Civil Nuclear Energy Policy – An Alternative Perspective

Introduction

This discussion paper considers recent energy related events in the UK and abroad to re-examine the Government's rationale for nuclear new-build. The three stated 'pillars' or rationale of the nuclear programme are or were : timely ie by mid 2020s low-carbon electricity, energy security and consumer affordability. The paper also considers evidence presented at the recent Public Accounts Committee (PAC) on a possible unstated rationale for the planned new-build programme.

This paper focuses on cost to consumers and security issues and should be considered in conjunction with two recent Forum discussion papers (listed below) covering the other significant issues of concern about new nuclear energy programmes :

'Reasons for an NPS Review' Jan 2015 (a 19 page report and presentation summary - covering nearly every issue of concern about nuclear energy)
'Nuclear Energy Policy - NGO's Issues of Concern' July 2017 (a 20 page discussion document summarising the main issues of concern). Circulated with this Agenda.

Neither of these papers has had, to date, any substantive response or rebuttal from BEIS. This paper puts forward estimates for subsidy costs for Hinkley Point C (HPC) and other first-tranche nuclear projects compared to an offshore wind counterfactual based on recent CfD auction awards. Subsidies for HPC range around **£ 30 billion**, and a 16 GW five project programme range between **£ 50-85 billion.**

The cost estimates are set out in some detail in an Annex to this paper to show transparency and to encourage BEIS response or rebuttal of the costs, methodology, assumptions and or conclusions. A critique of the HPC 'Value for Money' (VfM) assessment is also included in the Annex.

The paper also considers in detail a possible hidden military rationale for a new civil programme, as suggested by academics at Sussex University, and concludes any such rationale is a mis-perception with very significant adverse and counter-productive consequences for National Defence.

Consumer Affordability

It is becoming increasingly obvious, month by month, to more media and UK public that the cost of nuclear energy is becoming significantly more expensive than a mix of intermittent renewable technologies even after higher estimates of additional system integration costs are added in. The Hinkley Point C (HPC) CfD deal has faced widespread public criticism including from the Public Accounts Committee (PAC).

The Sept 2017 offshore windfarm auction awarded 15 year contracts around £ 60 / MWh for 2022 delivery. Contracts for 2025-27 delivery could well fall further. Additional 'system 'costs, ie the extra needed for intermittent renewables [offshore wind], comprising gas-fired back-up, 'gas' balancing, electrolyzers and other costs, are likely to be in the range of **£ 7.5 / MWh** more than a new-build nuclear-inclusive system equivalent (see author's estimates and scenario calculations in Annex).
So a reasonable offshore wind+ system comparator or 'counterfactual' for mid to late 2020s delivery would be around £ 67.50 /MWh (in 2017 prices) for the first 15 years. Contract costs would likely fall further by the time the 2020s turbines would need replacing in the late 2040s. In contrast, HPC CfD cost is £ 98 / MWh (in 2017 prices) falling to £ 95 / MWh if a Sizewell C is built.

A case can be made that the BEIS Sept 2016 Value for Money (VfM) assessment of HPC was so flawed in various assumptions and analyses that the next generations of British children will pay around **£ 30 billion more** as electricity consumers than they would have if HMG had followed a renewables pathway (see the author's HPC offshore wind system counterfactual calculations in Annex).

Yet Chancellor Hammond in his November 2017 budget spoke about 'not saddling our children with debts' one moment then announced that renewables funding to 2025 will be minimal the next. Notably, 2025 is when the Government is hoping that several nuclear new-builds will be coming online. So new nuclear schemes would from that time be drawing on the lion's share of low-carbon funds or other major subsidy mechanisms for 35 years (to around 2060) leaving renewables to fight for scraps.

That said, a 2017 National Grid report suggests that offshore wind may not need any subsidy by 2040 and the new BEIS climate change minister Claire Perry was enthusiastically saying on TV recently that some PV schemes are already subsidy-free.

It would be helpful in terms of public accountability, transparency and due diligence that BEIS respond to or provide a rebuttal of the conclusions, methodology, assumptions and estimates copied in this paper's Annex. The Annex gives a detail description and calculations which indicate that additional system costs of offshore wind are **about £ 7.50 / MWh** more than that of new nuclear build (assessed as part of a scale-up to a 100% Renewables Grid by 2050). It then uses a £ 5 and 10 / MWh additional system costs to provide an offshore wind scenario or 'counterfactual' to a 16-18 GW nuclear programme.

From a range of possible cost scenarios it can be shown that even IF subsequent nuclear CfD prices fell to between £ 70 / MWh and £ 82.50 / MWh then each remaining 3 GW scale project would still cost probably between **£ 5-16 billion pounds more than an offshore wind system counterfactual** which includes a highly reliable and resilient gas-fired back-up (including full replacement after 30 years). A five project 16 GW (125 TWh/y) nuclear deployment between 2025-2030 would **likely cost consumers £ 50-85 billion more than a renewable energy / offshore wind deployment** by 2030, assessed over 65 years between 2025 and 2090.

Given the criticisms of the HPC CfD deal HMG seems now to be looking to other funding mechanisms, such as equity finance, to procure any or all of the subsequent projects that comprise the five-six project 16-18 GW first-tranche new-build nuclear programme. Minister Harrington stated at a recent nuclear conference in London that '*nuclear will be cost competitive*' with other forms of electricity generation.

Clearly, IF the cost of borrowing £ billions for years is minimised by HMG backing for nuclear energy but NOT for large-scale renewables, particularly offshore wind, PV and PV-Thermal sources, then presumably nuclear could be made to look competitive to the lay-person even though it would be an anti-competitive action, and very probably outside public consent.

Offshore wind will likely be a major part of any renewable Grid, or indeed any Grid mix considering the 1,000+ TWh/y UK Continental Shelf (UKCS) resources. Yet the Government's vision of a 10 GW deployment in the 2020s represents a deceleration of the 10 GW built by 2020 from a standing start in about 2009. The Government could be aiming to build 35-40 GW or more of offshore windfarms from 2018 to 2030 which would generate the same annual electricity as a 16-18 GW nuclear programme.

Papers putting forward detailed system integrated renewable energy scenarios, and comparisons with nuclear-inclusive scenarios, have been presented to this Forum over the last five years and more :

* 'A Non-nuclear UK electricity system to 2030 and beyond' Feb 2013 (a 21 page report and presentation summary)
* 'Nuclear Pathways' paper/presentation June 2014 (a critique of HMG scoping reports of up to 75 GW nuclear by mid Century)

However, non of these reports have had any formal written response let alone convincing rebuttal by any CSA or DECC / BEIS staff with one minor exception. The exception was that a member of the DECC 2050 team (Simon Counsell) rebutted the 2013 report on the grounds that it would cost consumers about £ 40 billion more by 2050 than DECCs nuclear-focussed policy. However, in 2013 nuclear price forecasts were optimistic, early offshore windfarm contracts were high, the nuclear programme had not slipped by up to 10 years. Considering the sums of public money involved, £ 70 billion is a double-Brexit, BEIS would show significantly more public accountability if it responded in writing to Forum scrutiny.

The three pillared rationale for nuclear new-build

The three officially stated reasons for the 16-18 GW first-tranche nuclear programme are that it would provide : (timely) low-carbon electricity, energy security and affordable to consumers.

These three stated pillars are all now in ruins :

i. climate : renewables were always low-carbon, and bio-energy can be carbon-negative if coupled with CCS technology. The Government has shown zero concern that the significant slippages in the 2018-2025 nuclear programme will mean that 200 MtCO2 of emissions will not now be avoided by new-build nuclear as planned by 2025. In 2015 it also scaled back low-cost renewables and imported more Russian gas. So, a genuine commitment by Government to its professed 'climate' rationale is highly questionable.

i. security : cost-effective and practical UK Continental Shelf renewable energy resources are very large-scale, indigenous, geographically-dispersed, ever-replenishing and unstoppable, which can be harnessed by thousands of large and millions of small energy schemes and devices. Combined with widely dispersed 'gas'-fired and other back-up and storage, such resources would provide very high energy security, a highly reliable Grid supply, and a highly resilient Grid system, to match constantly changing consumer demand to changing supply. Centralised nuclear power infrastructure is a tempting terrorist target which could have devastating long-term radio-toxic consequences

i. cost : renewables costs inclusive of their additional system costs are clearly becoming significantly cheaper than the nuclear projects - how low-cost do renewables have to be in the DDM modelling and VfM assessment ?

Baseload and Intermittency

Minister after minister, since PM Blair's 'nuclear back with a vengeance' speech in 2006, have claimed that **nuclear energy is 'key', 'crucial' or of 'absolute' need**. Minister after minister claim that nuclear energy provides **'baseload'** and that renewable sources are intermittent and hence unreliable. This is a kindergarten level of understanding of an electricity system. How can a variable supply (from renewables) and a variable demand (by consumers) be balanced by the fixed output from a baseload (nuclear) supply ?

Yet, the constant repetition of this baseload versus intermittency argument, continues and new energy ministers (averaging one a year) do seem to get taken in by it. It seriously mis-represents the actual technical situation and engineering options that are available and likely to be built at scale in ANY likely future UK electricity-energy system, particularly 'gas'-fired back-up and electrolizers and energy storage.

It needs pointing out that the amount of 'gas' burnt and its annual carbon content ('gas' = Natural Gas, bio-methane, bio-SNG and electrolytic hydrogen) is likely to be about the same to balance the system in any likely 2050 energy scenarios nuclear-inclusive or not. That said, SoS Amber Rudd's 2015 energy policy to significantly reduce renewables deployment, particularly onshore wind and PV. That same year Centrica signed up for increased gas imports from Putin's Russia. So, it is clear that HMG would rather import gas from a nation implicated in proxy wars and the shooting down of civilian airliner than build PV and onshore windfarms which the majority of the British public continue to support in probably every poll ever carried out. Avoiding dependence on Natural Gas from Russia was a primary rationale for new-build nuclear during the energy reviews between 2005-2007 in the first place.

Security Issues

In terms of National Defence and energy security it would be difficult to significantly disrupt a decentralised renewable energy system, described above, even by concerted malicious or military actions or after major natural events. In stark contrast, large coastal radio-toxic critical infrastructure provide a relatively highly vulnerable, potentially devastating (and hence tempting) targets for terrorists or rogue states for at least 100 years to 2130.

The author's estimate (in previous papers) of nearly 40 mTBq of mainly Spent Fuel radioactivity (nearly half of all the UK's 87 mTBq legacy arisings) would have accumulated after 60 years at EACH of the five or six planned new nuclear sites has not been rebutted or confirmed by DECC or BEIS. Does BEIS actually know the amount for security?

A mix of renewable energy sources would provide significantly more UK energy security and energy system security than a nuclear-inclusive energy mix, let alone a nuclear-predominant Grid which is the Government's preferred vision and likely policy IF SMR's by 2030 can be made to look low-cost. Yet, despite the strength of these arguments, including that of falling renewables costs by 2016, the Government still pushed ahead with HPC.

This has led many observers to consider that some significant but hidden factor is playing on ministers' decisions that is not part of the three pillar rationale for a new nuclear programme.

A hidden military rationale for a civil nuclear programme ?

The Government's commitment to new nuclear build is now baffling many observers. Some form of secret national security and hence an unspoken rationale (real or perceived) has been proposed by the Science Policy Research Unit (SPRU) at Sussex University. It would explain so much that it needs to be considered.

The SPRU presented evidence to the recent PAC inquiry stating that (Summary 1.1) : '*...is partly due to a perceived need to subsidise the costs of operating and renewing the UK nuclear-propelled submarine fleet*'.

Yet, while such concerns may have seemed pressing and persuaded PM Blair in the post-Iraq War period, before the seven Astute-class SSNs and four Dreadnought-class SSBNs were ordered, this is hardly a convincing case by 2016. The Astute class construction is now half completed and the Trident replacement deterrent submarines have been voted by Parliament and are beginning construction for late 2020s delivery. **These submarines will not stop being built by a large workforce at BAE Barrow shipyards just because HPC is late or never works or the other nuclear schemes do not get consented.**

So any such 'concern' now would relate to post 2030 nuclear submarine manufacturing capability and a 2060 deterrent replacement class of submarines. Presumably, the Royal Navy would want a PWR4 reactor by 2030 for future fleet submarines and a PWR5 reactor by 2050 for a Dreadnought-class successor commissioning by 2060. Indeed, future British naval reactor designs that did NOT require fuelling with weapons-grade uranium (HEU), and could be refuelled relatively easily, would be a major benefit to global non-proliferation.

Note also that Tritium for ICBM warhead 'refreshment' can be produced using particle-accelerators and would not require new reactors. A new UK civil nuclear programme is not necessary for nuclear weapons production. Indeed, HMG's promotion of nuclear energy only provides non-nuclear countries an excuse to develop dual-capability nuclear sectors eg Iran, Saudi Arabia.

Neither would any 'hidden' cross-subsidy be that 'significant' in the context of annual UK defence spending of around £ 40 billion per year. Even directly retaining 1,000 Rolls Royce employees (CAD experienced naval architects, reactor designers, etc) and 1,000 more in nuclear submarine propulsion related industries (eg Sheffield Forgemasters) would only cost possibly £ 150 million per year (assuming £ 60k pa salaries plus other costs). That is less than 0.4 % of UK defence budget and would count towards the '2 % of GDP' defence budget anyway.

So why the political secrecy which can lead policy and sense astray ? In this case, any legitimate or dubious cross-subsidy might amount at most to about £ 5 billion over 35 years between 2025 and 2060.

Compare £ 5 billion with a minimum likely subsidy for a 16 GW nuclear programme of around £ 70 billion over 60 years. A fleet of 25 new nuclear-powered submarines (SSNs @ £1.4 b) would cost half that ie £ 35 billion. That scale of construction would keep the Barrow shipyards and associated industries in full employment (one SSN per year) from 2027 to 2052. For comparison, the seven Astute class submarines are scheduled over 14 years (one SSN every two years).

There is no military or civilian point for, or hiding, a nuclear subsidy, even IF it were worth several £ billion to the military, in a policy that costs consumers and taxpayers £ 70 billion or anything like such a sum.

To maintain the required nuclear submarines skills and construction capability it is easier to not fund the planned nuclear power projects, cancel HPC (costing £ 2 billion ?) and build nuclear-powered submarines instead. This assumes that battery-AIP (Air Independent Propulsion) electric submarines, at half the price, half the crew, and better stealth, do not become the submarine type of choice (nuclear-powered submarines are definitely very fast over long distances but they cannot be in two locations at once).

In any event, it seems likely that submarines of whatever propulsion system will be needed in significant numbers and skills at Barrow are safe anyway. Hypersonic weapons (missiles and rail-gun projectiles travelling at 5,000+ mph) may well soon dominate the future surface naval environment making the undersea battle-space relatively more survivable despite increasing detectability. The Russian Zircon missile is now entering service : http://nationalinterest.org/blog/the-buzz/imagine-almost-every-russian-warship-hypersonic-missiles-22675. The potential for submarine-launched ICBMs (eg Trident) to become easy pray for hypersonic missiles by the mid 2020s let alone 2060 also needs to be considered.

Note also that strategic-scale deployments of offshore windfarms would be a major defence benefit in themselves. Thousands of turbines could support detection systems, plug-in points for electric submarine recharging and, if necessary, weapons systems. The structures could ensure safer airspace and sub-surface areas for allied submarines and for intercepting hypersonic missiles and unmanned undersea drones targeted at coastal UK critical infrastructure.

Consequently, **any unspoken military rationale for new civil nuclear build is a ministerial mis-PERCEPTION carefully cultivated by the nuclear industry and its advocates**. The secrecy was probably a legacy of mid 2000's concerns and secretive Iraq-era Whitehall and Cabinet Office practices which should not continue.

It would be in the Government's, and the nation's, interests to discuss these strategic military issues with the MOD and Royal Navy as the OND is tasked with getting new reactors built, not finding reasons not to. The security remit and expertise within the Office for Nuclear Regulation and the Environment Agency also precludes authoritative consideration of such major strategic defence issues.

Summary

The three stated pillars of the nuclear programme rationale, (timely) low-carbon electricity, energy security and consumer affordability have been completely eroded by the reducing cost of renewables and the major delays in the planned nuclear programme. Hinkley Point C will, if completed, cost around **£ 30 billion**

more than a renewables strategy and a 16 GW programme could now cost **£ 50-85 billion more** than a 100% renewables by 2050 strategy. If there ever was an unspoken military rationale for a new civil nuclear programme then that too has now turned seriously counter-productive as renewables costs have fallen.

Future governments would have significantly more funds, amongst other things, to procure many more nuclear-powered submarines and maintain the related construction skills, if no more costly civil nuclear projects are subsidised (by whatever means) and preferably the HPC deal is cancelled (by whatever means). The children of today would not then be (secretly ?) saddled with this generation's nuclear debts (at Brexit times two scale costs).

Continuing with the planned (largely foreign) nuclear programme while reducing the speed of deployment of offshore wind, PV, PVT, onshore wind, other renewables and CCS has and is likely to cause serious harm to British innovation, invention and jobs in those technologies, which have safe export potential. The Government's industrial strategy is looking day by day more a case of industrial suicide.

Worse, there would be major and seriously long-term national defence and security issues surrounding any new civil nuclear infrastructure which are completely avoidable.

In total contrast, renewable energy systems and infrastructure would be, by their decentralised nature, highly reliable and highly resilient to both strategic-scale malicious and natural events. As the protection of a country's people is one of the first duties of a government then the national defence benefits of a renewables versus a nuclear-inclusive energy system should also be a major consideration.

The planned leviathan new nuclear structures would be built in thick reinforced concrete and would stand until the end of this Century at least and the Spent Fuel stores would remain well into the next. Some sites would be threatened by sea level rise and storm conditions.

These would not be the kind of lasting monuments any political party would want. As of 2018 such structures are already looking likely to become one of the costliest industrial blunders in UK history and potentially an even bigger naval blunder. The **Government now has overriding reasons to discontinue its support for the first-tranche nuclear energy projects** and plan for a major expansion of renewable energy systems in the UK, and for safe export globally, instead.

Neil Crumpton, Jan 2018