be achieved with no public subsidies has long been forgotten. At that time, government was forecasting that a station like Hinkley Point C could be built for £4-7.2bn.[10] Hinkley Point C is still staggering towards operating in the early 2030s. In January 2024, the estimated cost was up to £35bn compared to £18bn when the contracts were signed in 2016 (both in 2015 money) and at least thirteen years later than EDF originally claimed. Four other projects in that programme were abandoned, in three cases, Wylfa, Oldbury and Moorside, because they could not be financed despite the government offering to take a 30% stake in Wylfa and offering to provide all the borrowing needed. The fourth, Bradwell, failed at an early stage because of local opposition and national security concerns arising because the project was led by a Chinese company, CGN.[11]

The Sizewell project when agreed in 2016, was expected to cost £458m to reach FID. The work to reach FID was to be carried out by a consortium comprising EDF (80%) and CGN (20%). However, by 2022, security concerns about the presence of the Chinese state owned CGN led to its share being bought out by the UK government. By then it appears the original budget had been spent and the UK Government began to fund the project. By January 2024, £2.5bn had been committed and in May, a further subsidy to take the project to FID was notified. The amount of the subsidy was not specified but was then said to be 'hundreds of millions'. However, in August 2024, the Government announced the new subsidy would be £5.5bn, about four times the annual savings from the abolition of the winter fuel allowance for most pensioners.[12] By January 2024, EDF had reached the limit of its contracted contribution and stopped contributing. By the end of June 2024, the UK Government's stake in Sizewell C was 76.1% and the additional £5.5bn will take its stake to about 90% with EDF's contribution of about £700m giving it the remainder.

The process to get Sizewell to FID will cost nearly twenty times the budgeted cost. It appears much of the government contribution is being spent on ordering and beginning manufacture of components well before it is known when or if an FID would be taken. The Framatome annual report for 2023 states: "the fabrication of forged parts and equipment for the Sizewell C project is well underway"[13] This is an extraordinary pre-emption of decision-making, effectively leaving the Government either to choose to commit billions of pounds of public money to go

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[8] CGN ceased to contribute to construction of Hinkley Point C when it had met its contractual obligation in January 2023 leaving EDF to fund all work since then. At the end of June 2024, EDF's stake had increased to 70.5%.

[9] National Policy Statement for Nuclear Energy EN-6 https://www.gov.uk/government/publications/national-policy-statement-for-nuclear-power-generation-en-6

[10] https://assets.publishing.service.gov.uk/media/5a7490ace5274a44083b7b15/7296.pdf p 61.

[11] The Bradwell project was added after and was in addition to the 16GW by 2030 target.

[12] https://www.gov.uk/government/publications/fixing-the-foundations-public-spending-audit-2024-25/fixing-the-foundations-public-spending-audit-2024-25-html

[13] https://www.framatome.com/medias/framatome-reports-2023-financial-results/

ahead with FID or face writing off £8bn of public money if it does not. At a time when public finances are stretched to the limit either way the political costs may be significant.

Beyond the Sizewell project, claimed to be a copy of the Hinkley Point C station, there is a target of bringing two large projects to FID by 2030 but no large projects have been identified (though the Wylfa site appears to be the front runner for the next project) and the process for developing them has not been established so the earliest any follow-on large stations could be completed even if an FID on them was taken in 2030, would be well after 2040.

2.1.1. Where is the money?

The 2016 deal to build Hinkley Point C included a commitment by EDF to take the Sizewell C project to a Final Investment Decision and build the plant using the same finance arrangements. But within two years, EDF, decided not to go ahead with this finance model and not to take a stake in the project. In part this was because it did not have the capital and in part because the finance model used for Hinkley Point C (known as 'Contracts for Difference', or CfD) exposed it to huge risks. In 2024, the scale of the risks became apparent when it had to write off €12.9bn, a high proportion of the money spent so far, because of delays and cost overruns, the cost of which falls on EDF.[14] EDF is now looking for additional investors, including the UK government, to fund at least some of the remaining cost.[15] EDF dare not expose itself to the risks the CfD model imposes again.

The new finance model planned for Sizewell, 'Regulated Asset Base' (RAB), for which the investors were expected to be institutional companies such as pension funds, will place these risks squarely on consumers. Government claims of significant risk sharing with the financiers is not compatible with a project finance model that any financier would be willing to sign up to. Despite EDF belatedly stating it might take up to a 19.99% stake and the UK Government itself indicating it was prepared to take an unspecified, possibly majority stake, the Government will struggle to find sufficient investors to cover the expected, unspecified, cost, the only estimate being the £20bn. offered by EDF in 2019. The current authoritative estimate needed to make a Financial Investment Decision (FID) has not been disclosed but is unlikely to be less than £40bn in 2024 prices. That would require the plant to be built for 13% less than Hinkley Point C and all experience suggests successor projects will be more expensive than their predecessor. If EDF were to take 19.99% and the Government 50% of the equity, that would still leave £12bn to be raised from investors. Government might claim it will sell down its stake later to what it claims is a willing queue of investors. History says this is not likely.

The previous government claimed an FID on the next two large projects would be taken in 2029/30, but nothing has been established for these. The Wylfa site has been purchased by Great British Nuclear[16] and is expected to be the site for the first of these but the second has no site. No technology and vendor has been determined for either project, and if the RAB model at Sizewell fails to attract investors on terms acceptable to consumers, a new finance model would be needed. Government has not set out the steps that must be taken to bring projects to

[14] https://www.edf.fr/sites/groupe/files/2024-04/edf-urd-annual-financial-report-2023-en-updated-2024-04-11.pdf p 14
[15] In its annual report, it said: 'Complementary alternative financing solutions are being investigated by HPC.'
[16] https://www.gov.uk/government/news/great-british-nuclear-to-buy-two-hitachi-sites-for-new-nuclear-development

fruition. There were reports in September 2024 that the Energy Secretary was considering abandoning this commitment to two further large nuclear stations.[17]

It is still proving difficult to finance the two surviving big GW projects at Hinkley Point and Sizewell. It is inconceivable that sufficient private investment will be forthcoming to finance further projects because they pose such high investment risk in terms of cost overruns, time delays and complexity.

2.1.2. Where are the investors?

When the previous nuclear programme was announced in 2008, there was interest shown by large electricity utilities of Europe, EDF, GDF-Suez, RWE, EON, Iberdrola, S&SE and Centrica, in owning these reactors. These companies had a huge turnover and the resources to finance projects costing tens of billions of pounds. Six of the eight sites identified in 2010 by the Government as 'potentially suitable' for large reactor projects subject to detailed investigations attracted big utilities. All took equity stakes in the three consortia set up to build new reactors. The EDF-led consortium (with Centrica) chose the French Areva NP EPR design for its Hinkley Point and Sizewell sites; the RWE/EON consortium (Horizon) chose the Japanese Hitachi-GE ABWR design for its Wylfa and Oldbury sites and the Iberdrola-led consortium (NuGen) had not chosen a technology for its Moorside site when Iberdrola withdrew and sold the consortium to Westinghouse, who chose their own technology, the AP1000. The Bradwell project owned by a CGN-led consortium was added later and was in addition to the target of 16GW by 2030 target.

By 2013, all the European utilities except EDF, had withdrawn from their projects and reactor vendors took over two of the consortia[18] despite the vendors clearly not having the capability to finance such large projects. Utilities no longer have any interest in nuclear power and they are not now an option for ownership of future big nuclear plants in the UK. EDF is the exception but does not have the capital to take any more than a minority stake in future projects. Other companies that might profit from nuclear power such as the vendors of nuclear plants and engineering groups do not have sufficient financial resources to take a major stake in a big nuclear plant even if it was in their strategic interest. In 2017, the French government required EDF to take over the vendor for Hinkley, Framatome (successor company to the bankrupt Areva NP), so for Sizewell it would be in the position of supplier and customer. The record of the Hinkley/Sizewell technology, the EPR, is so universally poor it is unlikely to be an option beyond Sizewell – the decision to continue with Sizewell can only have been because there was no other option. If the Sizewell C project does not attract its target institutional investors, the only option for follow-on projects appears to be public ownership. Politically, requiring public ownership because private investors are unwilling to commit the massive resources required, would be a travesty of the use of public funds.

In terms of technology, the Hitachi-GE ABWR does not appear to be on offer any more. Westinghouse, which collapsed financially in 2017 because of losses incurred with sales of its AP1000 technology, will not be willing to expose itself to the risks plant ownership would bring. The only other option appears to be the South Korean KHNPC APR1400. Like Framatome (majority owned by EDF), KHNPC is a subsidiary of a huge nationally owned

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[17] https://www.telegraph.co.uk/business/2024/09/07/ed-miliband-considers-scrapping-planned-nuclear-plant/

[18] Hitachi-GE took over Horizon and Westinghouse took over NuGen choosing its own technology, AP1000 for deployment

utility, Korean Electric Power Company. The record of its technology, in terms of construction time, is little better than that of EPR and AP1000 and its only experience outside South Korea is a single station (also very late) sold to UAE in 2010. Its design would have to go through a comprehensive regulatory assessment before it could be ordered likely to be completed only after 2030.

It is evident that there are no longer credible companies with the resources or willingness to take forward the development of big GW reactors in the UK and public ownership is not really an option.

2.2. Are SMRs the Answer?

Small Modular Reactors (SMRs) can be divided into those based on the dominant existing reactor designs, the Pressurised and Boiling Water Reactors (PWRs and BWRs) collectively known as Light Water Reactors (LWRs) and those using designs not yet deployed as commercial reactors, Advanced Modular Reactors (AMRs). In this section we look at the technologies, their development status and their position in UK plans.

Government has not specified what proportion of the 24GW target would be filled by SMRs but it appears that a significant proportion was expected to come from them, mostly LWR SMRs. Yet the technology is, at present, at the design and experimental stage and nowhere near deployment in commercial terms.

2.2.1. LWR SMRs

LWR SMRs are claimed to be a new direction for reactor design. But instead of scaling reactors up when the economics are poor as has always happened in the past, the proposal is to scale them down to make them cheaper per unit of capacity. The untested and counterintuitive claim is that the lost scale economies will be more than compensated for by savings in the construction and manufacture processes. Given how poor the economics of large reactors is, these savings will have to be huge to make SMRs competitive with renewables. There is a great deal of rather vague rhetoric promoting them, for example; modular construction, factory production line manufacture of components, passive safety and reduced radioactive waste production. Media reports often portray them as proven, claiming they are cheaper, quicker to build, safer. At best these claims are untested and, at worst, simply wrong.

No commercial design of a LWR SMR has been ordered, much less built and operated, so claims on cost and buildability are no more than pious hopes and the reliability of LWR SMRs is unknown. No LWR SMR design has completed a comprehensive safety evaluation[19] and until this has been done and the features a regulator would require are known, the cost of the plant cannot be reliably estimated.

To get a fleet of SMRs up and running to meet the ambition of generating by the late 2030s, the Government is running a competition to identify the best LWR SMRs. In October 2023, six designs were shortlisted: GE-Hitachi BWRX-300, Holtec SMR300, Westinghouse AP300, Rolls Royce SMR, NuScale SMR and Framatome Nuward. Framatome Nuward has since been effectively abandoned and the collapse of a prospective order in the USA for NuScale has placed the future of that company in doubt. The first three designs are each 300MW while the

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[19] A 50MW version of the NuScale design completed safety evaluation in the USA but the design is no longer offered after it was scaled up to 55MW, then 60MW and most recently 77MW

Rolls Royce design is 470MW, hardly small, making them comparable in size to the commercial reactors already built in the UK. The intention is to choose two designs that can speedily receive regulatory approval and be built in time to make a significant contribution to meeting net zero by 2050.[20]

Unlike previous funding for SMRs which has involved grants of a few tens of millions, the competition has a budget of £20bn (presumably about £10bn per design) to be spent over the period to 2038 implying the cost of building the initial units would be covered and the plants would be publicly owned.[21] The Interim Chair of GBN, Simon Bowen said: "The tender is for the technology all the way through to completion of the regulatory process and final design and completion of design, with then the potential to place a contract."[22] Despite the Government's emphasis on moving 'at pace' to bring in SMRs as an important element of fulfilling the 24GW programme, the project is already faltering and announcement of the winning designs, expected for spring 2024 is not expected before end 2024. It seems premature to place firm orders for reactors until the designs are much more fully developed. It would be irresponsible if the contracts for constructing the reactors, were not conditional on satisfactory progress, for example, completion of a comprehensive design review and firm evidence the power from the reactors would be economic.

It appears the successful applicants will be allocated a site with an expectation that two reactors will be built at each, making a total of 1200-1600MW of SMR capacity to be contracted in 2029. So, the contribution of these initial orders to the 24GW target would be small. The current cost estimate for Hinkley Point C is about £47bn in 2024 money or more than £14,000/kW of capacity. Even if these SMRs, which would be first-of-a-kinds, could be built for less than the cost of Hinkley Point, this would still represent a cost of about £20bn. As with Sizewell C, pre-emptive investment of public money has undermined the option of abandoning the competition which would probably require painful compensatory payments of public money to the bidders.

It would be prudent if follow-on orders were only placed when the technology and the economics have been proven. If a FID for the demonstration plants is taken in 2029 and it takes two years to deploy resources ready for construction and only three years to build the plant, and a further two years to demonstrate successful operation that would mean any follow-on capacity would only come online well after 2040.

Therefore, LWR SMRs, in terms of development and timing cannot conceivably meet a significant share of the 24GW target and their contribution to achieving net zero is likely to be marginal at best.

2.2.2. Advanced Modular Reactors – nowhere near in sight

Some government money is going into so-called Advanced Modular Reactors (AMRs). While LWR SMRs are smaller versions of the dominant existing reactors, AMRs encompass a range of technologies not so far commercially deployed. They all have a history of being proposed for 50 years or more but, at most, have been built, unsuccessfully, at prototype or demonstration plant level or of getting no further than the drawing board. It is beyond fanciful to assume the problems that prevented the commercialisation of any of them for so long can now be

[20] https://world-nuclear-news.org/Articles/In-quotes-Great-British-Nuclear-s-Simon-Bowen-on
[21] https://www.find-tender.service.gov.uk/Notice/020640-2023?origin=SearchResults&p=1
[22] https://world-nuclear-news.org/Articles/In-quotes-Great-British-Nuclear-s-Simon-Bowen-on

overcome. Their availability is uncertain and they are unlikely to be deployable in volumes sufficient to make a significant contribution to meeting the 2050 target of 24GW.

In 2022, the Government stated it would prioritise High Temperature Gas Reactors (HTGR) over other AMR designs, presumably in the hope they might be able to operate at high enough temperatures, 900^{0}C, to allow the efficient synthesis of hydrogen to be used as a fuel to replace some fossil fuel applications. Accordingly, HTGR technology became the focus of the AMR programme although government recognised it to be, at best, a long-term option. The Government conceded it was not aware of 'any viable fully commercial proposals for HTGRs that could be deployed in time to make an impact on Net Zero by 2050'[23], citing low technology readiness as the reason. As a result, it simply invited the 'sector to carry out a demonstration that will address this technology gap to enable HTGRs to contribute to the Net Zero 2050 target'.[24]

The last reactor supplied by a UK vendor was in 1979 and was for the highly problematic Advanced Gas-cooled Reactor type. Relying on a new UK reactor design capability to develop a concept to commercial application of a reactor type that has had several prototype and several demonstration plants built worldwide all with poor performance, must be seen as an outside chance. If HTGRs are developed, it is more likely that other countries with a stronger reactor design capability than the UK will have led the way. The leading international HTGR design, the US X-Energy Xe-100 applied to be entered in the UK's Generic Design Assessment process in January 2023, but it failed government's 'readiness' assessment. A UK-based design is being pursued but this does not even exist in concept form and no foreign design is being pursued, so UK objectives on HTGRs are, at most, a long way from fruition.

It must be concluded that AMRs, for all the hype invested in them, are an elusive prospect, like fusion, always tantalisingly just out of reach in terms of feasibility and nowhere near deployment for the foreseeable net zero timescale.

3. Barriers to New Nuclear

3.1. Regulation and Planning

The record of the past two attempts to launch a large new programme of nuclear power capacity in the UK is poor. In 1979, Margaret Thatcher announced a programme of ten reactor orders, one per year with the first order placed in 1981. Only one order, for Sizewell B, was placed, completed in 1995, late and over budget. The 2008 Blair/Brown programme envisaged 16GW (11 reactors) to be built on sites 'considered to be potentially suitable for the deployment of new nuclear power stations by the end of 2025'[25]. In the event it resulted in only two reactors (3GW) under construction at Hinkley Point C at nearly double the original cost estimate at the point of FID and with completion after 2030, thirteen years later than EDF claimed it would be. When new reactor programmes are announced, the prescription for avoiding the problems of previous programmes is always the same. New reactor designs will solve the problems of past designs; learning from previous programmes will improve performance; red tape will be

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[23] https://assets.publishing.service.gov.uk/media/66bb67040808eaf43b50e101/advanced-modular-reactor-rdd-competition-phase-b-guidance-issue-2.pdf p 2
[24] Ibid, p 2
[25] National Policy Statement for Nuclear Energy EN-6, p.44 See note 6

cut; and planning and regulatory processes will be streamlined. In this section we look at the proposals to streamline the process of taking a nuclear project to construction completion including safety regulation, planning and siting.

Nuclear power has a history of reactor accidents caused by circumstances not foreseen and risks not identified by reactor designers and safety regulators until they actually happened. Reactor accidents at Three Mile Island, Chernobyl and Fukushima resulted in core melt-downs, an outcome designers claimed was all but inconceivable. The 9/11 terrorist attack and more recently the risks to the Zaporizhzhia reactors in Ukraine and the Kursk reactors in Russia within a war zone have alerted safety authorities to the possibility of catastrophe. The previous assumption was that in war situations, nuclear sites would be carefully avoided. Given this history of unforeseen risks, the priority must be to make regulation more rigorous, not cut corners. The possibility of terrorist attacks, cyber warfare, AI and deployment of drones has added immensely to the dangers and vulnerabilities facing nuclear facilities.

The Generic Design Assessment (GDA) process undertaken by the UK nuclear regulators (Office for Nuclear Regulation (ONR) and Environment Agency (EA)) is a process for assessing whether a reactor design is capable of safe deployment in the UK. The last GDA process to be successfully completed was for the HPR1000 reactor design for CGN in 2021. The Chinese state-owned company subsequently abandoned their interest in developing at the Bradwell site in Essex. GDA gives regulatory approval to build a design in any location; it is not a site-specific permission. GDA is not compulsory and a developer could apply for approval for a reactor design on a specific project, but it is hard to see how this would make the process simpler or quicker unless a one-off approval process was less rigorous. A reactor vendor must apply to the government for a GDA to be carried out. The first step is for government to carry out a 'readiness' assessment taking up to a year. Government instructs the ONR to carry out a GDA on designs that pass this test. It seems to have proved challenging to complete the GDA process in the four years claimed and the comparable process in the USA has taken significantly longer. The ONR's costs to carry out the GDA are paid for by the applicants with the large reactor designs, but with the SMRs, the Government has picked up the bill in most cases.

As well as design approval, a project on a specific site will require: a site licence from ONR; a permit for radioactive substance activities from the EA; and, as a Nationally Significant Infrastructure Project (NSIP), development consent (planning approval) from the relevant Secretary of State on the recommendation of the Planning Inspectorate (PINS). Although these can be overlapping processes, they necessarily take time and there is considerable scope for delay, review and refusal, generally for very good reasons. In the case of Sizewell C it may be noted that after a lengthy planning process culminating in contentious examination by PINS, the recommendation was against approval on the grounds 'that unless the outstanding water supply strategy can be resolved and sufficient information provided to enable the secretary of state carry out his obligations under the Habitats Regulations, the case for an order granting development consent for the application is not made out' (Examining Authority Decision Letter). Nevertheless, the Energy Minister chose to overrule the recommendation concluding that 'benefits, in particular the need for the development, outweigh the adverse impacts of the development'[26]. This decision was challenged by local protest groups and subjected to judicial review. Further legal challenges may impede progress. Similarly, in the case of the Wylfa

[26] https://infrastructure.planninginspectorate.gov.uk/projects/eastern/the-sizewell-c-project/?ipcsection=docs

Newydd project in Anglesey, PINS would have recommended refusal because of the potential disturbance to colonies of Arctic and Sandwich Tern and adverse impacts on tourism, the local economy, health and wellbeing and Welsh language and culture. However, Hitachi-GE, abandoned the project before the recommendation could be put to the Secretary of State.

Rigorous regulatory and planning processes are essential but are necessarily time-consuming, expensive and place significant hurdles in the way of an accelerated nuclear programme. Some projects may fail to gain site licences or planning permission and all will face substantial delays to the commencement of development.

3.2. Siting - Where are the sites for new nuclear in an age of Climate Change?

Claims are frequently made by ministers and nuclear developers that sites for new nuclear energy are 'oven ready' for development. That is far from the case. Great British Nuclear has been charged with delivering 'the ongoing flexibility needed to ensure there are enough sites to fulfil the country's nuclear ambitions, while ensuring that siting of new nuclear power stations is appropriately constrained and that nuclear power stations are only sited in suitable locations'[27]. There are only a handful of sites presently in the frame deemed 'potentially suitable' though not yet available for nuclear deployment and the number is bound to diminish essentially for one reason – Climate Change. This is making siting new nuclear power stations an even larger stumbling block to the programme than it has been in the past.

There are six sites passed on from earlier new nuclear campaigns. In 2010, the Government identified eight sites as potentially suitable for large new reactor projects subject to detailed investigations. Since then, the devastating consequences of climate change have become much more apparent and it cannot be assumed that the existing sites carried forward will survive scrutiny using rigorous siting criteria.

In 2024, only two sites (Hinkley Point and Sizewell) of the eight listed in 2010 had been allocated to developers. The six unallocated sites remaining from the list identified for deployment by 2025 (i.e. Oldbury, Wylfa, Bradwell, Moorside, Hartlepool and Heysham) have been carried forward in the Government's consultation on the new approach to siting beyond 2025'[28]. The Government cites 'inherent positive attributes' that make them potentially suitable for new nuclear development. These listed sites 'retain certain advantages, such as existing site characterisation work, skilled workforce and grid connections' (p.15). This is only partially true and does not apply to all six sites; not all have appropriate grid connections; few have a localised skilled workforce; nor can it be claimed that they all have widespread public support. In some cases, the opposite is the case. The 'potential suitability' of available sites has scarcely been tested. Only Wylfa has completed the DCO (planning) process but no decision was issued; Bradwell reached pre-Application; the rest have not proceeded through the decision-making phases. The Moorside site, adjacent to Sellafield, will be needed to allow the safe decommissioning of the Sellafield site. It is unlikely, even with a highly permissive decision-making process, that all six sites will be found suitable for deployment. Certainly, some at least

[27] National policy statement for new nuclear power generation: new approach to siting beyond 2025 – consultation document https://www.gov.uk/government/consultations/alternative-routes-to-market-for-new-nuclear-projects

[28] See note 17

will fall because of the impacts of Climate Change over the long term. Yet, as things stand, these six sites are the only sites available because no other potential sites have been identified. It is nearly 50 years since the last new reactor site (Torness in Scotland) was chosen and it is clear there will be significant local opposition to any new site

There are simply not enough existing sites in prospect in the time available with the potential to accommodate a 24GW programme of new nuclear power plants.

The lack of available existing sites led the Government to abandon Strategic Siting Assessment in 2024[29] and embark on its 'new approach' to siting in the hope that it would yield more sites able to accommodate a variety of technologies. In doing so the Government has ditched a rational siting strategy in favour of a market based randomised free-for-all.

The new approach can be characterised as criteria-based and developer-led. It is intended 'to be sufficiently flexible to enable a variety of siting options' (p.20). It is framed in the belief that 'developers are better placed to locate and then screen potentially suitable sites' (p.20) using a set of site assessment criteria. Developers will be advised and assisted in the process by the ONR and PINS. This seems an open invitation for retrospective justification for a pre-determined site instead of a strategy whereby criteria are applied first to identify potential sites. The new process relies on developers possessing the expertise, resources and motivation to identify sites beyond the usual and diminishing suspects that are dangled in front of them. It seems unlikely that developers will break into new territory where there is likely to be resistance from local communities. The approach is wide open to criticism such as that levelled by Colchester City Council: "the hybrid approach to site selection suggested is completely muddled and will be confusing to all who engage in the process"[30].

It is inconceivable that new nuclear will offer much mitigation to the problem of global warming; it is more likely that if such a gargantuan 24GW programme goes ahead it will be late and fall far short of the target capacity. Among the risks facing potential sites are: impacts of higher temperatures and drought on nuclear operation; impacts of changing weather conditions on ground conditions; impact of Climate Change on infrastructures; sea level rise, storm surge and coastal processes causing potential degradation of sites during operation, decommissioning and waste management.

As attention shifts from policymaking and finance to implementation of the 24GW programme, the big hole at the heart of the process – the lack of suitable sites in an era of Climate Change impacts – comes into focus.

4. Nuclear Power – Unsustainable and Indefensible

In this section we turn to the abiding reasons why nuclear energy should not be entertained as a part of the future mix as we transition to a net zero carbon future. A large-scale expansion of nuclear energy of up to 24GW would immeasurably increase the three most fundamental reasons why nuclear should be abandoned. One is the danger of radioactive releases arising from operating power stations and radioactive waste stores. The second is the cataclysmic megarisk of widespread destruction caused by a major accident or deliberate intervention. The

[29] See note 18
[30] Colchester City Council Response to consultation on the new approach to siting beyond 2025 Response ID ANON-2PFS-ZQB8-Z

third is the global risk from the links to the military nuclear sector including nuclear weapons deployment and proliferation. These risks are present at the local and global scale.

4.1. Risk from radioactive waste and decommissioning

The timescale for a nuclear project from inception to completion of site clearance at the end of its life is huge. From project inception to operation will take about 20 years, plant lifetime is now expected to be 60 years or more while the time to complete decommissioning is uncertain but unlikely to be less than 60 years. Most of the UK's 19 civil nuclear power stations have been retired, the first in 1987, but there is no firm timescale to complete decommissioning, including disposal of radioactive wastes, at any of them. The indicative forecast is for the first ones, Trawsfynydd and Dungeness A, to be completed by the 2050s, with the remaining nine Magnox (the UK first-generation design) stations at different points until the last in the 2080s. The seven Advanced Gas-cooled Reactor (AGR) stations (successor to Magnox) will follow on from completion of Magnox decommissioning and the first AGR reactor sites might complete decommissioning after 2100. Sizewell B which is unlikely to be closed until mid-century will not reach a point of final site clearance until well into the next century. As for new nuclear stations such as Hinkley Point C, if it begins operation in the 2030s, it will be the end of this century when it closes and towards the end of the next century before final site clearance assuming a deep repository,[31] a Geological Disposal Facility (GDF) is available for disposal of the wastes. As the Committee for Radioactive Waste Management (CoRWM) said long ago: 'New build wastes would extend the time-scales for implementation, possibly for very long but essentially unknowable future periods. Further, the political and ethical issues raised by the creation of more wastes are quite different from those relating to already committed - and therefore, unavoidable - wastes'[32]. Therefore, the method of establishing the suitability of a site for new reactors will require an extremely rigorous process requiring the site to be safe and secure 160 or more years forward. That is not a tenable proposition.

Radioactive waste management remains a major obstacle to new build. These dangerous wastes will be in stores on vulnerable sites far into the future creating risks for future generations for which a GDF, even if it can be built, may not be available in time.

4.2. Risk from routine or accidental release of radioactivity

One risk is the danger to human health and environments of routine or accidental radioactive releases arising from operating power stations and radioactive waste stores. The other is the cataclysmic megarisk of widespread destruction caused by a major accident or deliberate intervention. These risks are present at the local and global scale. That nuclear accidents sometimes involving widespread radioactive releases occur is well documented.[33] Major nuclear accidents, on the scale of a Chernobyl or Fukushima, can, do and will occur, so much so that Charles Perrow has dubbed them 'normal accidents', that is accidents arising from interactive complexity and tight coupling in nuclear technologies that, from time to time, but

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[31] It is expected waste would be disposed of at up to 1km depth.

[32] Committee on Radioactive Waste Management, *Managing our Radioactive Waste Safely, CoRWM's recommendations to Government.* November 2006, p.15 CoRWM Doc.700 https://assets.publishing.service.gov.uk/media/5a7c52e540f0b62dffde157c/700_-_CoRWM_July_2006_Recommendations_to_Government_pdf.pdf

[33] Benjamin Sovacool, Contesting the Future of Nuclear Power: A Critical Global Assessment of Atomic Energy, Singapore World Scientific, 2011

inevitably, result in system failure and catastrophic consequences. He posits that 'the probability of a nuclear plant meltdown with dispersion of radioactive materials to the atmosphere is not one chance in a million years but more like one chance in the next decade'[34].

Accidents are impossible to legislate for. Adequate preventative and protective measures are required to protect the public from routine and accidental releases of radioactivity in the area surrounding a site. It needs to be emphasised that in the event of a low probability/high consequence accident the impacts could be devastating over a wide area and cannot be anticipated or protected against.

The risk from radioactivity releases is a major reason why nuclear power stations, large or small, should not be built.

4.3. The Military Connection

There is another possible explanation for the UK's undying commitment to civil nuclear energy, the link between civil and military nuclear power. Civil nuclear energy supports key capabilities and skills necessary for the maintenance of the UK's nuclear fleet and weapons and provides a hidden subsidy from the taxpayer to the military. Stirling and Johnson have persistently argued that civil nuclear is integral to the maintenance of the UK's nuclear deterrent.[35] Hence, civil nuclear helps to secure the UK's international status, including membership of the UN Security Council. The link between civil and military nuclear applications, for long discounted, has been explicitly acknowledged by government. The Nuclear Roadmap confirms that government 'is working closely with MOD and the defence nuclear sector…to tackle shared challenges and identify further opportunities to collaborate'[36]. Whether support for the military sector requires a civil programme of up to 24GW must be open to doubt. While military links may be a contributory factor in the development of civil nuclear power, it does not signify that it is an intrinsic reason for its survival.

In the surge of enthusiasm for a reboot of the nuclear energy programme the debate has been on cost, timing, technology and siting. The need for nuclear has been taken as a given and the implementation of a programme of up to 24GW an overriding priority for the UK's energy and environmental security. Long standing and fundamental concerns about the problem of the nuclear legacy, its intrinsic risks to safety and security and its unambiguous links to the military nuclear sector have been subordinated.

A 24GW nuclear programme by 2050 is from a technological and economic viewpoint impossible to implement. In any case, completion of the Hinkley Point C and, perhaps, Sizewell C would be more than sufficient and is already detracting from the more cost-effective, implementable and sustainable alternatives.

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[34] Charles Perrow, Normal Accidents Living with High-Risk Technologies, Princeton University Press, 1999 p.4
[35] Andy Stirling and Phil Johnson Illuminating the Nuclear Complex: Implications of hidden links between military and civil nuclear activities for replacing negative with positive irreversibilities around nuclear technologies, York IND Research Report March 2024
[36] Civil Nuclear: roadmap to 2050 Department for Energy Security and Net Zero p.61 https://assets.publishing.service.gov.uk/media/65c0e7cac43191000d1a457d/6.8610_DESNZ_Civil_Nuclear_Roadmap_report_Final_Web.pdf

5. Conclusion

The history of nuclear power worldwide is of ambitious programmes falling far short of plans, with huge delays and time overruns. The impact of these failures has been masked by less than expected electricity demand growth and the availability of quicker and cheaper alternatives. However, there has been a significant opportunity cost to money wasted on these ill-fated policies. For decades UK governments have been seduced by claims from the nuclear industry that, this time, a major nuclear programme will go to plan. More than ever before, the latest programme will be dependent on huge quantities of public money with financial risks falling squarely on the public. It strains credibility that, with a massive hole in the finances and urgent priorities in health and welfare, the justice system, education and infrastructure, the idea of plugging the nuclear black hole will be met with universal enthusiasm. The signs are all too clear, the rhetoric has no concrete foundations and the programme will vaporise slowly, perhaps but with inevitable termination. Future demand is again being over-estimated and cheaper, quicker alternatives exist. The real cost of nuclear power continues to rise and the delays increase, while the cost of alternatives continues to fall. The latest prices for off-shore and onshore wind, and solar photovoltaic are about half the likely price for new nuclear.[37] The IEA reported that over the 10 years from 2013-23, battery costs fell by more than 80%.[38] Authoritative analysis by an Oxford University team found that UK energy demand could be halved by 2050 with substantial welfare benefits in terms of reducing fuel poverty.[39]

While government documents on nuclear invariably speak of things moving 'at pace', the reality is that in the period since the 24GW programme was announced, delays have mounted. In only two years, the completion date for Hinkley Point C went back up to four years and Sizewell C's FID has been delayed by at least three years. By October 2024, more than two years after it was announced, Great British Nuclear barely exists. It has no permanent executive, no premises and no independent budget and its staff are temporary secondees. Great British Nuclear's first substantive task was to complete the SMR competition and award contracts. In October 2023, it expected this to happen in spring 2024. It now seems likely this will not happen until the end of 2024, so a task expected to take about 6 months will, if there are no more delays, take 15 months. The new Labour administration has yet to say whether Great British Nuclear will remain as a separate body or whether it will be absorbed into its own new creation, Great British Energy This uncertainty could delay the decision further.

Despite the sound and fury, the Great British Nuclear project is bound to fail. Its contribution to achieving net zero by 2050 will be nugatory. No amount of political commitment can overcome the lack of investors, the absence of credible builders and operators or available technologies let alone secure regulatory assessment and approval. Moreover, in an era of climate change there will be few potentially suitable sites to host new nuclear power stations for indefinite, indeed unknowable, operating, decommissioning and waste management lifetimes. And there are the anxieties and fears that nuclear foments, the danger of accidents and proliferation and the environmental and public health issues arising from the legacy of radioactive waste scattered on sites around the country.

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[37] https://www.gov.uk/government/publications/contracts-for-difference-cfd-allocation-round-6-results/contracts-for-difference-cfd-allocation-round-6-results-accessible-webpage
[38] IEA, "World Energy Outlook Special Report—Batteries and Secure Energy Transitions", April 2024
[39] https://www.creds.ac.uk/creds-research-findings/

Abandoning Sizewell C and the SMR competition will lead to howls of anguish from interest groups such as the nuclear industry and trade unions with a strong presence in the sector. It will also require compensation payments to be made to organisations affected. However, the scale of these payments will be tiny in comparison with the cost of not abandoning them.

It is our hope that sanity and rationality may prevail and lead to a future energy policy shorn of the burden of new nuclear and on a pathway to sustainable energy in the pursuit of net zero.

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