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# Special Issue on Bradwell Consultation

## Preface

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https://www.nuclearpolicy.info/news/nfla-submits-views-bradwell-b-development-not-required-cheaper-cleaner-renewable-energy-alternatives/

## The Consultation Exercise

This Stage One consultation exercise is being held at the height of the coronavirus pandemic lockdown. The consultation began on 4th March 2020. It was intended to run for 12 weeks until 27th May 2020 and include 15 public exhibitions and events, but 10 of these have now been cancelled. The end date for the consultation has now been extended to 1st July.

We agree with the Blackwater Against New Nuclear Group that: "*it is preposterous to assert that there is an urgent national need for a project which cannot at the very best be operating until the 2030s. By continuing with a consultation where some communities are denied an opportunity to make their voice heard face-to-face and at a time when the population of the country is facing more immediate existential issues, is both irresponsible and reprehensible*". (1)

Responses to the consultation, such as it is, can be given by:

• A public questionnaire can be found online at: www.bradwellb.co.uk

• You can email your comments on this document to: info@bradwellb.co.uk

• Written responses can be posted to Freepost Bradwell B Consultation.

• You can also submit your comments via the Bradwell B Freephone hotline 01621 451 451 during normal office hours.

## Introduction

The Bradwell B Consultation Document (2) begins with the following foreword:

*The United Kingdom has a long history in nuclear generation. It is more than 60 years since our first commercial nuclear power station opened and today nuclear power plays an important role in moving towards a carbon-free electricity system. Bradwell B would make a vital contribution to meeting the UK's future need for low carbon, secure and affordable energy and achieving the UK's legally binding target of net zero carbon by 2050. A valuable - and necessary - part of our electricity mix, nuclear power ensures there is reliable and affordable electricity, including when limited wind and solar power is produced.*

This is a carefully crafted paragraph which avoids mentioning nuclear power's embarrassingly poor history, the relatively high carbon emissions from the nuclear power life-cycle and the extremely expensive electricity which would be produced by new reactors soaking up funds which could be better spent on alternatives thus making the climate change problem worse. In fact, new nuclear power stations are not required, and the Government's National Policy Statements on Energy and Nuclear Power are badly out of date and need to be scrapped. Over its 60-year life Bradwell B would produce the equivalent, in terms of radioactivity, of 60% of the radioactive waste the UK has already produced and has yet to find a final resting place for. The economic gold-rush type situation the construction project would create will be extremely disruptive to the local community and environment. As global average temperatures increase and sea levels rise there are huge uncertainties associated with the impact of potential storm surges. With highly radioactive spent fuel stored on site for up to the next 160 years the consequences of future storms could be catastrophic.

## Nuclear power in Britain: 'A catastrophe we must not repeat'[1]

The history of nuclear construction in the UK has been dismal. Massive time and budget overruns, poor labour relations, and unexpected engineering and design problems have been recurrent themes. The first two Magnox plants owned by the electricity company, Bradwell and Berkeley, were completed over a year late. The final Magnox plant, at Wylfa on Anglesey, ran three years over schedule. None of the AGRs were completed on time or on budget. Dungeness B the first AGR plant to be ordered in 1965, and at the time expected to be operational in 1970/1971, did not produce commercial energy until 1989 and was thought to have exceeded its budget by 400%. Even the final pair of AGR power stations, Torness and Heysham B, were both over a year late (approved in 1977, expected operational 1986/87, commercial operation started 1988). (3) Torness was estimated to be 15% over budget. On 10th November 1989 the main headline story in the Glasgow Herald, quoting a Scottish Office source, declared that Torness was a £2.5billion mistake and should never have been built. (4)

The world's first nuclear power station was a Magnox station built by the UK Atomic Energy Authority (UKAEA) at Calder Hall, near Sellafield, Cumbria, and opened in 1956. A second was built at Chapelcross in Dumfries and Galloway, southern Scotland, and opened in 1959.  Both these power

[1] In 1973 the Chairman of the Central Electricity Generating Board described the AGR programme as a 'catastrophe we must not repeat' (Select Committee on Science and Technology 1974)

stations were dual use: designed primarily to produce plutonium for nuclear weapons, generating electricity for the national grid was, at least initially, a by-product. (5)

## Carbon Emissions

All energy sources produce some carbon emissions during their life cycle, so we need to work out the life cycle emissions to properly compare different energy sources. Professor Benjamin Sovacool, now at Sussex University, has looked at 103 different studies and concluded that the mean value is about 66 grams of carbon dioxide for every kWh produced by nuclear power. This compares to about 9g for wind, 32g for solar and 443g for gas. This puts nuclear as the third highest carbon emitter after coal-fired plants and natural gas. (6) If a large programme of reactors were built around the globe, life-cycle emissions would increase as the quality of uranium used decreased, making it necessary to use more energy to get the uranium out of the ground. (7)

Mark Z. Jacobson, director of Stanford University's Atmosphere and Energy Programme points out that construction of a new nuclear power station can take anything up to 10 to 15 years longer than renewable projects. The emissions not saved over those years should be taken into account. Olkiluoto 3 reactor in Finland, the Hinkley Point nuclear plan in the UK and Vogtle 3 and 4 reactors in Georgia, among others, are examples of projects for which planning began in the past decade and whose entry into commercial operation is still far from complete. Utility scale solar or wind schemes take about 2-5 years to begin commercial operations – nuclear effectively emits 64-102g of $CO_2$ per kilowatt-hour of plant capacity just from grid emissions during the wait for projects to come online or be refurbished, compared to wind or solar farms. Jacobson argues that even existing plants emit carbon dioxide due to the continuous mining and refining of uranium needed for the plant. However, all plants also emit 4.4g-$CO_2$e/kWh from the water vapour and heat they release. This contrasts with solar panels and wind turbines, which reduce heat or water vapour fluxes to the air by about 2.2 g-$CO_2$e/kWh for a net difference from this factor alone of 6.6 g-$CO_2$e/kWh. (8)

Building Bradwell B would, in fact, detract attention and divert much needed investment from renewable and energy efficiency projects. Even if only some of the new nuclear power stations proposed come online, new, cheaper renewable energy would be crowded out. (9) Far from being secure and affordable, it fails the post Covid-19 resilience test, (10) and is expensive. By spending money on a project which saves less carbon per pound than other alternative projects it would actually make the climate change problem worse. Amory Lovins, former chief scientist at the Rocky Mountain Institute, says coal-fired power plants were justified by counting cost but not carbon. Nuclear advocates defend their preference by counting carbon but not cost. But to protect the climate, we must save the most carbon at the least cost and in the least time, counting all three variables—carbon and cost and time. Being carbon-free does not establish climate-effectiveness. Since money and time are both limited, our priorities in providing energy services must be informed by relative cost and speed. Lower cost saves more carbon per dollar. Faster deployment saves more carbon per year. We need both. (11)

## Nuclear is not needed

New nuclear plants are *not* a necessary part of the energy mix. In fact, they cause problems because they cannot be turned off when renewables are generating enough electricity on their own. Bradwell B would get in the way of expanding renewables, because it is inflexible and can't balance the output from variable renewables like wind and solar. (12) What is needed is flexible supply and demand side balancing systems, smart grids, and storage, including electrolytic 'Power to Gas' hydrogen production, using surplus renewables power, stored ready for conversion back to electricity when renewables inputs are low. Baseload plants are inefficient and cannot meet demand as needed. In fact, nuclear energy has the lowest flexibility and the worst response speed compared to all other power technologies. (13)

## Nuclear is not affordable

Nuclear power is not 'affordable'. As Tom Burke, former advisor to several conservative environment ministers points out, if EDF had managed to build Hinkley Point C on time to cook our Christmas turkeys in 2017 with nuclear electricity as promised we would now be paying them £113 for every MWh of electricity they produced instead of buying it from the current market at £36/MWh. (14) EDF claims it can significantly reduce the cost of Sizewell by transferring workers and equipment from Hinkley. But the company requires the Government to agree to introduce the Regulated Asset Base (RAB) system for subsidising new reactors. This involves consumers paying for the project while it is still under construction. This would cut borrowing costs but also put consumers on the hook for cost overruns. Over the past decade the extraordinary cost of the U.K.'s proposed nuclear power programme has become even more apparent. This is perhaps most clearly demonstrated by the change in the views of the Committee on Climate Change (CCC). In 2011, it stated that "*nuclear power currently appears to be the most cost-effective of the low-carbon technologies*". Yet in its June 2018 report, the CCC says that "*if new nuclear projects were not to come forward, it is likely that renewables would be able to be deployed on shorter timescales and at lower cost*". In May 2019, in its report on "Net Zero", the CCC estimates that the cost of power in 2025 from solar PV could be £47/MWh, for wind £69/MWh and nuclear £98/MWh. (15)

Solar and onshore wind power are now the cheapest new sources of electricity for at least two-thirds of the world's population. The levelized cost of electricity for onshore wind projects has fallen 9% to $44 (£35) a megawatt-hour since the second half of last year. Solar declined 4% to $50 (£40) a megawatt-hour, according to BloombergNEF. Battery storage is also getting more competitive. The levelized cost of electricity for batteries has fallen to $150 a megawatt-hour, about half of what it was two years ago. That's made it the cheapest new peaking-power technology in places that import gas, including Europe, China and Japan. (16)

Now that the government has removed its block against onshore wind projects by allowing schemes to compete for subsidies alongside solar power and floating offshore wind, (17) analysis undertaken by Vivid Economics suggests that growing onshore wind from 13GW today to 35GW by 2035 would reduce the cost of electricity by 7%. (18)

## Radioactive Waste

The Bradwell A nuclear plant, was the first Magnox reactor in the UK to enter its 'care and maintenance' (C&M) state. The station ceased generating in 2002 – 16 years ago. Since then all the fuel has been removed from the site, and the reactors have been prepared for the C&M phase. De-fuelling took until 2005. Many of the other Magnox reactors will take longer to reach the care and maintenance stage, with Trawsfynydd taking the longest – 38 years. The C&M phase is expected to last around 70 years before final dismantling begins. This means there will be nuclear waste on the Essex site until at least the end of the century, even without Bradwell B. This means the great-great-great-grandchildren of the Bradwell A nuclear workers could be the ones called upon to carry out the final decommissioning.

It's clear from the consultation document that the promoters of Bradwell B do not expect spent fuel from the reactors to be reprocessed in the way that spent fuel from Bradwell A was reprocessed. In fact, the Magnox Reprocessing Plant at Sellafield is expected to close this year and there are no plans to replace it. Section 2.2.10 to 2.2.13 of the consultation document deals very briefly with spent fuel and radioactive waste. It says the interim spent fuel store would be designed for a life of at least 100 years, which could be extended if necessary. Spent nuclear waste fuel from Bradwell B could, in fact, be stored on-site for around 160 years.

After more than 60 years of a civil nuclear power programme, the UK is still seeking a long-term solution for dealing with its higher activity radioactive waste (i.e. spent fuel and intermediate level waste). Government policy is that most higher activity waste (HAW) should be buried deep underground in what is known as a Geological Disposal Facility (GDF). But past experience tells us there can be no certainty that such a facility will ever get built. (19)

A GDF is not expected to be ready to receive waste until around 2040. Waste from new reactors like Bradwell B is not expected to be emplaced in the GDF until after all our existing waste has been emplaced which is expected to take around 90 years taking us to around 2130. (20) The other factor which needs to be taken into account is that Bradwell B is expected to use high burn up fuel which could require up to 100 years of cooling before it will be cool enough to be emplaced in a GDF. (21) So, assuming Bradwell B comes on stream around 2030, with an expected reactor life of 60 years, this means spent fuel may need to be stored in Essex until about 2190. The consequences of a fire in the Bradwell storage ponds could dwarf the accident at Fukushima. (22)

The nuclear industry and government repeatedly claim that the volume of nuclear waste produced by new reactors will be small, approximately 10% of the volume of existing wastes; implying this additional amount will not make a significant difference to finding an underground dump for the wastes the UK's nuclear industry has already created. (23) The use of volume as a measure of the impact of radioactive waste is, however, highly misleading – it is not the best measure to use to assess the likely impact of wastes and spent fuel. The 'high burn-up fuel' which Bradwell B would use would be much more radioactive than the spent fuel produced by existing reactors like Sizewell B. So rather than using volume as a yardstick, the amount of radioactivity in the waste, which affects how much space will be required in a deep geological repository, is a more appropriate way of measuring its impact.

According to Radioactive Waste Management Ltd, the radioactivity from existing waste (i.e. not including new reactors) is expected to be 4,770,000 Terabecquerels (TBq) in the year 2200. The radioactivity of the spent fuel alone (not including other types of waste) generated by a 16GW programme of new reactors is expected to be around 19,000,000TBq. Assuming Bradwell would be a 2.2GW station, the amount of radioactivity in the spent fuel in the year 2200 would be 2,600,000TBq – or about 55% of the radioactivity in existing waste. (24)

## National Policy Statement Past its Sell-By Date

The consultation document states that:

"*The National Policy Statement for Nuclear Power Generation (NPS EN-6) (2011) explains that there is an urgent need for new nuclear power stations and identifies Bradwell as a potentially suitable site for a new nuclear power station*."

As Greenpeace lawyers have explained to the Planning Inspectorate, EN6 only has effect for the purposes of Section 104 of the Planning Act 2008 for development with expected deployment by the end of 2025. In fact, the Secretary of State should only attach significant weight to the NPS where there have been no relevant changes of circumstances. In fact, the landscape has changed considerably since 2011, (as evidenced by the shifting view of the CCC discussed above) and the argument that nuclear new build is both necessary and urgent is in itself out dated, meaning that significant weight should not and cannot be placed on government support for new nuclear. (25)

Since the original National Policy Statements on Energy (26) and Nuclear (27) were published in July 2011, justifying new nuclear power stations on the grounds that electricity demand is likely to double by 2050, the situation has changed radically.

The incoming Conservative-LibDem Coalition Government of 2010 was officially planning on the basis of a doubling or possibly even a tripling of electricity consumption by 2050. The 2005 Energy White Paper was expecting that by 2020 electricity consumption would have increased by 15%. In reality it has decreased by 16%. Nowadays primary energy demand is expected to continue falling by a further 11% by 2025. Imperial College says electricity demand may bottom out towards the end of the 2020s and then begin growing. But on the other hand: "*it may continue its gradual decline*". (28)

The amount of electricity generated in the UK in 2018 fell to its lowest level in a quarter century - 63TWh (16%) lower than in 2005, a reduction equivalent to 2.5 times the expected output of Hinkley Point C. This is despite the UK population increasing by 10% from 60 million to 66 million people. This trend since 2005 breaks with the economic orthodoxy that a growing economy must be fuelled by rising electricity use. Instead, the economy has continued to grow even as electricity generation has levelled off and then started to decline. The reasons for this decoupling may not be fully understood, but product energy efficiency regulations, energy-efficient lighting, environmentally conscious consumers and economic restructuring, including offshoring of energy-intensive industries have all have played a part. For example, low-energy lightbulbs can cut electricity use for lighting by up to 90% while newer "white goods" such as fridges, freezers and washing machines can use up to 75% less electricity each year than the oldest models. There is significant untapped potential to continue cutting electricity use by replacing old appliances at the end of their lives with the latest models. (29)

While continued reductions in UK electricity demand are likely in the short term, the Committee on Climate Change (CCC) and others expect UK electricity demand to increase in the medium term as a result of increased demand from electric vehicles (EVs) and electric heat pumps. But research suggests the growing energy efficiency of Electric Vehicles (EVs) means that there may be a very limited increase in demand as a result of the electrification of transport. (30)

Nuclear generation was 72TWh in 2016 or about 21% of electricity produced in the UK. Total installed nuclear capacity is around 8.9GW. Yet an accelerated programme of LED lighting installation could, on its own, reduce peak electricity demand by almost 8GW. (31) Cost-effective investments in domestic energy efficiency alone between now and 2035 could save around 140TWh of energy – roughly equivalent to the output of six power stations the size of Hinkley Point C, according to a report by the UK Energy Research Council. Such a programme could save an average of £270 per household per year at current energy prices. The investments would deliver net benefits worth £7.5bn to the UK, and could reach £47bn, if benefits such as health improvements and additional economic activity are counted. (32)

In December 2017, rather than updating the National Policy Statement on Energy to take account of falling demand, the Government proposed a new nuclear NPS which just looked at a process and criteria for designating potentially suitable sites for new nuclear reactors above 1GW capacity for deployment between 2026 and the end of 2035. Paragraph 1.7 of the consultation document stated that: "*The Government's view is that the assessment of the need for new electricity generation carried out to support EN-1 remains valuable and continues to be relevant. Currently, all but one of the existing fleet of nuclear reactors are due to cease generating before 2030, so the need for new nuclear power remains significant*." (33)

The Government Response to the consultation (para 3.9) states that:

*"Government continues to believe nuclear has an important role to play in the UK's energy future as we transition to the low-carbon economy. The public will have an opportunity to comment on the ongoing need for nuclear as part of the consultation on the draft new nuclear NPS … Sites listed in EN-6 on which a new nuclear power station is anticipated to deploy after 2025 will continue to be considered appropriate sites and retain strong Government support during the designation of the new NPS"* (34)

It continues (para 3.11)

*"Where there is no relevant change in circumstances it is likely that significant weight would be given to the policy in EN-1 and EN-6."*

But, as we have seen, there have been relevant changes in circumstance.

Writing in the FT in March 2019 about a report from global management consultancy, McKinsey, Nick Butler said over the next 20-30 years the energy business is set for an industrial revolution. The 20th-century energy economy, centred on coal and oil, is giving way to something very different. And this transition has ceased to be a matter for the distant future or something that can be pushed off by industry leaders to the next generation of executives. Butler concludes that the complacency that smothers hard thinking is outdated. The revolution is happening now. (35).

If there was ever a relevant change in circumstances, an industrial revolution must surely be it.

## The Principle of Building a New Nuclear Power at Bradwell

The consultation document says that the principle of building a new nuclear power station next to existing Bradwell power station will not be influence by this consultation because this is a matter of Government policy (figure 1.1). But as we have seen Government policy in this regard is seriously flawed.

The UK's first National Infrastructure Assessment, published by the National Infrastructure Commission (NIC) says a shift to greener energy is a "golden opportunity" and that ministers must act now to seize it. The report sets out how the UK can move to "*highly renewable, clean and low-cost energy*", while ending the use of gas for heating and shifting to 100% sales of electric vehicle (EVs) by 2030. It says a "quiet revolution" in renewable costs means government should prioritise wind and solar, echoing new scenarios from the Committee on Climate Change (CCC). It also calls for investment in energy efficiency to triple and for no more than one new nuclear plant to be agreed before 2025. (36)

The commission says: "*It is now possible to conceive of a low-cost electricity system that is principally powered by renewable energy sources*." It says at least 50% and up to 65% of electricity in 2030 should come from renewables. The average cost of this highly renewable system between 2030 and 2050 would be comparable to investing heavily in new nuclear. However, it recommends a focus on wind and solar, where costs are more likely to fall even faster than expected. This conclusion applies whether heat is predominantly supplied by electric heat pumps or whether it is met using low-carbon hydrogen and biomass. (37)

The NIC says the government "*should not agree support for more than one nuclear power station beyond Hinkley Point C before 2025*", since their cost seem unlikely to fall, while renewables are getting cheaper and could prove a safer investment. NIC calculates that the average costs for a 2030-2050 scenario with 90% renewables and less than 10% nuclear would be slightly less than for a scenario with 40% renewables and around 40% nuclear. It adds "*the higher cost of managing the variable nature of many renewables ('balancing') is offset by the lower capital cost, which translates into lower costs in the wholesale market*". (38)

Building Magazine, almost 2 years ago commented "*It is only because of all the uncertainties inherent in these [cost] predictions that it recommends continuing with nuclear at all, albeit on a 'go slow' basis, so as not to entirely lose capacity in the industry in case the programme has to be fired up again*." It continues:

"*What the NIC's team has reacted to is a dramatic fall in the price of renewable technologies, particularly offshore wind, alongside a steady maturation in the technologies needed to balance the inevitable intermittency of renewable power generation. … Consultant Alistair Smith, formerly nuclear development director at contractor Costain, says this experience means most contractors* *have already lost faith. 'Aside from those involved in Hinkley, contractors have lost interest and have moved on to more exciting things. Everyone's been burnt so many times that it would take a lot to convince a chief executive to go for another project again*.'" (39)

In its 2018 Progress Report the Committee on Climate Change (CCC) said "*If new nuclear projects were not to come forward, it is likely that renewables would be able to be deployed on shorter timescales and at lower cost*." (40)

In 2019 it said: "*Contingency plans have still not been set out in case new nuclear projects are not delivered. Contract prices for nuclear projects remain significantly higher than those of mature renewable technologies such as wind and solar*." (41)

In its latest Net Zero Technical Report the CCC has effectively sunk nuclear power. The old argument that large quantities of nuclear power are necessary has been quietly side-lined. Rather, the evidence presented by the CCC says that not only can renewables do the whole job, along with energy efficiency, on their own, but they can do things much more cheaply than either nuclear power or carbon capture and storage. The CCC argues that investment in renewable energy will save consumers money, whilst investment in nuclear power and carbon capture and storage will cost a lot more. It estimates that renewable energy resources to be very large - 29-96 of GW of onshore wind, 145-615 GW of solar power and 95-245 GW of offshore wind.

Using the lower end of the range, the electricity would be enough to provide all of the electricity needed for a net zero energy economy in the UK. That's not even counting other renewable energy sources, including biomass and marine renewables. (42)

## 100% Renewables

In July 2019, in his last week as Business Secretary, Greg Clark told a private meeting, he thinks Britain needs to build up to 40GW of non-intermittent low carbon power stations to hit climate change targets. (43) Unfortunately, the government's justification for this appears to rest on model simulations run internally, which have not been published. Michael Liebreich of Bloomberg New Energy Finance told Carbon Brief:

"*Firm power which cannot be switched off when you don't need it will be as much of a problem as variable power which cannot be switched on when you do. What is called for is flexibility, in huge quantities and of all types*." (44)

Conventional wisdom used to be that supplying our electricity with 100% renewables was impossible. But now, it seems, that for the Committee on Climate Change (CCC) it is a question of cost. It says you can only go so far with the proportion of our energy supplied by renewables before costs start to rise so we are going to need nuclear or Carbon Capture and Storage to provide some firm power. But the CCC is relying on its own estimate of nuclear costs in 2050, believing they will be 28% lower by then. (45)

The CCC says variable renewable electricity - such as large-scale onshore wind, offshore wind and solar PV - is now the cheapest form of electricity generation in the UK and can be deployed at scale to meet UK electricity demand. In 2018 these sources provided 22% of the UK's electricity. (46) That proportion rises to 50-65% in its scenarios to 2030, and potentially higher towards 2050. Several studies demonstrate that annual penetrations of over 80% of variable renewables in the UK's electricity system are technically achievable (i.e. electricity demand can be met at all times, whilst meeting the standards expected of a modern electricity system). However, evidence suggests integration costs could be around £10-25/MWh for annual penetrations of up to 50-65% renewables, but could increase further at higher penetrations. But the CCC is just putting forward possible scenarios. It says "*while the policy challenge in delivering these scenarios is undeniable, there is good reason to believe that the range of options could be wider and/or cheaper than we have assumed*". So, a future based on a much higher percentage of variable renewables could actually turn out to be cheaper and more feasible than implied by the CCC's scenarios. (47)

Lord Deben, Chair of the CCC says: "*By the time you get to the need for the next nuclear power stations, there will be alternative ways of doing this. If we get better at balancing the grid and the amount of baseload energy, the need becomes smaller. Nuclear isn't the best way of getting that base energy because you can't turn it on and off: you have to use it all the time. If you are really concerned about what happens when the sun doesn't shine and the wind doesn't blow, you install in people's homes hybrid boilers that can run on electricity or gas.*" (48)

The National Infrastructure Commission says there is great scope for flexibility technologies to balance a system with very high renewables. (49) At a Spectator Energy Summit, chaired by Andrew Neil, Phil Graham (Chief Executive, National Infrastructure Commission) argued there isn't a strong case for more than one more new nuclear plant beyond Hinkley Point C because the cost of renewables is low and getting lower. (50)

The myth that a very high level of renewables can't be integrated into the electric grid is being demolished by the clean tech and battery storage revolution. "*By 2040, renewables make up 90% of the electricity mix in Europe, with wind and solar accounting for 80%*," according to projections by Bloomberg New Energy Finance (BNEF) in their annual energy outlook. "*Cheap renewable energy and batteries fundamentally reshape the electricity system*," explains BNEF. Since 2010, wind power globally has dropped 49% in cost. Both solar and battery prices have plummeted 85%. (51)

BNEF also says combining batteries, demand response, and fast-ramping natural gas plants for peak power generation helps "*wind and solar reach more than 80% penetration in some markets*." When you add in the other forms of renewable power — such as hydropower and geothermal — total renewable generation becomes 90% or more.

The National Grid Electricity System Operator (ESO has suggested demand-side response (DSR) is more reliable than nuclear power in its latest Capacity Market auction guidelines. It has given DSR a de-rating factor of 86%, while nuclear is de-rated to 81%. DSR is also deemed to be marginally more reliable than biomass, coal and most interconnectors. Industry participants suggested the move reflected the expertise of DSR providers in managing their portfolios. (52)

Mark Jacobson and his team from Stanford University, reckon that 100% of all global energy can come from renewable sources (with biomass excluded) by 2050 with full grid balancing. The Stanford team say many possible solution mixes for grid stability with 100% wind, water and solar power are possible. They found that the full final cost per unit of energy, in every scenario, was about one-quarter what it would be if the world continues on its current energy path. (53)

A new report by LUT University in Finland and the Energy Watch Group (EWG) in Germany outlines a cross-sector, global 100% renewable energy system. The full modelling study simulates a total global energy transition in the electricity, heat, transport and desalination sectors by 2050. It claims that a transition to 100% renewable energy would lead to a system that was economically competitive with the current fossil and nuclear-based system. It could also, the study says, reduce greenhouse gas emissions in the energy system to zero by 2050, or perhaps earlier, without relying on negative $CO_2$ emission technologies. (54)

## Jobs and the Local Economy

According to the Consultation Document, the Bradwell B Project is expected to create approximately 900 permanent jobs, with an additional 1,000 jobs during periods of outage for maintenance and refuelling. During construction several thousand workers would be required. Numbers could reach between 9,100 and 10,600 workers during peak periods.

Construction and operation of Hinkley Point C was said to be able to create 25,000 employment opportunities without defining exactly what that would mean. (55) Numbers on site have just been reduced due to the coronavirus pandemic by about 50% from around 4,000 to 2,000. (56). The maximum number of workers allowed on site is currently 5,600. Before the pandemic the possibility of increasing this to 7,900 was discussed at a Stogursey Parish Council Meeting in February. (57)

Building new reactors has a high opportunity cost - the cost of forgoing the alternative outcomes that could have been purchased with the same investment. The local Essex economy would be able to achieve far more if money spent on new nuclear reactors were instead spent on energy efficiency and renewables. Building nuclear reactors would kill any hope the area might have of diversifying the local economy, after years of dependency on the nuclear industry. Many new businesses would be reluctant to move into an area which is so heavily focused on promoting the nuclear industry. It would be likely to detract from the promotion of any industries, such as those connected to food and agriculture or tourism, which require an area with a reputation for having a clean environment.

A large influx of workers during the construction phase of a new reactor would put a strain on local services and facilities. Short duration, capital intensive construction projects have been shown to seriously distort the local labour market. Often the bulk of those employed are from outside of the area. After the project is completed many migrant workers remain in the area compounding local employment problems. Even when an effort is made to hire local people the construction project can have a detrimental effect by competing with local firms for a limited number of skilled workers. In some cases where a local firm is already in difficulty the higher wages offered on a large construction project can be the last straw. Evidence suggests that major construction projects in rural areas prevent the growth of employment in more stable industries, and increase unemployment over the longer term. (58)

Roy Pumfrey of the local Stop Hinkley campaign writing in the local press asks "*Is the economic growth from Hinkley C worth the costs?*" He says he gets tired of reading how easily impressed councillors are when they visit the giant incomplete building site. "*In our case, economic growth also means a host of problems*." For instance, what will become of the seven hotels built after the HPC Gold Rush is history. (59)

Another resident local to Hinkley, Sue Aubrey takes up the story "*The worst problem we are all coping with is TRAFFIC. As long ago as the 1988/89 public Inquiry for Hinkley C it was acknowledged that traffic would be an issue and a new road was considered. But this time round EDF would not countenance any discussion on building a new road. People can't get to work on time, Bridgwater is frequently gridlocked. During the summer with holiday traffic it is impossible to get anywhere on a Friday. We are always suffering from road works with EDF tinkering with junctions for the convenience of lorries going to Hinkley. Lorries all the time even now in spite of the jetty … The jetty looked finished several years ago, but its first load was not until Sept 2019. This has meant 6 years of 300 lorry loads a day carrying aggregate by road rather than being brought in by sea as promised.*"

"*Workers at Hinkley C have to park in specially built car parks and then they are bussed to and from the site. We see the busses all day and night going round and round, generally they look almost empty. EDF have admitted that the one thing they had not anticipated was the problem of fly parking and many extra cars parking in the villages*."

It is a "gold rush economy". Care workers are going to HPC to be cleaners because they are paid more and the hours are better and there is no responsibility. "*My local garage lost a good mechanic to Hinkley – he drives a tractor all day but gets double time on Sundays. These well paid jobs unbalance the economy and leads to local difficulty for us getting skilled and unskilled workers*."

"*Rental property costs have soared. Tenants are evicted for HPC workers who can pay more. I was shocked the other day to hear that long term tenants in Minehead who had been in accommodation 18 and 20 years were being evicted for homes to be done up for HPC workers. One fellow Stop Hinkley member, a single parent, looking after her 4 year old grandson, has had to move 3 times in his short life. Each time the landlord has wanted to do up the accommodation for multi occupancy for HPC workers. Rising rents have led to greater use of Food Banks in Minehead and Bridgwater*."

"*The site is working 24 hours a day. Many people are upset about the light pollution and the noise and dust if you are living nearby … if you live in Bridgwater near a bus stop you are disturbed at 5am when the early shift leaves [and] we are hearing that holiday cottages are being used as brothels!*" (60)

## Sea-Level Rise

The consultation document says:

*Bradwell B would need to be constructed on a raised platform to protect it from extreme flooding events. The indicative optimal platform level would be around 7.4m AOD, which would protect the* *site from a 1 in 10,000 year extreme sea level (as informed by the Environment Agency's published data and ONR and Environment Agency guidance), taking account of potential climate change. This favoured development on the higher ground to the south and west of the existing Bradwell power station. Sea defences: Setting the power station back from the coast would avoid interference with the existing flood embankment and reduce the required scale of the new defences. Enough space should be allocated for their construction around the permanent development, with an allowance for adaptation as appropriate, especially at more constrained points close to Bradwell A.*

UKCP18 expects a sea level rise on the East Coast of between 0.29 and 1.15metres (61) In 2007, a report for Greenpeace by the Middlesex Flood Hazard Research Centre took as the basis for its worse-case scenario the collapse of the West Antarctic Ice Sheet (WAIS), which would trigger an abrupt and extreme rise in sea level, estimated at 5-6m. The report pointed out that there are widely divergent opinions on the likelihood of this extreme sea-level rise but one view is that WAIS collapse could begin in the 21st century. (62)

The Antarctic ice sheet contains enough ice to raise sea level by approximately 57 metres, about half the length of a soccer pitch. (63) While it is unlikely all of this would melt, satellite data suggests that Antarctica is now causing sea levels to rise at a rate of 0.6mm a year – faster now than at any time in the past 25 years. The rate at which ice losses from Antarctica will increase in response to a warming world remains uncertain. (64) But now a massive hole has been discovered in the Thwaites glacier suggesting it may be melting even faster than scientists have long feared. Its melting would destabilise the entire region by exposing it to warmer waters. The void, in total, is about six miles long and 1,000 feet deep — representing the loss of some 14 billion tons of ice. (65)

At the other side of the planet, the Greenland Ice Sheet has the potential to raise sea levels by 7 metres. (66) What is particularly worrying about some recent research is that the rate ice is melting now seems to be increasing. Greenland's icecap is melting faster than ever. The message for the future is ominous. "*Rather than increasing steadily as climate warms, Greenland will melt increasingly more and more for every degree of warming*," says Dr Trusel, a glaciologist from Rowan University in the US. (67) East Antarctica's glaciers too are melting faster than previously thought. Chris Fogwill, a professor at Keele University says "*...our sea-level projections could be an order of magnitude higher than we're anticipating*." (68)

## Storm Surges

But it's not just the height of the rise in sea level that is important for the protection of nuclear facilities, it's also the likely increase in storm surges. Since 1970, the magnitude and frequency of extreme sea levels (ESLs, a factor of mean sea level, tide and storm-induced increases), which can cause catastrophic flooding, have increased throughout the world, according to the Global Extreme Sea Level Analysis project. New satellite studies by the U.S. government's National Oceanic and Atmospheric Administration (NOAA), NASA, and other leading scientific institutions all show mean sea level rising and magnifying the frequency and severity of ESLs. (69)

The Office for Nuclear Regulation's (ONR's) Expert Committee (20th May 2019) says the projections for 2100 contain "considerable uncertainty". It points out, for instance that " small changes to UK storm systems can alter the height of storm surges significantly". In particular, it continues "...the loss of a substantial portion of the West Antarctic Ice Sheet may already be committed ... could result in more frequent extreme weather events."(70)

Crucially, sea level has a huge effect on the severity of storm surges, according to Prof David Vaughan, the director of science at the British Antarctic Survey. An increase in sea level of 50cm would mean the storm that used to come every thousand years will now come every 100 years. If you increase that to a metre then that millennial storm is likely to come once a decade. (71)

ONR's Expert Panel on External Hazards says:

"*The IPCC Fifth Assessment Report* [which is the one used for UKCP18] *considers that it is very likely that there will be a significant increase in the occurrence of future sea level extremes by 2050 and 2100, with the increase being primarily the result of increases in mean sea level. Storm surge and wave projections for the UK depend on global climate models (ONR, 2018c) producing consistent and accurate simulation of the North Atlantic storm track. At the present time, there is low confidence and as yet no consensus on the future storm surge and wave climate, stemming from diverse projections of future storm track behaviour*." (72)

Researchers says that UK coasts are likely to have more "compound flooding" in future when storm surges combine with heavy rainfall. Storm surges can be made worse with heavy precipitation but they can also cause trouble by blocking or slowing down the draining of a river into the sea following a period of sustained rainfall. (73)

David Smith Distinguished Research Associate, Oxford University Centre for the Environment Climate Change Risk Management told the ONR Expert Panel in 2014:

"*Rises in GMSL (Global Mean Sea Level) will render the world's coastlines more vulnerable to storm surges and tsunamis, although the pattern and incidence of these events are as yet unclear*." (74)

## Environmental Impact Assessment

The consultation document says that Stage Two Consultation will "*provide preliminary environmental information on the Project and likely impacts that could arise, based on that environmental impact assessment work.*"

It is widely regarded as good practice when carrying out an Environmental Impact Assessment to consider the alternatives to a project. If this were done for Bradwell B, NFLA believe it would be seen that there are plenty of opportunities to reduce energy demand and produce cheaper renewable energy alternatives.

## Severe Accident Scenarios

The Environmental Impact Assessment should also look at potentially severe accident scenarios from a precautionary point of view. According to EDF Energy´s Environmental Statement for Hinkley Point C (Appendix 7E "Assessment of Transboundary impacts"), the likely impacts of an accident do not extend beyond the county of Somerset and the Severn Estuary. In contrast a report for the Austrian Environment Agency says severe accidents at HPC with considerable releases of caesium137 cannot be ruled out, although their probability may be low. There is no convincing rationale why such accidents should not be addressed in the Environmental Statement (ES); quite to the contrary, it would appear rather evident that they should be included in the assessment since their effects can be widespread and long-lasting. (75)

In comparison, the Radiological Protection Institute of Ireland (now part of the Environmental Protection Agency) suggested a severe accident scenario which would involve a loss of coolant combined with a bypass of the containment. In this scenario core damage would be initially delayed by actions of the plant operators, but eventually take place after 12.75 hours. The release of fission products to the environment starts 12.8 hours after reactor shutdown, and lasts for 35.2 hours eventually stopping 48 hour after reactor shutdown. The RPII Severe Accident Scenario suggests a radioactive release of I-131 and Cs-137 amounting to 610,000TBq which is quite a bit larger than Fukushima. (76) Cs-137 has a half-life of 30 years, whereas I-131 only has a half- life of 8 days. So, Cs-137 is much more important in the longer term. With its longer half-life Cs-137 is around for much longer. Having said that I-131 distribution after an accident is important when looking at the incidence of thyroid cancer. Austria had the second highest average I-131 deposition density, outside Belarus, Ukraine and Russia, after Chernobyl.

## Table 1 Comparison of Source Terms for Cs-137

| | |
|---|---|
| Largest release from HPC suggested in UK Article 37 Submission | 0.0447TBq (77) |
| EIA for the planned Dukovany NPP (Czech Republic) | 30TBq (78) |
| EIA for the planned Hanhikivi NPP (Finland) | 100TBq (79) |
| RPII ST4 severe accident scenario | 10,000TBq (80) |
| Austrian analysis severe accident at Hinkley Point C | 53,180TBq (81) |
| Severe accident in the HPC spent fuel pool | 1,780,000 TBq (82) |
| Fukushima | 12,000TBq (83) |
| Chernobyl | 80-85,000TBq (84) |

## Conclusion

Going ahead with the construction of Bradwell B nuclear power station would be a huge error of judgement. Building a facility which will produce the equivalent of 55% of the radioactive waste which already exists in the UK; which has the potential to cause an accident on the scale of Fukushima; and yet will actually, in effect, make climate change worse by diverting funds and detracting effort from cheaper more effective climate mitigation measures, does not make any sense at all. The construction period would be hugely disruptive to the local economy, environment and well-being of the local population. Given the huge advances in technologies over the past few years which can offer the required flexibility to the electricity grid – storage and demand-side management for instance – the overriding case for a comprehensive national energy efficiency programme and the growing consensus that an energy system based on 100% renewables is not only feasible, but also desirable, it is tempting to ask 'who came up with that crazy idea in the first place?'


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