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Expanding Horizons: The Role for New Nuclear in the UK's Energy Mix

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R E S P U B L I C A R E C O M M E N D S



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About Horizon

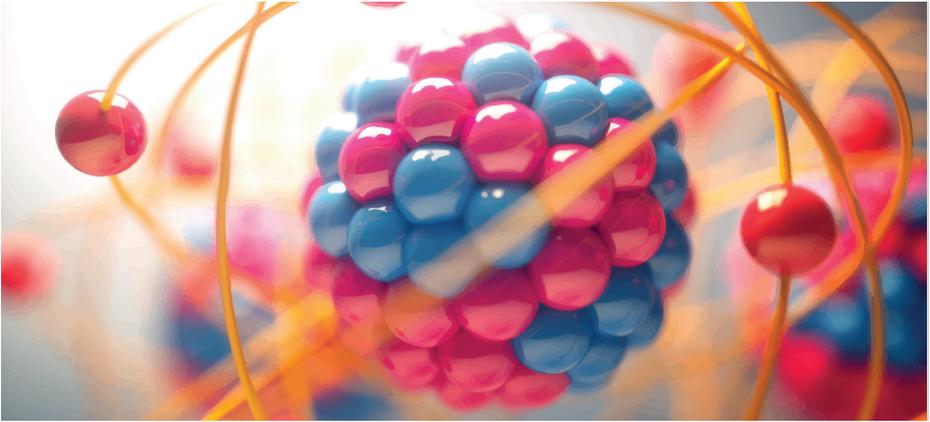
Horizon Nuclear Power was formed in 2009 to develop new nuclear power stations in the UK. It was acquired by Hitachi Ltd of Japan in November 2012. The company is developing plans to build at least 5,400MW of new nuclear power generation in plants at Wylfa on the Isle of Anglesey and Oldbury-on-Severn in South Gloucestershire. Its power station sites will each employ 850 people once operational with a construction workforce of between 8,000 and 10,000. For more information about Horizon, please visit www.horizonnuclearpower.com.

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1. Introduction

The UK is home to the world's oldest nuclear energy programme. In 1956, this country opened the world's first commercial nuclear power station at Calder Hall (now Sellafield) in Cumbria, the first in a fleet of nuclear power stations that would come, at its peak, to produce more than a quarter of the UK's energy.¹ The UK led the world in harnessing the power that nuclear technology unlocked and, in doing so, was able to keep homes warm and lit without dependence on imports such as gas from overseas. We exported the technology to other countries such as Italy and Japan, and were world-leading in many aspects of the field. The nuclear programme

embodied the virtues of ingenuity, invention, and self-reliance that have long been part of Britain's national story.

Today, though, the future of nuclear power in Britain is being called into question. A pipeline of new projects – from Hinkley Point C in Somerset, to Wylfa Newydd on Anglesey, to Bradwell in Essex, to Moorside, back where it all began in Cumbria – all stand ready to take up Britain's new nuclear baton. Each of them can make a crucial contribution to the UK's future energy mix, and together would form a significant revitalisation of the sector in the UK. Each of them, also, would

create many thousands of jobs, cultivate new high-level skills in our economy, and help to ensure Britain's energy security long into an uncertain future. Each would also play a vital role if we are to create in this country a platform for further innovation in energy. But the new nuclear programme requires significant ongoing political support if it is to succeed.

Long gone are the days of the Central Electricity Generating Board (CEGB)², where government planning could pave the way for future power stations, deciding how many (and what type) of power plants to build in order to power the nation. With electricity now a privatised sector for roughly the past two decades, the picture is now very different – it is power companies that decide what stations build, but government can still influence the choices that they make, by providing the political backing needed to facilitate this. In no aspect of the sector does this ring more true than with nuclear, given the costs and timescales involved. The costs of building a new nuclear power station that will operate for 60 years or more are significant, and the risk attached to such large-scale projects is unavoidable. Britain's new nuclear programme, currently, is ready to go and is necessary to meet Britain's medium and long-term ambitions on both energy security and decarbonisation. Successive administrations of all political stripes have given their backing to new nuclear over the last decade; but sustained political will

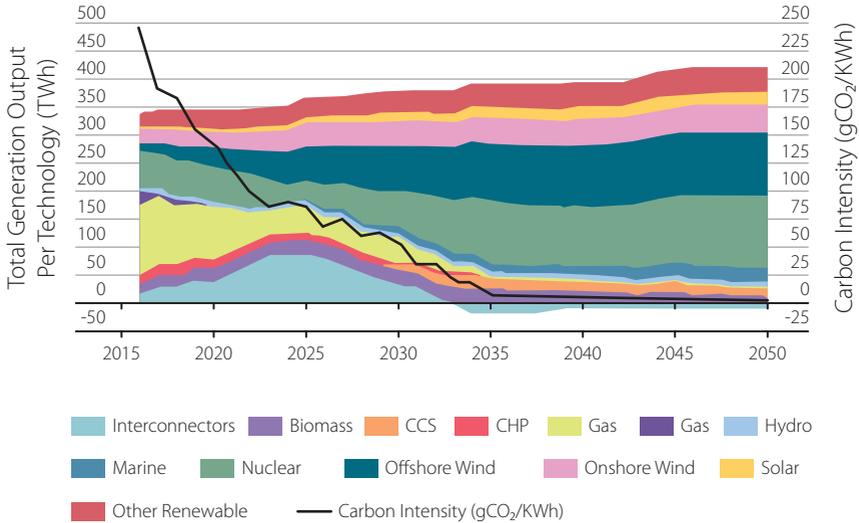
and commitment over the coming years are absolutely vital to help finish the job.

But just at this point questions have again begun to be raised about whether the Government is right to back new nuclear and these questions all have some legitimacy. New nuclear is very capital intensive and the nature of such large-scale infrastructure projects means that they take time to come online. Brexit and the economic uncertainty that comes with it means that the Government is wary of making significant financial commitments, whilst the promises of revolutionary improvements in both renewable energy production and in battery technology appear to offer an attractive potential alternative.

None of these concerns and cautions should be ignored. It is right and proper that Government carefully considers the new nuclear programme in the context of the UK's wider economic position, and indeed it is also important that innovation elsewhere in the energy market is considered carefully and closely. But those who argue that these factors should lessen our enthusiasm for new nuclear are – frankly – drawing the wrong conclusions.

New nuclear is not an *alternative* to renewable and battery technology – it is a (significant) part of the wider solution, and is a platform that makes innovation and investigation in these other areas much, much more viable. In chapter

UK's Energy Mix – Generation output (2015 – 2050)



Source: The National Grid, Future Energy Scenarios, July 2017

This figure shows electricity output for the 'two degrees' scenario model that estimates higher electricity demand due to economic growth. This is the only scenario that achieves the 2050 carbon reduction target.

two, we will explain why and how new nuclear should be central to this country's longer term energy strategy – and why it is vital to our aspiration for a sustainable, low carbon, and secure energy mix.

Whilst it is certainly true that Brexit brings economic uncertainty, that is precisely the reason why we must invest in things now; both in order to secure the UK's correct future energy mix, and indeed also

to lay the ground for our future global relationships outside of the EU. In chapter three, we will explain how new nuclear can help the UK to forge strong, profitable, and close trading relationships around the world – clearly vital in the post-Brexit era in which we will soon find ourselves.

Britain is shaping for itself a new place in the world at the same time as we seek to tackle deep and entrenched domestic

challenges. As the Prime Minister has argued, we cannot succeed in either endeavour unless we are prepared to be bold³. This statement rings particularly true with new nuclear prospects in the UK. The new nuclear programme alone will not solve all of the UK's energy and trade challenges, but it should be understood as more than simply one part of the energy mix. Investment in new nuclear also gives Britain a secure platform for innovation, exciting new opportunities for high-value, high-skills trade, and a set of deep relationships with powerful global trading partners. These benefits far outweigh, and indeed should justify, both the costs and the risks of the new nuclear pipeline.

This report makes a new, broad case for new nuclear in the UK, and explains the significant and wide-ranging benefits involved. It recommends that Government builds on the support it has already provided to the industry and, confidently and proudly, to move forward together to deliver the benefits which we outline below.



2. Platform for Innovation

The debate about meeting Britain's future energy needs is unfortunately often characterised by unhelpful absolutes. A range of options – nuclear, renewables, biomass, fossil fuels – are often presented as competing alternatives whilst, in fact, each are important and interdependent parts of the answer. If there is a real desire to meet climate change targets then in fact *all* low-carbon sources need to be employed together, rather than doing a bit with one source, and not others. One should, therefore, not view energy policy as a process by which one trades off mutually exclusive methods of production in order to arrive at a single-source

solution. Instead, energy policy must be focused on building and maintaining the right diverse mix in order to provide the UK with energy security, resilience, low carbon emissions, and adaptability to future challenges and innovation.

Nuclear energy sometimes feels like the odd one out in energy policy. Older, carbon-based production is widely acknowledged to be unsustainable. By being relatively cheap and easy to implement, however, it remains central to our energy reality in the here and now. On the other hand, renewable energy (including solar, wind and tidal) meets our aspirations for cleaner

and more sustainable energy. Although costs are reducing quickly, technologies are limited by their ability to generate power around the clock and can be expensive to install at scale once all system costs are factored. Increasing renewable capacity comes at a premium and with significant restrictions on the contributions they can bring to the total energy mix.⁴ Nuclear perhaps falls somewhere in-between. It is still relatively new technology, but could be considered to lack the bleeding-edge feel and freshness of advanced renewables. It is sometimes considered expensive, when compared to fossil fuels, but it is reliable and capable of high power output which is uniquely well-placed to supplement the intermittent and lower capacity generated by renewables. It does not fit easily into the world-view of either climate sceptics (who believe that we are making an expensive and foolish error by abandoning carbon fuels too soon) or of the most ardent campaigners for renewable energy (many of whom assert that nuclear is unnecessary as wind and other technologies improve).

This paper takes an unashamed view that nuclear technology will be important to protecting the UK's energy security into the future; and that it is an essential part of the solution. However, no-one should make the mistake of building the case for nuclear by arguing that the exciting alternatives are somehow illusory or undesirable. That position is unhelpful. Nuclear is not the future of the UK's energy needs alone, and nor is it needed grudgingly simply because

other technologies will fail to meet their promise. Nuclear matters to our energy mix because of the following reasons, which will be elaborated on in this chapter:

1. Our energy needs are increasing, because of new technology –

New nuclear is not needed simply because we struggle to fulfil our current energy needs, or because our existing capacity is on the decline thanks to demand for cleaner energy and the retirement of existing coal⁵ and nuclear power stations. Energy demand tends to ever be on the increase, so the UK will in the future require far more electricity than now⁶. This is not necessarily a bad thing, and indeed could be celebrated by both those in favour of economic growth and by those deeply concerned about our environment. The growth of new high-technology and highly-skilled manufacturing will, however, place additional pressures upon the grid. The growth in the use of electric vehicles will also create massive new demands on our supply of electricity.⁷ The long-term need to electrify heat – in order to reduce the UK's dependence on natural gas – will also further increase demands on the grid. Finally, meeting the Government's cautious plans for new homes – there are projections that we should be building at least 200,000 new homes a year – requires yet more electricity generation.⁸ Even if we were able to meet our carbon commitments *and* meet current needs without new nuclear, it will not be possible to do so into the medium and long term.

Nuclear currently provides the UK with close to 50% of our non-carbon energy. As our demand for electricity rises, we will require a much greater stable baseload supply. Without new nuclear it is hard to see us meeting our medium and long-term ambitions and needs for greater production, more stable and secure production, and lower carbon production.

2. Innovation in generation requires security of supply

– It is natural for proponents of renewables, carbon capture, or battery technologies to see a new fleet of nuclear power stations as a threat. Faith in the ability of new technology to bridge the energy gap, combined with the idea that urgency breeds innovation, means that many see nuclear energy as a redundant technology. However, this concern is unhelpful because these technologies are not yet proven, and sole reliance on this fails to see the broader picture. Whilst the promise of technologies across a range of areas is exciting, as yet none of the above is of sufficient maturity or scale to answer the UK's twin needs of energy security and carbon reduction. Nuclear, therefore, has a crucial role to play in addressing both challenges. However, it should be noted that investing in new nuclear is not an alternative to future innovation, but is in fact an enabler. By creating a secure and sustainable supply of electricity, the UK can create the right infrastructure and framework for experimentation with new renewable and storage technology – de-risking the UK energy market for

innovation so that this is a safe, secure, and open-minded market in which to develop new forms of generation and storage without harm to consumers. In this way, new nuclear can be a platform for further innovation rather than a barrier.

3. Faster, smaller, cheaper new nuclear requires expertise and experience

– One factor often forgotten by those who would dismiss new nuclear as 'old technology' is that innovation within nuclear remains an exciting potential partial answer to the UK's energy 'trilemma' – that is the balance and inter-relationship between energy affordability, climate change, and energy security. Whilst our existing nuclear capabilities provide much of the answer to the energy and environmental needs that we face today, new (smaller, cheaper and quicker to build) nuclear technologies may well form part of the answer to tomorrow's challenges. It is important that we deliver on our current pipeline of projects in order to meet our existing and looming energy challenges, but with foresight this investment would bring with it other, longer-term benefits, such as next generation fission reactors or even nuclear fusion as that technology reaches maturity. By delivering on the current pipeline of new nuclear projects we can ensure that Britain has the skills and the technology it needs to further improve upon and innovate with nuclear technology.

On its own, new nuclear will not solve the UK's energy challenges. But neither will

any of the proposed alternatives. So it is important to have a broader view of the overall solution required – there is no quick or single-fix. New nuclear helps significantly to create the right infrastructure, skills and market for further innovation as part of this country's dynamic and ongoing mission to meet its energy needs as cheaply, securely, and greenly as possible.

Security of supply

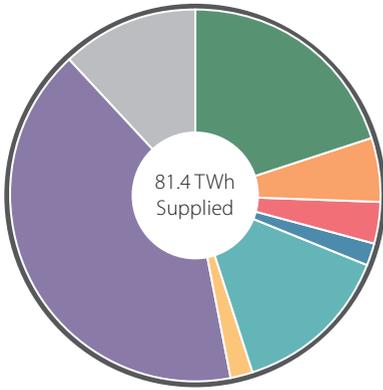
By 2025, if the UK is to meet its obligations under international treaties and ensure that electricity is generated securely and safely, this country will have closed its last few remaining coal-fired power stations.⁹ Our centuries-long dependence on coal will finally be drawing to a close. Not only will this mean that the UK is a greener country, contributing less to global pollution and climate change but, if we make the right choices about what should bridge the energy supply gap, it can mean that energy generation is more secure and less exposed to global market fluctuations. It heralds a potentially bright future – one in which our lights are kept on, our homes kept warm and (increasingly) our cars are kept on the road without damaging the environment and without dependency, for supply of fossil fuels, on foreign powers.

For context, fossil fuel electricity production currently accounts for more than 50% of electricity on the UK grid, whilst nuclear and renewables combined account for

around 45%.¹⁰ Fossil fuels contribute significantly more when one considers the broader sector of energy production in the UK and worldwide as a whole (i.e. when one includes fossil fuel use in heating, transport, and industry, and not just in electricity production). The challenge of decarbonising UK energy is already enormous. But the gap between the energy that we need and the energy that we can produce without recourse to fossil fuels looks set to grow. In part, this is exacerbated by the upcoming retirement of many existing nuclear stations, making their replacement by new nuclear even more urgent. For every household that is added to the UK grid, an average additional burden of 3,940kWh per year is placed on the grid.¹¹ If the UK were to meet its annual home-building targets then we would need to find a regular and secure supply – above and beyond the UK's current levels of supply which are around 788,000,000kWh per year.

Currently, the majority of energy used to heat homes in the UK comes from natural gas. It is difficult to see how the UK can reduce dependency on natural gas, which produces carbon dioxide when burned and which increasingly makes the UK dependent on foreign supply, without investing in a fleet of new nuclear power stations. Alongside renewables, however, new nuclear could pick up the additional burden on the grid generated by retirement of existing coal and nuclear plants, and that switching to electric heat

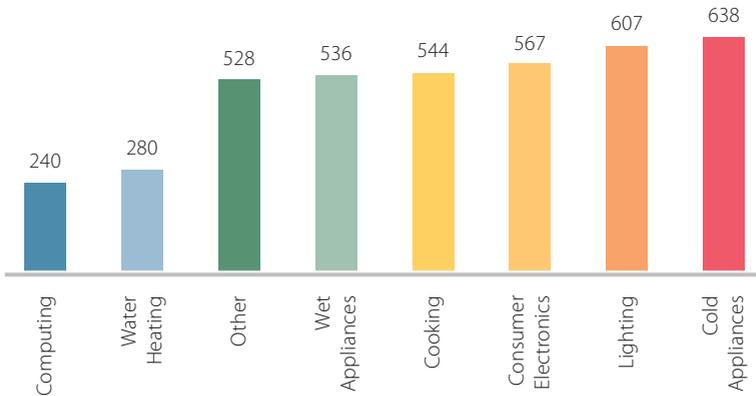
Britain's Electricity Supply Mix in the First Quarter of 2017



	Output (TWh)	% of Mix
● Nuclear	16.5	20.2
● Biomass	4.4	5.4
● Imports	3.0	3.7
● Hydro	1.6	2.0
● Wind	11.3	13.9
● Solar	1.5	1.9
● Gas	33.3	40.9
● Coal	9.7	11.9

Source: Drax Electric Insights Quarterly – Q1 2017

Average Electricity End Use in UK Homes (kWh/year)



Source: Ovo Energy

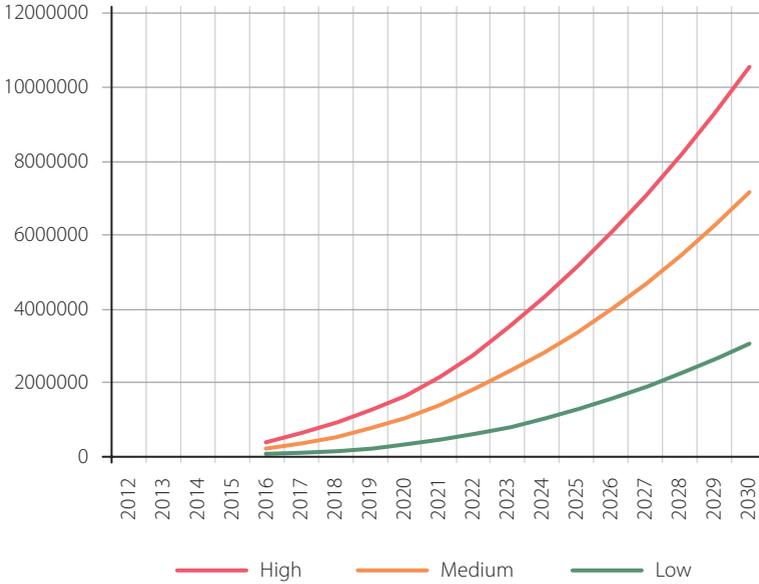
would also create. Promoting household switching to electricity for both heat and for home cooking is fundamental to the UK's chances of meeting its obligations and emissions targets in 2030 and beyond but, as yet, there is no strategy for moving households from gas to electricity.¹² In part, this is a consequence of Government's understanding of the huge strain that such large-scale switching would place on the grid – particularly at peak times – and of our inability to meet such new levels of demand. With its reliability and ability to generate electricity at a scale unmatched by renewable alternatives, however, new nuclear represents the best chance that the UK has of bridging this future energy gap.

It is not simply our growing population that affects our use of electricity. Changes to how we use technology, and what technology is available, also drive energy use. If the UK is to meet its target to reduce greenhouse gas emissions by 80% of 1990 levels by 2050 then it will need to significantly reduce the number of petrol and diesel cars on its roads.¹³ That will require mass take-up of electric vehicles – enabled both by improvements to electric vehicle technology and by a significantly wider roll-out of charging stations for such vehicles (the UK currently has a network of just over 10,000 charging points).¹⁴ The demands that electric vehicles are likely to place on the grid are exacerbated by the behaviour of electric vehicle owners – who, quite understandably, tend to charge their vehicles in the evening

when they return home from work. This not only adds to the overall additional demand that electric vehicles inevitably create, but also means that they place a specific strain on the distribution network at peak energy-use times, meaning that more overall capacity is needed.

Promoting electric vehicle take-up is an implicit policy aim of Government, as demonstrated by exemptions from Vehicle Excise Duty (VED), and greater take-up is necessary if the UK is to come close to meeting its international targets on greenhouse gases. This country is already making progress towards making electric vehicle use more practical for drivers – the Automated and Electric Vehicles Bill will, for example, require motorway petrol stations to make charging points available, hugely increasing our network and making take-up much more attractive to distance drivers. However, greater use of electric vehicles does not come without a cost. What a national transition from diesel and petrol to electric fuel would represent is a wholesale transfer of the energy burden – one that is placed onto the national grid. On current projections, at least half (or potentially even the significant majority) of the UK's vehicles will be electric in 2050 (a proportion that will have to grow if we are to meet our targets).¹⁵ This equates to enormous new demand on the National Grid. It is also worth noting that even if the technology were immediately available to transfer to a network of smaller, more flexible power generation - of the sort often argued for by

Government Forecasts for the Uptake of Electric Vehicles



Source: Department for Business, Energy and Industrial Strategy

campaigners - it is unlikely that the National Grid would be able to adapt quickly enough in order to manage that supply properly. Transitioning to a decentralised energy network will take huge investment over a long period of time and is likely to occur only at an incremental pace.

The above examples illustrate the depth of the challenge facing the UK if it is to meet the twin demands of meeting

consumption need and also reducing carbon and emission of greenhouse gases. New technology, even that which reduces the UK's overall levels of pollution, such as electric vehicles, places an additional burden on our energy supply. At the same time, we need to decommission and retire those power stations that generate more than half of the electricity used in this country. Even were we able to meet our current needs using renewable technology

alone the UK cannot possibly hope to bridge the growing energy gap into the medium and long-term future by simply relying on wind, solar, tidal and biomass. All of these are, it should be stressed, part of the solution. But without new nuclear they will simply fail to meet existing demand – let alone the new energy needs that technology will create.

If the UK is to truly embrace the potential of a low-carbon, low-polluting future we will require significant new baseload electricity production. We will simply not be able to house our growing population properly without significant new energy production plugged into the National Grid. And we cannot hope to encourage the take-up of responsible, sustainable new technology such as electric cars and electric heat if we fail to ensure the security of our energy supply. Furthermore, the failure to build new nuclear capacity will, therefore, leave the UK with an unpalatable choice; either we will remain dependent on natural gas and imported petrol and diesel, or we will be forced to continue using carbon-heavy means to produce electricity in order to satisfy demand for marginally less polluting alternatives to our current car and home-heat solutions. The rollout of renewable technology at the scale necessary to try to meet the immediate and pressing demands on our grid would be at a scale – both in terms of innovation and of deployment – beyond anything achieved elsewhere in the

world to date. Therefore, the failure to deliver our new nuclear pipeline is a risk that could leave the UK unable to meet its obligations, unable to significantly reduce air pollution, and almost wholly dependent on imported fuels to keep our economy running. These are the perils of continued failure to replace, or expand on, our nuclear capacity.

Innovation

As outlined above, new nuclear provides a secure baseload from which we can safely pivot away from our dependence on fossil fuels in our domestic consumption. Transitioning from diesel and natural gas to clean electric cars and homes requires investment in a secure supply of electricity – one that nuclear can provide. It would be a mistake, however, to presume that investment in nuclear now precludes supporting and nurturing other technologies for the future. In fact, investment in nuclear should be understood as the platform from which innovation in many sectors can safely take-off.

Many opponents of nuclear power speak from a position of good faith. They recognise the urgent need to replace environmentally unfriendly electricity production – and fossil fuels in our homes and our cars – but they argue persuasively that alternative technologies will evolve to bridge the emerging gap,

or that their deployment on the huge scale necessary is possible and practical. Renewable technology such as wind, tide, and solar are often discussed – alongside options such as biomass and fracking – as alternatives, whilst carbon capture is promoted as a means by which we might continue to use natural gas and coal without negative environmental impact.

These claims for the alternatives are sometimes dismissed out of hand as pipe-dreams that have little to offer our urgent and pressing needs. In part, this is because many of the technologies advocated – particularly carbon capture and tidal – are simply untested or unproven at the scale required. In part, it is also because, even where the technology is reasonably mature, it is simply too unreliable to consistently meet our growing energy needs. Whatever the pitfalls and unknowns involved in speculating on future energy solutions, however, it is neither helpful nor necessary for supporters of nuclear power to disparage their potential. Each of the technologies outlined above – as well as advances in other supporting technologies such as battery storage – has great potential for the UK's future and deserves both support and investment. But what they are not is a complete solution now, or indeed a total solution in the future. What they require – if each is to be tested, developed and improved – is a secure, low-carbon, reliable national grid that gives them the time and the space they need to reach full maturity.

The UK started operating its first nuclear power station in 1956. At that time, the UK was a major producer of coal and was engaged in extremely promising prospecting for oil and gas off Scotland's coastline. Debates about the impact of fossil fuel consumption on the environment – let alone on the global climate – were rare and limited almost entirely to obscure corners of academia. Our energy supply of traditional coal and gas looked secure, the primary cause of disruption being human (industrial action) rather than political or practical. Yet we invested in the huge challenge of building a fleet of nuclear power stations anyway. In part, this exercise was driven by a determination not to be left behind when it came to strategic technology – particularly in the context of the Cold War. But, in part, this drive was also the product of relative energy security. Our security of supply enabled the UK to make decisions about, and invest in the question of, what came next. We were not bound by the need to urgently patch-up our existing infrastructure, and so were free to experiment and explore.

This is the lesson that proponents of as yet untested or unscaled technologies ought to learn from the UK's history of innovation. A secure baseload – provided by nuclear – will not hinder further innovation and the development of alternative technologies; it will provide the right circumstances for such efforts, as well as unlock other potential nuclear options for the future.

One can consider the alternative – in which the UK does not commit fully to a fleet of new nuclear power stations to meet existing and medium-term needs, but instead invests solely in supporting further renewable roll-out and in research and development for other technologies. Even at the most optimistic estimates, renewable-only supply would require unprecedented levels of investment and near ubiquitous adoption of as-yet-nascent battery technology and a profound change in consumer behaviour to even out UK demand peaks on an industrial scale. If any of these factors were to fail – or to prove disappointing in take-up or delivery – then such an effort would certainly fail. This would leave policy-makers with two choices: either consumers would be required to do without domestic energy at peak periods, or the UK would have to fall back upon old and environmentally damaging technology in order to plug the gap. Neither option is attractive, whilst the damage done to public consent for renewables would be enormous.

This is particularly the case when it comes to the difficult business of behaviour change. It is worth noting the levels of investment – both of time and of resources – that can be required in order to effect even marginal large-scale consumer behaviour change. From public health to utility switching, Government finds it hard to transition consumers en masse away from familiar behaviours even where there is a clear and individual gain or

benefit from such a change. Where we are asking consumers to change their behaviour to their immediate detriment, change is even harder to effect. This is why new nuclear is so central to our ability to meet the aspirations and expectations that we have set ourselves when it comes to decarbonisation – new nuclear will make it easy for consumers to adapt their consumption with relatively little noticeable or negative impact on behaviour, choice and lifestyle.

There is a further problem for those who urge the UK to depend on rapidly evolving technology to meet our future energy trilemma; their own arguments caution against such an approach. As such, advocates say, betting on nuclear when other options improve all the time looks risky. Why not wait until something better comes along? As outlined above, in truth we cannot wait – meeting the challenges of today and tomorrow requires bold solutions to massively scale-up our low-carbon electricity production. The retirement of existing coal and nuclear stations within the next decade makes the challenge of tomorrow even more urgent and pressing. This being the case, surely betting the house on one means of alternate production – from a range of untested and unscaled technologies – is deeply imprudent?

None of this is an argument against investing in new and emerging energy technology; quite the reverse. The UK

should do all that it can to be at the forefront of innovation in the production and storage of electricity (both for reasons of security and, as outlined in chapter three of this paper, for reasons of prosperity and global competitiveness). At this stage, however, the UK requires a platform for that future innovation that secures our supply in order to make the experimentation, research and development possible, without the urgent and naive demand that fledgling technology should fix all of our current energy needs. A country that can power itself, and power its transition away from fossil fuels, will be much better positioned to encourage a competition of technology and ideas in what comes next, than a country which must devote all of its resources to plugging emerging energy gaps as quickly and cheaply as possible.

Aiming for a low-carbon future requires boldness and commitment. In this sense, it is useful to apply an analogy to the role of existing nuclear technology and our proposed new nuclear fleet. Much as the debate over Brexit has coalesced around two extreme positions. So too, has much of the debate over the future low-carbon energy mix. On one side we have Hard Brexit (renewable/new tech-only) which demands that the future be embraced despite having few convincing answers as to what that future might look like. On the other we have Hard Remain (new nuclear-only) which insists that only a version of the status quo can provide for the future, despite the reality of global change. In

the middle is this report, arguing for an appropriate energy mix and a sensible transitional period that works, and seeks a more concrete future that facilitates greater possibilities. New nuclear is the bridge between where we are now and where we wish to be – between dependency on fossil fuels and a truly mixed, low-carbon energy supply chain. It will secure our present as we make decisions about our future. It is the transition between the pressures of now and the promise of what is next – and, as such, it deserves support from those policy-makers who wish this country to be both secure and flexible as we meet our energy challenges for both the more immediate and longer term futures.

From new nuclear to next nuclear

None of what this report has said is meant to imply that nuclear itself is anything other than one part of our longer term energy future. Current nuclear technology allows us to build what we need now – a fleet of new, low-carbon, reliable power stations that can fuel both our transition away from fossil fuels and our efforts to innovate in energy production and storage. But nuclear technology has not stopped innovating since its early inception. New nuclear power stations that the UK is proposing to build today are markedly different – safer, cleaner, lower in waste production, and more efficient – than reactors in the earlier days of nuclear power. So, too, the nuclear technology of tomorrow has enormous potential.

A key development in nuclear energy production that holds great future promise for the UK, beyond the fleet of stations currently in the pipeline, is in a different form of reactor.

Small Modular Reactors (SMRs) are – as the name implies – smaller in scale of output than traditional nuclear power stations.¹⁶ They typically produce less than 300 MWe, compared to a typical output of around 1000 MWe for a standard nuclear reactor. Their modular construction brings several benefits – such as allowing SMRs to be easily transported from factory to site, thereby reducing both construction risk and the need for localised expertise. Their modular design also allows SMRs to be scaled up rapidly as demand increases, bringing greater flexibility of scale, and making SMRs particularly useful for generating power for emerging centres of manufacturing (which could of course be for emerging technologies) or for high-growth residential communities (such as the UK's long-proposed network of new garden cities).¹⁷ There are also cost and environmental benefits to SMR use; some manufacturers claim that waste is reduced via higher energy extraction from the fuel, for example. Known and respected British companies, such as Rolls-Royce, are developing ideas for SMR systems based off of traditional water reactor technology.¹⁸

Currently, SMRs are not planned for any of the pipeline of new UK nuclear stations though – this is an emerging technology

that also lacks the capacity to provide the scale of delivery required to bridge the UK's more immediate energy gap. It faces many of the same challenges that new battery technology and other emerging technologies do. Small Modular Reactors are also initially expensive to build and fail to produce economies of scale that are seen with traditional reactors. However, it is clear that there are many potential future uses for SMRs if the technology is improved, and if the UK is seeking solutions around the edges of our energy grid, having already secured supply through a mix of new nuclear and renewables. In particular, SMRs have a potential future role in meeting the graduated energy needs of emerging manufacturing clusters or new towns, despite not being ready for immediate deployment.

SMRs are not the only developing field in nuclear energy. Exciting research in related fields, such as molten-salt reactors and liquid metal cooling, points to a vibrant emerging generation of new nuclear technologies. These could well emerge into solutions that are cheaper and even easier to build than SMRs. The UK would seem potentially well positioned in these areas – particularly if there is a new nuclear renaissance beforehand to keep the industry strong and maintain the skills base.

If the UK is to benefit domestically from advances in nuclear technology, enabling us to power ourselves more cheaply, and in a more environmentally friendly way

beyond the 2030s and 2050s, we will need to invest in talent and expertise here in the UK. Rightly, successive governments have promoted research and development across the full spectrum of renewable energy innovation. But crucial to this country's growing global reputation as a centre of excellence in renewable energy has been the market incentives created by Government subsidy and support for renewables.¹⁹ That has created an environment in which it is attractive and rewarding to work in the UK renewables sector. In contrast, the long gap between new nuclear projects in the UK has drained our skills base and has left a gap on "UK PLC's" collective CV that impedes our ability to fully benefit from a global boom in new and next generation nuclear. A new nuclear fleet would not simply ensure that the UK was able to overcome its current and emerging energy trilemma, whilst creating the space and security for innovation in other energy fields; it could, and should, mark a renaissance for investment and innovation in future-thinking about nuclear energy in both the UK and beyond.

Transitioning to the future

The UK was at the forefront of the development of atomic energy in the 1950s. We constructed the world's first commercial nuclear power station, and exported that design (the so-called "Magnox") to other countries, including a joint project with the Japanese in building

their first station. The evolution of the Magnox into its successor design, the AGR, forms most of our current nuclear fleet. This current and previous fleet of enduring, low-carbon nuclear stations that provided the country with a secure, reliable supply of energy that we now know reduced our contribution to climate change and helped to secure and insulate the country from dependence on foreign sources of energy. France has, for many years, had the lowest carbon emissions per capita in Europe due to its high percentage of nuclear-generated power. Now we need to rediscover our love for nuclear energy in the UK. Where once nuclear was untested but exciting, now we benefit from its reliability and its potential for scale and future innovation. Only with a key role for new nuclear can we transition sufficiently rapidly and securely from carbon-based energy to clean power, as well as position ourselves for future possibilities, such as next-generation nuclear. By securing our supply of green energy, via new nuclear and renewables, the UK will have the capability to move road users into electric vehicles, and households away from gas, and to cope with rising demand. We will have the freedom and the flexibility to experiment with alternatives and to promote leading research and development instead of focusing our energy infrastructure investments on plugging short-term gaps. This represents the UK's best chance of meeting the immediate future with our options open for the much longer term. It means that we can continue to grow and

thrive as an economy – with consumer choice and consumption still viable – whilst meeting our urgent obligations to the environment and to decarbonisation.

As outlined in the next chapter of this paper, that won't just make Britain a greener and more secure country; it will help us to compete in the global economic race as well. New nuclear should be understood not as the catch-all

solution to our energy and environmental needs, nor as an old technology getting in the way of alternatives. New nuclear is a platform for innovation across the energy sector and a vital part of the answer to the UK's growing energy gap. It is the transitional arrangement towards a bright, low-carbon future.



3. A New, Global Market

As laid out above, new nuclear can help the UK to meet the challenges created by decarbonisation and by increasing demands on the grid. The UK is not alone in facing these demands, and we are not alone in identifying nuclear power as a crucial part of the solution. Around the world, countries that have previously depended upon fossil fuels are recognising that they face a pressing need to diversify and secure their energy mix. This presents the UK with enormous global opportunities – the chance to capitalise on the drive to transition to reliable, carbon-free nuclear. Not only can investment in – and support of – new

nuclear create new, high-quality jobs here in the UK, but it can prepare us to seize the global opportunities that any global shift to nuclear will present. The World Nuclear Association has estimated that if we are to meet our global commitments to decarbonisation, we will need to increase global nuclear capacity by 25 GWe per year from 2021.²⁰ That will require massive global investment – of which the UK can be a prime recipient – but is eminently achievable; it is roughly the same annual increase in production as was achieved in the 1980s.

Domestic jobs

It is important to understand the scale of employment that is already created by the nuclear industry simply to run and maintain our existing stock of nuclear power stations. Currently, around 78,000 people work in Britain's nuclear industry²¹ – many of them in highly-skilled, high-value STEM jobs. In addition, the UK nuclear industry offers apprenticeships and graduate training to around 3,000 young people, often in regions of the UK that lack high-skilled employment and training opportunities.²² These high-value jobs, many of which have transferable skills to related sectors, look set to grow as the new nuclear fleet comes online. The Nuclear Skills Alliance estimates that the total nuclear workforce will have to grow to over 100,000 by 2021 – representing a 43% growth in nuclear employment in just six years.²³

These numbers do not account for the growth in employment in construction, engineering, and related workforces that can be driven by a programme of investment in building our new fleet of nuclear power stations. For an example of the scale of economic impact of building the new nuclear fleet, it is worth looking at the specific example of Wylfa Newydd – a new nuclear power station that is proposed for the island of Anglesey in Wales.²⁴

Wylfa Newydd will be built adjacent to the site of a decommissioned power station (the Wylfa Magnox station) and

will house two Advanced Boiler Water Reactors (ABWRs) that will each have an expected lifespan of at least 60 years. Each will generate at least 1350 MWe. For context, this is greater than the amount required to power the whole of Wales with electricity.²⁵ During its construction, the new station will employ around 8,500 people at its peak – creating an enormous economic boost for the region, and offering hundreds of opportunities for training apprenticeships and for upskilling the existing workforce. Once the reactors are online in the mid-2020s, a highly-skilled, full-time staff of at least 850 will manage the station. The scale of the impact on jobs and the local economy in Wylfa Newydd is potentially transformative.²⁶ Replicated across the existing proposed new nuclear fleet (Hinkley Point, Wylfa, Sizewell, Oldbury, Moorside, and Bradwell), we can expect to see tens of thousands of new jobs created in the construction and management of nuclear power stations.

The sites proposed in the current pipeline of new nuclear projects also highlight the value that such projects can offer specifically to regions of the UK that have sometimes struggled to attract new infrastructure investment or to generate high-value, high-skilled jobs. Projects are proposed in Cumbria, in rural Wales, and in the South West – all regions that fall behind the national average in terms of productivity and GVA. Because new nuclear takes a long time to build it involves significant planning,

phasing and construction expertise (all arguments sometimes deployed against investment in new nuclear) so these projects generate substantial, long-term employment in the areas that host them. They also bring with them significant investment in local transport infrastructure (in order to enable the movement of heavy vehicles and equipment) and are often associated with local housebuilding and regeneration to house medium-term and permanent staff. In this sense, new nuclear projects create both local jobs and local growth beyond their direct impact.

But this is not simply about creating jobs at home. Upskilling our workforce through the construction of the new nuclear fleet – providing UK workers and SMEs with the opportunity to take a site from brown or green field to a fully functioning, working power station – will also equip the UK sector to exploit opportunities around the world.

Markets for global trade

Globally, the market for new nuclear projects is expected to reach £1 trillion in value over the next decade.²⁷ Countries around the world – such as the United Arab Emirates, Turkey and Saudi Arabia – are investing heavily in new nuclear in order to meet the same challenges as those facing the UK. These countries share with the UK an acceptance of the need to decarbonise their energy use and to

secure themselves against reducing stocks of fossil fuels. Many of these countries, unlike the UK, have little to no history of successfully constructing new nuclear power stations. There is, therefore, a huge and obvious opportunity for the UK to provide high-quality, highly-skilled services to emerging nuclear markets such as these. But taking advantage of these opportunities requires us to update and upskill our domestic workforce, and to demonstrate credibility through successful existing and recently completed projects.

The Secretary of State for International Trade has spoken frequently about the need for the UK to be better at exporting our world-leading services. As he pointed out, in a speech to the World Trade Organisation:

“Globalisation has eliminated many of the barriers of distance and time that once separated nations. As the global economy shifts towards services, knowledge and digital trade, the geographic proximity that underpins the traditional trade bloc will become increasingly less relevant.”²⁸

This is true in nuclear too. Many critics of the UK’s new nuclear fleet point to the fact that the pipeline of projects currently proposed depend on technology imported from key trade partners such as, Japan, rather than on domestically manufactured nuclear technology. It is true that the UK should look, in the future, to develop its domestic capacity

for nuclear innovation (as discussed in chapter two of this paper). But the UK is undertaking a massively complex programme of design and construction in order to build our new nuclear fleet – one that few other countries have recent and credible experience of delivering. It would be wrong to see the opportunities for global trade, created by the global boom in new nuclear, as merely resting in the export of reactor technology. The complexity of undertaking the design-build-operation of new nuclear power stations makes it difficult for countries without a legacy of success in this to successfully undertake projects at this scale. It is in these services that the UK can thrive and succeed in, with emerging nuclear markets, and the opportunities for high-value service exports are significant.²⁹

The UK can become a global powerhouse for servicing the global nuclear industry. Building on the legacy of our leadership – having been the first state to successfully build and operate a commercial nuclear power station – and on the success of the new nuclear pipeline, the UK should market itself as international leaders in taking a site from brown or green field to a safe, secure and functioning nuclear power station. In this way, our experience delivering projects using technology that has been imported will be an advantage; emerging countries are also importing their technology, and the UK will have the skills and the expertise to construct and operate power stations

running on globally leading technology anywhere in the world. It is this aspect of a growing, £1 trillion market where the UK can become expert, credible, and can generate new markets for global trade.³⁰

Cementing our partnerships

As mentioned above, the UK's current pipeline of new nuclear projects depend on foreign technology and on partnerships at the state-to-state level and below with key strategic trading partners. The Wylfa Newydd new nuclear station, for example, will be constructed using cutting-edge Japanese technology, and involves close work between the UK and Japanese governments. This development will represent a significant, multi-billion pound inward investment into the UK by a key non-EU trading partner. The Prime Minister and the Secretary of State for International Trade have both publicly suggested that a post-Brexit trade deal with countries, such as Japan, are a priority. Binding, long-term projects of mutual benefit and mutual investment – such as new nuclear – are important centre-pieces of such future trade relationships after Brexit. What is more, our nuclear sector relationships with Japan are genuinely reciprocal. Whilst projects such as Wylfa Newydd depend on Japanese investment and technology to succeed, the UK is an exporter of experience and technology in waste management and decommissioning into Japan. This is, therefore, an industry

that already functions at global scale and which fosters co-operation and interdependency between nations.

Crucial to the UK's ability to establish itself as an independent trading power outside of the European Union will be our ability to establish credibility and reliability with our current and potential partners. This means cementing relationships of trust and demonstrating this country's seriousness and ability to engage in long-term, binational projects of significance. The new nuclear pipeline presents a clear opportunity to demonstrate precisely these attributes of doing business with, and in, Britain. These are projects of scale and strategic significance, which help to connect the UK with key global trading partners and which provide proof of the UK's ongoing capability and appetite to deliver binational and multinational trade.

A global opportunity

As Brexit becomes a reality, the UK is reshaping and re-establishing its relationship with the world. We need to demonstrate that we are a country that wants to do business around the world. We need to ensure that a pipeline of new, highly-skilled jobs is delivered into the regions of the UK which lag behind in terms of growth and productivity. And we need to explore new markets where the UK can show credibility and expertise, in order to profit from the global shift away

from carbon. New nuclear provides the UK with opportunities on all three fronts. Forging ahead with our new nuclear pipeline will give the UK the opportunity to invest domestically in much-needed jobs and infrastructure; it will give us the expertise and recent experience that we need to service the global growth in nuclear energy; and it will cement our global partnerships with key trading allies.

The trust invested in this country by our partners in order to get our pipeline of new nuclear projects has been significant, and the strategic alliances formed on these huge projects can be as long lasting as the jobs and skills they deliver across the three generations over which they will operate. It is not difficult to understand, in light of Brexit and the UK's fresh urgency in developing and cementing global partnerships outside of the EU, how important these links will really be.



4. Conclusion

It can sometimes feel as though new nuclear is a “grudge purchase” as far as the UK is concerned. Since at least 2010 we have, as a country, been committed to a pipeline of new nuclear projects. Work has been undertaken – at vast expense – in order to prepare new nuclear projects across the UK, and successive Governments have signalled their support for the industry. And yet some continue to question the role nuclear can play. For the sake of the UK’s medium and long-term energy needs and ambitions – and in order to foster our global trading relationships – we need to answer these questions both confidently and definitively,

and to push on with our new nuclear programme. This is not as an alternative to other technologies; it is as a complement to them and as an enabler to them.

There is no doubt that there remains a political battle to be won – or re-won – on new nuclear. A significant factor in this country’s indecision about nuclear power is that we have allowed the case for nuclear energy to be framed poorly.

Nuclear energy should not be presented to government or consumers as either the only hope for our energy needs or as that grudge purchase, unwelcome but

necessary. Nuclear is part of the solution but it is not – and nor should it be – the end of the conversation; it gives us security of supply, low-carbon, and a springboard to innovate elsewhere. Advanced renewable technology, new battery and storage technology, next-generation nuclear, and innovation in areas that are as yet only a reality in the lab will all form part of tomorrow's answers. The key point is that new nuclear will give us the security to explore these options safely and with a focus on what can work best, rather than what can fill immediate and urgent need. New nuclear will give the UK a platform for innovation – helping us to transition away from carbon fuels whilst keeping our options open about what comes next.

We have also, as a country, failed to properly recognise the direct and the peripheral benefits that updating and upgrading this country's new nuclear fleet will bring economically. Tens of thousands of jobs will be created as we embark on constructing our new nuclear fleet, many thousands of jobs will be created in running and maintaining that fleet. What is more, this will be a process of sector-wide upskilling; hundreds of businesses and individuals will – through the new nuclear programme – acquire skills in design-build-operation that are in global demand as other countries look to nuclear to bridge their own energy gaps. There is a huge and untapped global opportunity to service a booming, £1 trillion industry. The UK has enormous legitimacy and credibility to bring to this market – but

that depends on refreshing and revitalising our experience, and our skills-base. Domestic new nuclear projects can help us to unlock those huge global opportunities.

Failure to push forward will bring costs – particularly in the shadow of Brexit. It will undermine faith in the UK's ability, and willingness, to live up to our commitments and to engage in large-scale international projects of significance. But investing in new nuclear is not important simply because it will cement our relationships with allies; it is vital to our position as a global leader in energy innovation, and as an energy-secure trading partner across the world.

New nuclear is an opportunity to be seized, but to do so it needs Government to build on the support that it has already shown and boldly tell UK consumers and our global partners that this country will invest in order to ensure that we benefit from the huge potential of a new nuclear fleet. To do so is to embrace the changing world with ambition but also with caution. Not to do so means Britain losing out.

Endnotes

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Prosperity

The UK has some of the highest levels of wealth concentration in the developed world. It has an economy where most mature markets are dominated by a small number of players and the barriers to entry are far too high. It is not an exaggeration to suggest that in many areas, from energy to banking to groceries, the UK has a monopolistic rentier rather than a market economy – a system in which certain individuals or small groups gain market dominance and excessive returns through anti-competitive practices. This conspires against innovation and is detrimental to the small and emergent businesses that generate growth and spread prosperity. Added to this, our education system, by specialising too early and often in the wrong areas, fails to produce students with fully rounded skill-sets. We are simply not equipping our future workforce with the means to safeguard our, and their, economic future. This is one reason why the real value of wages in proportion to growth in GDP continues to stagnate or fall. Our long-term productivity dilemma is a function of market capture and the effective de-skilling of the population.

We believe that shared prosperity cannot be achieved by simply tweaking the market. Britain needs significant demand and supply-side transformation, with new visionary institutions re-ordering our economy. We need long-term solutions that give power over wealth and assets, not simply handouts, to ordinary people. Central to this process of economic empowerment is an ethical, practical and adaptable education that gives people the skills to build their own businesses, or develop their own talents, rather than a conveyor belt to a service industry of low wage and less return.

New financial institutions to promote small business lending are required, and this involves smaller, more specialised and decentralised banks that can deliver advice as well as capital. We wish to explore ways in which all financial transactions can be linked to a wider social purpose and profit, which itself needs a transformation of the legal framework within which economic transactions take place. We believe that the future lies in the shaping of a genuinely social market which would be in consequence a genuinely free and open market. Internalising externalities and creating a level economic playing field in terms of tax paid and monopolies recognised and challenged, remains beyond the scope of contemporary governments to deliver. Such a vision requires new concepts. The viable transformative solutions lie beyond the purview of the current visions of both left and right in the UK.

PROSPERITY PROSPERITY PROSPERITY PROSPERITY

The UK is home to the world's oldest nuclear energy programme. We led the world in harnessing the power of nuclear technology, exporting our expertise to other countries. Today, though, the role of nuclear power in Britain's future energy production is less certain.

In this report we argue that new nuclear is not an alternative to renewable and battery technology - it is an important part of the wider solution providing a platform that makes innovation and investigation in these other areas much more viable.

Here we explain why and how new nuclear should be central to this country's longer term energy strategy – and why it is vital to our aspiration for a sustainable, low carbon, and secure energy mix. And we describe how new nuclear can help the UK to forge strong, profitable, and close trading relationships around the world – clearly vital in the post-Brexit era in which we will soon find ourselves.

This report makes a new, broad case for new nuclear in the UK, and explains the significant and wide-ranging benefits involved.

HORIZON

NUCLEAR POWER

R E S P U B L I C A R E C O M M E N D S