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The 8 key reasons why building new nuclear reactors in England and Wales is not the answer for the UK's future energy mix – the views of NGOs and the NFLA to the BEIS NGO Nuclear Policy Forum

i. Overview of Policy Briefing

This edition of New Nuclear Monitor provides a summary document that was tabled to the meeting of the BEIS NGO Nuclear Policy Forum on the 18th July in London. The meeting brings together national and local NGOs and the Nuclear Free Local Authorities (NFLA) for a regular interface and challenge with the UK Government's Office for Nuclear Development (OND) in the Business, Energy and Industrial Strategy (BEIS) department. Officers from the Nuclear Decommissioning Authority (NDA), Radioactive Waste Management Ltd (RWM), the Office for Nuclear Regulation (ONR), the Environment Agency and the Committee on Radioactive Waste Management (CoRWM, as observers) also attend the meeting and contribute on relevant issues. The July meeting considered how UK energy policy, should develop over the next three decades, and what role new nuclear power stations should play in that policy.

In the meeting, the Government put forward projections of the UK's needs for electricity, heat and transport. It argued this would require a substantial amount of new nuclear power stations and small modular nuclear reactors. This paper is the common view of the NGOs and NFLA that rebuts the Government's arguments. The Forum can often feel a frustrating venture given the polarisation of views on much of nuclear policy, but it is useful to both receive information on government nuclear policy as well as providing robust challenge of it. It also does lead to an improved understanding of the viewpoints from both sides and interaction with the nuclear regulatory and decommissioning agencies. The next meeting will be considering the effects of low level radiation exposure on health. The Minister responsible for nuclear issues, Richard Harrington, is expected to attend this meeting.

This paper is an excellent summary of the key concerns the NFLA and anti-nuclear NGOs have with new nuclear build.

ii. Introduction

NGOs and the NFLA have presented various issues of major concern on numerous occasions at the DECC, now BEIS NGO Nuclear Policy Forum about the deployment of a new-build nuclear power programme as a 'necessary and integral element of UK energy policy and balanced electricity mix'. NGOs have put forward detailed evidence that cost, need, security, safety, national defence, siting and radioactive waste issues associated with nuclear energy can only be avoided by abandoning nuclear energy altogether and focusing on the clean-up and management of its legacy. It is becoming increasingly clear that a transition to low-carbon renewables by 2050 is not only safer and more secure but very likely to be cheaper, if not significantly cheaper, to consumers too.

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Yet, impervious to such major concerns, successive UK governments since 2007 have been intent on a new nuclear programme supplying up to 18 GW of new nuclear capacity by 2030, and seemingly as much electricity as (SMR) investors are willing to develop beyond 2030. Nuclear power has been occupying a privileged position in UK energy policy, and a very dominant part of any post 2020 electricity infrastructure funding, irrespective of significant advances in several other low-carbon renewable energy technologies.

The main issues of concern are:

1. New nuclear will place burdens of high cost and financial risk onto future consumers and the taxpayer

The financial model for new nuclear power is to seek foreign capital investment in the absence of UK state funding. This raises issues of financial security of projects and, in the case of Chinese investment in particular, potentially national security issues. The bigger the eventual programme, the greater will be the UK's dependence on foreign investment for delivery of its nuclear infrastructure. And, the greater will be the guarantees and subsidies provided by the UK taxpayer.

The experience of Hinkley Point (HPC) and other planned nuclear projects illustrates rising costs, project delays, industry traumas and investor risks compared to unexpectedly high cost reductions in offshore (and onshore) wind and PV schemes which could be or were being delivered on schedule. There is also a requirement for financial guarantees for long-term but limited liability radio-toxic waste management which are not clear. Actual future costs could exceed liabilities, and so would fall on 22nd century taxpayers.

Recent offshore wind schemes in Denmark and The Netherlands show contract prices are now around the £90/MWh mark or less (including transmission lines etc). German manufacturers are now suggesting that offshore wind could be near 'subsidy-free' by 2025 which is no longer the earliest date (that has now been put back to 2027) HPC may just commence supply at £95/MWh for 35 years to 2060 (in 2017 prices). Offshore wind contracts are for 15 years and by 2040 and 2055 designs are likely to be even cheaper. The forthcoming UK offshore wind auction strike-prices will be instructive.

Onshore wind and PV technology costs are already competitive or cheaper now than what a Sizewell C deal may cost in the late 2020s. By 2030 when nuclear schemes may just be generating at £80-90/MWh, substantive offshore wind and PV (and PVT) deployments could be generating in the £60-70/MWh range.

Importantly, even when contract lengths and the overall Grid system costs are considered (including balancing fuel inefficiencies, and decentralised back-up, power quality and electrolyser capacity at around £5-10/MWh for wind and PV versus estimated £2/MWh for twin 1.5 GW reactor sites) a 100 % renewably powered electricity supply and wider energy system built by 2060 is still likely to be cheaper, potentially significantly so, than the planned nuclear-inclusive system.

Reliance on foreign investment for new nuclear power carries potential financial and security risks. On grounds of costs, new nuclear energy is increasingly unlikely to prove cheaper or more competitive than alternative energy supply systems and will have to be subsidised by future consumers and taxpayers.

2. New nuclear energy is an inflexible, uncertain and increasingly unnecessary component of the future energy mix

Inflexibility. Renewable electricity infrastructure would be much more physically resilient, adding to supply reliability, contrary to some current public and political perceptions. Such resilience, an intrinsic feature of a large number of high-redundancy, widely-dispersed, fast-start, mostly gas-fired back-up schemes, would have highly valuable national defence and security benefits. In direct contrast, just five or six large coastal radio-toxic electricity supply sites operating at baseload with limited back-up would add significantly to the UK's vulnerable critical infrastructure requiring potentially large future security costs.

The new nuclear programme is based on large units connected to a national grid. These units are inflexible and, once developed, lock the system in for around 60 years with decommissioning and waste management extending for many decades. Large units will be increasingly incompatible with a more localised, distributed network of electricity distribution. There are problems with design, for example with castings, and some of the technologies are still at an experimental stage. The risks of technological failure, delays, appraisal optimism and regulatory concerns are considerable and infuse the programme with risks in construction and performance.

Uncertainty. The nuclear programme envisaged was based on a programme for deployment by 2025. This has already slipped severely to the extent that, with Hinkley Point now deferred until 2027, there will not be even one new nuclear power station commissioned by that date and possibly none will ever materialise. The attached appendix 1 on '*Why the UK nuclear programme will fail'* provides evidence on the parlous state of the programme.

Unnecessary. The costs, timing and uncertainties of the nuclear programme indicate that its role in the future energy mix will become redundant to the point of contributing to *overcapacity* of supply. Depending on the scale of the programme, the contribution of new nuclear power would be at the expense of alternative lower cost, low carbon options. The nuclear programme might come on stream at the very point when it is no longer needed. Nuclear would become a cuckoo in the nest. We conclude that:

A new nuclear programme of the scale envisaged is unlikely to be achievable within the anticipated time-scales and any new nuclear plants coming on stream would be inflexible, unreliable and liable to displace much cheaper, more flexible and reliable renewable alternatives.

3. Health, safety and security concerns

The impacts of radioactivity on environments and human health are abiding and serious concerns. Safety is a controversial issue but the evidence of a link between nuclear energy and health is established. The issue of health and radiation is a matter of profound concern to the NGO Forum and is the subject of an imminent scientific engagement with the Forum and COMARE (Committee on Medical Aspects of Radiation in the Environment).

Risks arise from routine operations and emissions and discharges. Nuclear incidents and accidents contribute further to risk. Globally, nuclear accidents are 'normal' including cataclysmic accidents such as Chernobyl or Fukushima occurring every generation. The planned UK nuclear programme would span four to five generations from 2025 assuming spent fuels were transported to a GDF or GDFs by 2140.

Emergency planning measures are currently inadequate and could not possibly prevent serious consequences in the event of a major incident. Nuclear power stations are tempting targets for malicious and terrorist actions, including cyber, armed 'suicide' attack groups and future weapon attacks, against which there is no guaranteed defence, and so pose significant and inter-generational security risks. Since the dangers are inherent to the technology and therefore are totally avoidable the practice is not justified and should be discontinued in favour of safer and cheaper electricity supply options.

Risks to health and environment from routine, accidental and deliberate emissions and discharges are integral to nuclear technology and pose potential catastrophic

harm to substantial populations. Nuclear energy is harmful and unnecessary and therefore can and should be avoided in favour of benign and cheaper alternatives.

4. Decommissioning and radioactive waste management

A new build programme would introduce a steep increase in the radioactivity of the inventory of UK radioactive wastes, including spent fuel, to be managed on vulnerable sites. There are uncertainties about the inventory, location, management and timing of hot 'high burn-up' waste arising from it. However, an NGO estimate of up to 40mTBq of highly radioactive spent fuel accumulating over 60 years at each of the interim stores (i.e. nearly half the 87mTBq peak legacy waste activity mostly stored at Sellafield) has neither been confirmed nor rebutted by HMG. The radioactive content of the stores rather than the volumes of wastes should always have been a focus for informed public consultation.

There is, as yet, no clear, let alone provable, long term solution to the problem of managing these wastes beyond continuing storage far into the future. The claim that 'effective arrangements will exist to manage and dispose of the waste that will be produced from new nuclear power stations' is wishful thinking at this stage. This raises ethical issues of intergenerational equity where burdens are imposed on far future generations who will have to cope with managing wastes in potentially deteriorating circumstances. This alone should be sufficient justification for not persisting further with nuclear energy when non radio-toxic supply options are available and cheaper.

A new nuclear programme would substantially increase the radioactivity in the UK's inventory of highly active wastes for which there is no available long-term management solution. This would place an unnecessary and unfair burden on future generations and is a fundamental reason why the new nuclear programme should be abandoned.

5. Siting and environmental impacts

The Government's National Policy Statement (NPS) on nuclear energy generation identified eight sites 'potentially suitable' for the deployment of nuclear power stations by 2025. All were coastal sites near existing nuclear facilities chosen, pragmatically and politically, on grounds of land availability, existing infrastructure and presumed public acquiescence (which NGOs would vigorously challenge). Most are in areas of environmental value with a range of environmental designations. Some are highly vulnerable in the longer term to coastal change, storm surges and inundation as sea levels rise with climate change.

The NPS has used the concept of Imperative Reasons of Overriding National Interest (IROPI) to insist on the primacy given to nuclear development over environmental conservation. Most, if not all, the sites will not be developed by 2025 and, therefore, the NPS siting strategy requires review. As the need for nuclear energy recedes so IROPI cannot prevail. The impacts on environments at the sites will be open to serious challenge to the point where mitigation will not be possible and the requisite permits refused.

The basis on which the eight sites were nominated is no longer valid. The sites are mostly in environmentally designated areas and most are vulnerable to the impacts of climate change and rising sea levels in the long run. The premise that new nuclear energy is necessary has been overtaken by the pace of the energy transition towards a renewable energy future. The eight sites are therefore no longer needed and should be deleted from the list.

6. Proliferation and Military Needs

Nuclear weapons production has been a major if not the primary rationale for the development of ostensibly 'civil' nuclear power industries in several countries, including the

UK. Nuclear fuels, infrastructure and expertise have an essentially dual military-civil capability and dual programmes do or can overtly or covertly overlap, despite international safeguards and inspections. Criminal or terrorist groups could also acquire weapons-grade uranium or plutonium and the expertise to make crude but effective fission bombs, not just 'dirty' bombs. Thorium has been presented as a safe 'only fertile' fuel but it too can still be diverted, or transmuted via increasingly available particle accelerators, for making U233 fission weapons.

Indeed, it may be argued that promoting nuclear power is detrimental to national defence, a priority duty of government, and diminishes the development of a safe and sustainable British manufacturing sector and export strategy. Considering the emerging 21st century extreme terrorist and asymmetric warfare threats it may be thought that the last thing a globally influential nation should be doing is promoting, let alone leading, a global nuclear power renaissance, with an intent to export nuclear hardware and expertise as part of its industrial strategy. As was demonstrated earlier, renewable energy technologies are safe and cheaper than nuclear energy technologies (current PWRs and probably future SMRs and Generation IV fast reactors). So it is simply reckless for the government to promote the continuing, let alone wider use of nuclear energy which would expose billions of people over many generations to nuclear security and health risks.

Some experts are of the view that the continuing political support for a new civil programme is rooted in a (perceived) military need despite the repeatedly stated three pillared civil energy rationale (low-carbon, secure, low-cost). Yet any military needs or skills base hardly requires being hidden within a £90 billion construction programme and 35 year subsidy of up to £49 billion more than a renewable system (assuming a system cost differential of £10 /MWh over a renewable system, so 140TWh per year x 35 years at £10 m per TWh net additional support = £ 49 billion).

The need for a nuclear military programme which includes Trident is, indeed, a controversial issue (NFLA is fully opposed to Trident replacement). However, if it remains a continuing commitment it does not need a massive programme of new nuclear energy to support it. A cohort of specialist submarine reactor designers and operators could be trained up directly at a relatively modest cost. It may be noted that civil SMRs would likely be around ten times bigger than naval reactors (300MWs as against 30MW for naval reactors), and a civil reactor would not be fuelled with weapons-grade Highly Enriched Uranium (HEU) and does not have to be designed for silent running or to withstand depth-charging. Tritium for Trident warhead refreshment may cost £5million per year using particle accelerators and the UK already has sufficient weapons-grade uranium stocks for fuelling its nuclear powered submarines for decades.

There is also a clear and substantive national defence detriment associated with a new nuclear programme (i.e. vulnerable critical infrastructure, terrorism, asymmetric warfare, proliferation) to factor into any defence equation.

An expanded civil nuclear programme will increase the risks of proliferation and is unnecessary to support the UK's nuclear defence capabilities.

7. Climate / emission reductions and energy policy choices

The claim, by nuclear advocates, some energy agencies and the UK Government, that nuclear power is necessary to tackle climate change or to provide reliable supply does not withstand even basic engineering or fiscal scrutiny. For a start, the claim that nuclear energy is 'low carbon' needs to be examined in its broader context. For such claims to have any meaning CO2 audits would need to consider a "Whole Life" approach; from reactor construction, yellowcake mining, fuel assembly, the operational phase through to decommissioning and final waste disposal.

It is a fact that the UK's offshore wind resources are well in excess of any likely future UK electricity demand and the UK has some leads in PV, dual PV-Thermal and storage (electricity and gas) technologies.

A major rationale for the 2011 nuclear NPS was that a nuclear programme in the 2017-2025 period was needed to achieve sufficient and timely UK emission reductions before renewable energy sources or CCS technologies could be developed and deployed and as natural gas resource declined requiring imports from unstable regions like Russia.

By 2013 it was clear that none of the planned projects would be generating before 2022. Yet, in 2015 the government drastically cut onshore wind and PV funding support while approving a Centrica-Gazprom deal which increased Russian gas imports to 4.16 bcm per year sufficient to generate about 25TWh/y electricity. That is similar to the output which would have been generated by secure indigenous unstoppable onshore wind and PV schemes now not built to date owing to the cuts. Yet there has consistently been high public support for onshore wind and PV in Britain and little support for fossil fuel export from Russia and the Ukraine.

Similarly, the offshore wind industry around the North Sea is looking to build over 40 GW of capacity in the 2020s. Yet the government is suggesting possibly funding only up to 10 GW (36 TWh/y) in the 2020s so flat-lining progress which is, or was expected to, deliver 10 GW by 2020 from a standing start in around 2009. Meanwhile, UK emission reductions are not on track to meet the Committee on Climate Change's fourth carbon budget (years 2023-2027) and legal schedule. An extra 20 GW (70 TWh/y) of offshore wind in the 2020s, alongside a 7.5 GW per year of PV deployment (70 TWh/y by 2030), could reliably fill the 2020-2025 low-carbon electricity hole that the delayed and stumbling 18 GW (140 TWh/y) nuclear programme has left.

It is difficult for NGOs or the NFLA to fathom what is driving such an irrational, unnecessary and arguably unlawful nuclear policy despite the public's strong and consistent support for renewable energy.

8. Nuclear baseload is no longer necessary

Finally, ministers and politicians of all hue should not be led to believe that nuclear power is 'necessary', 'key' or 'absolutely' required to provide reliable 'baseload' power for when the wind does not blow or the sun shine. Although the baseload argument is fallacious it has been used to effect over decades by some nuclear proponents and the nuclear industry deliberately to mislead the public and politicians into supporting nuclear power.

There are three reasons nuclear energy is not necessary to ensure baseload supply. The first is that baseload, the minimum amount of power that the system is required to deliver, is a diminishing component of electricity supply. This is a result of a variety of factors, including climate change (warmer winters especially) and energy efficiency and greater flexibility on the demand side. Second, is the problem, referred to earlier, that the development of renewables as a cheaper, safer and low carbon alternative would be constrained by the necessity (though not, ultimately, the need) to keep nuclear plants running at baseload to fulfil long-term contractual obligations. There is a paradox inherent in maintaining nuclear energy far into the future as a low carbon, baseload option at the expense of alternatives that will be increasingly able to supply an abundance of low carbon, low cost and flexible energy. And the third reason is that with lower baseload and the availability of a variety of renewable technologies the need for back-up can increasingly be met with low-cost, fast response methods that are both flexible and low carbon. Appendix 2 outlines how the back-up system might work.

Baseload supply can be achieved by non-nuclear supply systems that are flexible, low cost and low carbon.

9. Conclusion

NGOs and the NFLA have raised the issues of concern listed above about a new nuclear programme many times without convincing response or rebuttal. Meanwhile the continued and remarkable technical, manufacturing and deployment advances and consequent cost reductions in renewable energy technologies, particularly wind and solar PV, together with conservation and efficiency measures, have rendered the 2011 nuclear policy based on the National Policy Statements (EN1 and EN-6) outdated and ever more clearly unnecessary and unjustified.

For several reasons alone, be it cost, safety and health, security and system resilience, inter-generational waste or proliferation, and certainly all the reasons considered together, NGOs and the NFLA on the Forum call for the prospective nuclear programme to be cancelled. NGOs and the NFLA also call for the possible future deployment of SMRs or fast reactor technologies to be considered by BEIS and ministers with a sceptical eye about performance claims and cost estimates.

Considering the inherent and intractable dangers of all nuclear technologies and fuel cycles it would be in the interests of present and future generations to withdraw from any further development of nuclear power and focus on deploying inherently safer and peace-promoting renewably-powered energy systems.

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On behalf, and with the full agreement, of NGO group members and the NFLA who attend the BEIS / NGO Nuclear Policy Forum

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Appendix 1

Why the UK nuclear programme will fail

Like the three previous attempts in the past 50 years, despite numerous concessions and subsidies and more than 10 years of support, the government's attempt to launch a new nuclear programme is doomed. Its plans to have 11 new reactors (16GW) on line by 2030 is likely to result in no more than one or two very expensive new reactors. There are three factors that mean that even with further subsidies and concessions, the programme will fail: inability to find finance; the poor record of the technologies proposed; and collapse of the reactor vendors.

The 16GW programme comprises: 2 EPR reactors at both of the Hinkley and Sizewell sites supplied by the French company, Areva NP and owned by a consortium led by Electricite de France (EDF); 2 ABWR reactors at both of the Wylfa and Oldbury sites to be supplied by Hitachi-GE and developed by a consortium wholly owned by Hitachi-GE; and 3 AP1000 reactors at the Moorside site to be supplied by Toshiba-owned Westinghouse developed by a consortium wholly owned by Toshiba. Using the costs agreed for Hinkley, the 16GW programme will cost £90bn plus financing charges, likely to add about a third more. Looking beyond 2030, there is the possibility of additional reactors being built at Bradwell by China General Nuclear using their Hualong One design.

Large scale projects are typically financed using a mixture of borrowing (perhaps 70%) and the developers own money. The consistent failure of nuclear plants to be built to time and costs means that banks will be unwilling to lend money for any of these projects unless the loans are guaranteed by the UK so that if things go wrong, taxpayers will have to repay the banks. So the 16GW programme is likely to require taxpayers to bet more than £60bn of their money that the projects will not fail. Even a company as large as the state-controlled EDF is struggling to raise their share of the finance. Hitachi-GE and Toshiba are much smaller companies and will have to bring in large partners, such as Middle East wealth funds if they are to finance their projects. There is no sign of serious interest from organisations of the size required.

None of the EPRs (4) and AP1000 (8) is yet in service but experience of construction is dreadful. By June 2017, there appeared a serious risk that 3 of the EPRs would have to be abandoned after a decade of construction because of defects in the reactor vessel, while 4 of the AP1000s may have to be abandoned because of the bankruptcy of Westinghouse. There are 4 operating ABWRs but these all use a version of the design that is more than 30 years old, and their record of reliability is poor. Experience with Hualong One comprises no more than a couple of years of construction for 4 reactors in China.

Both Areva NP and Westinghouse are effectively bankrupt, hoping for some form of rescue. Areva NP largely owned by the French state, is also tainted by the discovery in 2015 that it had been falsifying quality control records for up to 50 years in all three of its factories. These failings may add to the already large liabilities making them so large that even the French state will not be willing to meet them and Areva NP will go to the wall. Toshiba is looking for a buyer for Westinghouse but there seems little interest. Even if new owners for Areva NP and Westinghouse are found, they may decide to stop the risky, loss-making business of selling new reactors to concentrate on the more profitable, less risky business of reactor service and maintenance.

There will be a temptation when the first of the consortia finally fails to fast-track the remaining ones to try to keep the nuclear programme from collapse. This would be a mistake and would only add to the 10 years already wasted pursuing nuclear power rather than the cheaper, less risky renewable energy options for meeting our greenhouse gas targets.

Appendix 2

Baseload and Back-Up

Gas-fired turbine 'back-up' (open, aero-derivative or combined cycle) can quickly ramp up when the cumulative output of renewables on the National Grid begins to fall below consumer demand (demand-side smart measures may also have a role but to a much smaller extent). Aero-derivative gas turbines can reach maximum electrical output in about 10 minutes or less (witness a modern jet fighter take off from standing start and ascend near vertically to 15,000ft in about 45 seconds). Fuel cells, pumped storage schemes, flywheels and batteries can react at scale within seconds or less.

The cold-start ramp-up times of a mix of back-up schemes nationwide would significantly exceed the fastest weather related supply changes (e.g. a fast-moving 100 mph storm front would take several hours to cross the UK even directly east-west).

Gas-fired turbine schemes cost about £450 million per GW installed (less than one tenth per GW than HPC) and would have a lifetime of around 30 years. The turbines would only actually operate for a relatively low number of hours over a year, mainly on winter evenings in low wind cold spells. Such a large gas-fired turbine back-up 'fleet' would have a highly valuable emergency response role, much greater than that of an equivalent nuclear system. e.g. 18 GW may comprise over a hundred decentralised schemes dotted up and down the country mainly in cities. The 'fleet' could provide fast-response back-up if there were a major incident which disabled parts of the UK Grid transmission network e.g. ice storm, flooding, GPS meltdown or co-ordinated terrorist event. A nuclear-inclusive system would only have limited gas-fired back-up e.g. 1.6 GW to cover for an unplanned outage of a nuclear reactor or 3.2 GW if the National Grid or HMG specified cover for a transmission line outage to a twin reactor site (HPC, Wylfa B, Sizewell C).

The 'back-up' cost of constructing sufficient gas-fired turbine capacity to back-up the intermittent output from the UK's wind and PV schemes would amount to adding about £1.80 per MWh of wind or PV electricity generated (i.e. on top of the Contract for Difference or CfD cost). For comparison, the construction cost of the limited nuclear back-up may add £0.17 to £0.34 per MWh of nuclear electricity generated, but its emergency-response value would be much less than that of renewables back-up. The costs of fuel, including inefficient hot-spinning or cold-start operation, would be additional to any systems and might add another £1-2 per MWh generated.

The gas fuelling the back-up can be natural gas or low-carbon renewable gases as they become available at scale (bio-methane from anaerobic digestion schemes linked to the UK gas network, hydrogen from PV and wind powered electrolysers or hydrogen-methane mixes, or synthetic natural gas SNG from bio-gasifiers). The capital expenditure for a substantive deployment of electrolysers and gas storage might add say £2-3 per MWh to a renewably-powered system. When cold-start and open-cycle fuel inefficiency, electrolyser efficiency and other balancing and back-up costs are factored in renewably-powered system costs might add £6-8 per MWh to technology / CfD costs and a nuclear system maybe £0.5-1.0 per MWh. More accurate system back-up cost estimates would require considerable analysis.