Policy Brief

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EVIDENCE FROM SPRU TO THE BRADWELL B PRE-APPLICATION CONSULTATION

A: SUMMARY AND RECOMMENDATIONS

1. This evidence reviews the status of UK Government policy justification for its presently intense commitment to new nuclear build, as compared with alternative low carbon energy strategies. This is a central issue for the present Consultation, because it is a presumption that this justification is adequate, that forms the basis for the ***remarkable restriction on the Consultation scope*** – effectively ruling out crucial general questions concerning the overall merits of the case for building a new UK nuclear power station.

2. Despite uncertainties and latitude for many different reasonable informed views, what this evidence shows is that ***the comparative case for new nuclear build is actually extremely poor***. What are also substantiated, are a series of further serious grounds for concern over the scope, quality and orientation of extant efforts over the past seventeen years, to justify this persistent official attachment to nuclear power. It emerges that ***major reasons for this intense commitment are strikingly different to what is declared***.

3. It is in light of this broad background, that key official bodies with core mandates directly in this field **–** including the ***National Audit Office*** and the ***House of Commons Public Accounts Committee –*** have repeatedly ***strongly criticised Government*** for failing to publish rigorous justification for nuclear policy.

4. On the grounds that the conditions justifying the Consultation remit are not in place, then, we therefore respectfully recommend that ***the present proceedings be formally suspended until Government delivers on the calls from its own responsible bodies that these conditions for the Consultation remit be fulfilled***.

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B: POLICY BACKGROUND

5. The authors work in one of the UK's leading energy policy research institutes[1]. Over the past twenty-five years, we have witnessed many radical changes, but also a number of oddly enduring patterns. In tension with well documented evidence, wider international trends and growing practice in other countries, one of these is the ***remarkably persistent intensity of official UK policy entrenchment in favour of nuclear power***. This implacable attachment applies across a succession of otherwise politically contrasting Governments[2].

6. The partisan bias in this position is evident, irrespective of the perspective from which it is viewed. It is, for instance, not necessary to be a nuclear critic to appreciate that a UK Chief Scientist's statement that "*there is no alternative to nuclear power*", is seriously deficient as a balanced reflection of evidence based analysis[3]. When Ministers declare that "*investing in nuclear power is what this Government is all about for the next twenty years*" or that there is "*no limit*" on the capacity the Government is be prepared to build, it is similarly ***clear that something is odd about the intensity of UK policy attachments to nuclear power***[4].

7. The eccentricity of this position is also visible in other ways – with many examples of this partisanshp shown by Ministers or senior officials, only during their tenure in office[5] and not in their personal views either before or afterwards[6]. Also evident, is a ***disturbing lack of national capacity properly to interrogate this policy bias***. Despite the integrity and best intentions of individual professionals, remits and framings of statutory procedures like the present consultation remain – like wider policy processes – seriously tilted.

8. For instance, there is the ***general mandate underlying the present consultation exercise***. This hightlights that because "*it is government policy that new nuclear power stations should play a significant role in the future generation of electricity in the UK*", the present consultation shall not be permitted to take into account questions regarding "*the principle of building a new nuclear power station*"[7]. Yet, it is precisely this eccentrically assumed unconditional national necessity for nuclear power, which forms the single most important driver for approving the present application. And it is this general single-sector bias that remains so remarkably entirely unsubstantiated by rigorous policy analysis or wider democratic accountability.

9. Among many ***severe criticisms*** of this state of affairs are highly unusual interventions both from the ***National Audit Office*** (NAO)[8] and the ***House of Commons Public Accounts Committee*** (PAC)[9]. These bodies have drawn attention to the indefensibly long period that has passed since the last substantive justification in the public domain, of the general UK Government attachment to nuclear power[10].

10. The last full UK Energy White Paper (that was not at a key stage successfully challenged by judicial review for being inadequate), was published in 2003[11]. Seventeen years ago, this was at a time when the comparative economic and strategic position of nuclear power was far less disadvantaged than it is now by comparison with alternative zero carbon renewable and energy service options. Yet even in 2003, ***this last full general Energy White Paper found that nuclear power presents an "unattractive" option for the UK***[12]***.***

11. In one of the most striking *volte-faces* in major UK Government policymaking over the past half century – which itself remains remarkably under-interrogated – this 2003 Energy White Paper was followed after an unprecedently short interval in 2006, by a far more superficial further review, revising the nuclear power position[13]. This further Energy Review followed a period of very intense activity in UK defence policy, with regard to ***the dependence of UK military nuclear industrial capabilities on a continuing civil sector***[14].

12. Key in preparing this later more superficial 2006 Energy Review, was a private Number 10 advisory group, of which full membership still remains undeclared and from which no evidence or other documents have ever been published. ***The secrecy of this process has been criticised even by nuclear proponents***[15]. It was on this basis, that the then Prime Minister declared that "*nuclear power is back with a vengeance*"[16].

13. The analysis and consultation undertaken for this more cursory and secretive 2006 Energy Review, was far less substantial than the two-year process undertaken for the 2003 Energy White Paper. Indeed, the ***House of Commons Environmental Audit Committee*** noted of the 2006 Review that "*the Government has failed to clarify the nature of the review*" and that "*…the manner in which it is being conducted appears far less structured and transparent than the process by which the* [2003] *White Paper itself was reached*"[17].

14. When the flawed process running up to the 2006 Energy Review was duly ***challenged by judicial review***, the verdict (strikingly for a white paper) found in ***favour of the complainants***[18]. Yet the then Prime Minister simply convened a further similarly rapid response and stated "[this] *won't affect policy at all*"[19].

15. So, the judicially criticised and relatively insubstantial 2006 Energy Review reversed the position on nuclear power taken in the far more deeply researched and widely

consulted 2003 Energy White Paper. ***No specific evidence or development was pointed to, such as to justify this shifted position***[20]. The military rationales so intensely advocated in defence policy during this period, remained entirely unreferred to[21].

16. Since then, global trends in ***rising costs and deteriorating performance on the part of nuclear power***, and steeply ***growing relative competitiveness and viable resources on the part of renewable energy***, grid management and energy storage have strongly underscored the seriously unfavourable picture for nuclear power already documented in the 2003 Energy White Paper[22]. Yet it is this picture, which the Government has resolutely failed to address in any full detailed energy policy justification over the past 17 years[23].

17. It is this situation that bodies like the NAO and PAC have severely criticised in light of continuing growth in the comparative disadvantages suffered by nuclear power. It is on this basis that these duly responsible bodies have called upon Government to revise and publish a formal strategic case for new nuclear power[24]. Yet with the ***Government remarkably persistently failing to do this, it is this flawed basis that underpins the partisan mandate imposed on the present inquiry simply to assume the merits of nuclear power***.

18. Under extraordinary circumstances like this – where a particular partisan sectoral interest is evidently being imposed in flagrant disregard for due processes of policy rigour and democratic accountability – ***a clearly over-riding responsibility arises with regard to the present consultation exercise***. In short, it is a duty of all involved ***actively to question a circumscribed remit that risks seriously biasing the outcomes***.

C: WIDER STRATEGIC CONTEXT

19. The conclusions summarised above are further underscored when detailed attention is given to the wider strategic context for the comparative current position of nuclear power in relation to available alternatives – which the present consultation remit so unjustifiably excludes from consideration. In short, ***worsening comparative cost, resource, employment and strategic disadvantages on the part of nuclear power are prominent on the global stage***[25]. With particularly large and competitive renewable resources and no internationally leading nuclear equipment vendors, ***the predicament is especially acute in the UK***[26].

20. Around the world, ***nations without ambitions or existing commitments to nuclear weapons or their nuclear-powered military delivery systems, are overwhelmingly turning away from nuclear power***[27].

The economics and wider strategic performance of diverse renewables and their associated grid and demand management technologies have been advancing at an accelerating rate[28], with costs falling precipitously and developments proceeding at a pace well beyond even proponents' earlier projections.

21. Take for instance, the status of offshore wind and solar power. The economically realisable UK resource in these two renewable options alone is clearly sufficient over time, to ***maintain a supply that far exceeds foreseeable national energy needs*** – including shifts towards electric mobility and heating that are much needed for other reasons[29]. Costs have plummeted far faster than official projections[30]. Despite measures to slow and restrict the pace of development, these markets have expanded far faster than predicted[31].

22. As in any industry – especially one undergoing transformation at this pace – many technical challenges and uncertainties remain. But ***the speed with which these challenges are being resolved in the renewables sector contrasts starkly with the pattern of rising costs and escalating problems in the nuclear sector.*** For instance, measures to address intermittency and seasonal contrasts in energy demand are already available at well below the existing cost advantage of renewables over nuclear power[32]. And this gap is growing fast.

23. Beyond wind and solar power, a host of more diverse renewable energy, grid management, distributed service, smart management and energy efficiency measures are also becoming available[33]. Taken together, these non-nuclear engineering and organisational innovations are presenting the UK, for the first time in its industrial history, with the opportunity to develop ***far more rapidly than a nuclear programme, a cheap, diverse, secure, zero carbon renewables-based energy system sufficient to meet all emerging needs***.

24. With regard to the crucial issue of employment, UK Government statements are especially problematic – being repeatedly restricted simply to noting the overall numbers of jobs associated just with envisaged nuclear investments alone[34]. That this should be thought a serious contribution to debate is itself a sign of the kind of bias documented above. It is obvious that any large-scale investment will result in job creation. ***The salient issue lies not in asserted numbers for any single investment option, but in the comparative job-creation potential of each individual option under rigorous comparison with available alternatives.***

25. When such evidence is analysed comparatively, the nuclear case again emerges as far from favourable. ***Jobs in the UK renewable sector already surpass those***

associated with nuclear and this are continuing to grow[35]. With a far greater existing UK comparative advantage in renewables than in nuclear power; with global nuclear markets seriously contracting; and with renewable markets growing very fast; the ***export opportunities are further significantly more favourable for UK renewable jobs than for UK nuclear jobs***[36].

26. Yet despite this remarkably declining outlook, the intensity of UK Government commitments to nuclear infrastructures has remained strangely constant over time. In a period when other ***countries with far more successful and larger scale nuclear engineering industries are completing rapid nuclear phase-outs***[37], UK governments continue to proclaim a 'nuclear renaissance' – as if this were a self-evident end in itself[38].

27. The remarkable bias evident in UK policy statements is made more concrete in a discrepancy between UK policy measures enacted in support of nuclear power on the one hand, or renewable energy and energy efficiency on the other. Around the same time that loan guarantees and additional investment for nuclear were being announced in 2015[39], for instance, support for renewables was effectively retracted[40]. ***Several support mechanisms for renewables and energy efficiency were abruptly halted, leading international commentators to question the 'puzzling' direction that UK energy policy seemed to be taking***[41].

28. ***These increasingly idiosyncratic developments are leading the UK to become a growing world anomaly.*** Despite a succession of setbacks (and lessons of history concerning the dangers of fragmented nuclear development plans), a bewildering diversity of nuclear projects stagger on alongside the present plans for Bradwell, variously championed by French, Japanese, Chinese – and (most recently) UK defence interests. That the Bradwell B project is beset with potentially prohibitive strategic foreign policy problems, adds to the oddity that such incoherently-diverse and manifestly problematic options are being pursued[42].

29. In a further complication, diminishing global nuclear orders are leading many international nuclear firms elsewhere to be recognised as nearing insolvency[43]. It is disproportionately in the UK that this ailing global industry seeks to find a market[44]. ***Yet despite holding no significant track record in international civil nuclear sales, UK defence suppliers now declare aims to enter into this diminishing global market,*** by proposing an entirely new and untested military-derived small modular nuclear reactor design[45].

30. With the picture so stark, it is not as if evidence for concern over the above trends is undocumented in the UK. Although typically relegated to the margins of national energy policy communities, independent experts are clearly on record as repeatedly pointing out all these and other difficulties. For example, ***poor performance and even worse trends over time have been continuously and robustly documented with respect to: nuclear energy costs***[46]***; the comparative case for zero carbon alternatives***[47]***; the potentialities for catastrophic accidents; and the practical insolubility of waste management challenges***[48].

31. Yet, ***despite the wider comparative strategic positon of nuclear power becoming rapidly more unfavourable, official UK commitments to nuclear power have remained effectively unchanged.*** Data and appraisals highlighted in high-level policy documents have become increasingly detached from wider energy market analysis[49]. Ever more ambitious new UK nuclear infrastructure programmes grow, despite a persistent track record (distinctively bad in the nuclear sector) of failure to deliver on early promises[50].

32. ***Numerous further eccentricities remain seriously under-interrogated in official UK nuclear policy.*** For instance: the recruitment of senior policy advisors. Despite strong UK capabilities in energy policy analysis, individuals have been selected for 'scientific advisory' positions in this field, who have no background at all in energy issues. In the year of the *volte-face* discussed above (2006), one such departmental chief scientist unprecedentedly gained resources to publish in a freely-released and widely publicised book, a series of eccentric statements deprecating renewable energy technologies and falsely implying that viable national renewable energy resources are insufficient to power the UK[51]. Even at the time, these claims clashed with available Government data. In less than a decade, they have been manifestly refuted even by unfolding events[52]. Yet neither this episode nor other similar examples of bias are ever properly scrutinised.

33. Against this background, perhaps the most pressing questions concern how and why it is that such an anomalous situation could possibly continue? With the starkness of these eccentricities in UK nuclear policy processes being rather hard to believe, there are dangers that the sheer severity of the problem might itself become a major impediment to resolving it. But there is actually no shortage of available evidence that helps clearly to explain this situation. Indeed, it is notable that the reasons for these eccentricities are openly provided by officials and robustly documented in academic literatures[53], parliamentary deliberation[54] and intermittent press reports[55]. ***What is especially disturbing in this regard, is that this underlying picture is so generally ignored in mainstream UK energy policy debates and wider media discussions.***

34. The cause of this otherwise-inexplicable state of affairs

does not seem to be that UK policy processes are somehow unable to grasp the transformed conditions of UK and global energy markets. A key reason evidently lies instead in that official UK nuclear attachments are actually largely driven by significantly different rationales to those that are formally declared (but which remain so tellingly unjustified). In short, what is evidently strongly driving this situation, is the ***openly unconditional priority attached by influential elements in UK political culture to the perceived status of the UK as a military nuclear power***[56]. Without civilian nuclear infrastructures, costs of maintaining this military status are recognised to be prohibitive[57].

35. Leading figures have long emphasised ***UK nuclear military capabilities to remain essential "whatever the cost"***[58]. But grave concerns are now evident in military circles, that these costs have now become too high to be publicly supportable[59]. So, although under-discussed in the energy field, it is political pressures that are very clear in defence strategies that are evidently (at least partly) driving UK civil nuclear policy.

36. In short, implacable official commitments to retaining nuclear power in UK electricity supply (despite its cost), is a way to ensure that ***electricity consumer revenues are channelled into supporting a joint civil-military national nuclear industrial base*** (including specialised skills, training, research, design, regulatory, engineering and special materials capacities) that relies indirectly for funding on civil nuclear new build[60].

37. ***This situation need not be taken to imply a narrow 'conspiracy'***[61]. It reflects underlying political forces more than individual agency. To the committed interests involved, it is likely viewed simply as an elegant solution to an intractable problem. Associated levels of ***secrecy are routine in military nuclear affairs***.

38. Despite the secrecy, there is much general evidence for a growing official priority attached to linking UK civil and military nuclear activities. Repeatedly acknowledged by ministers[62] this was directly defended by a key responsible official under questioning by the Public Accounts Committee[63]. ***Appearing repeatedly in national media, detailed analysis by the authors (that has not been refuted) highlights how this amounts to a hidden subsidy***[64]. Yet the massive economic implications remain more widely entirely undiscussed[65].

39. What is in effect happening, is that ***ordinary UK electricity consumers are funding a major hidden de facto subsidy of many tens of billions of pounds to military interests***. In this way, otherwise insupportable costs of the military nuclear industrial base are covered outside a hard-pressed defence budget, entirely off the public books and – in absence of energy policy justification – conveniently concealed from due scrutiny.

40. Whatever position is taken on pros and cons of civil or military nuclear technologies, the lack of official energy-specific analysis and the under-scrutinised intensity of UK Government bias towards nuclear power, are a national embarrassment. ***That key drivers of this bias are so obvious but so under-discussed is even more troubling***[66]. That UK media, policy and academic institutions are failing adequately to interrogate this situation, raises disturbing questions about the health of British democracy in the widest sense[67].

D: CONCLUSIONS

41. It is in the interests of citizens and stakeholders in the Bradwell area – as in the rest of the country – that these wider issues be subject to fair scrutiny. If the UK Government and wider policy processes had shown themselves to be open to justifying this commitment, then it might be reasonable that local level consultations be constrained by it. The circumscribed remit for this present consultation might in this event be justified. But ***(as a variety of statutory and parliamentary bodies have noted) there is actually a serious deficit of rigorous, transparent or accountable policy attention on these wider issues at national level***.

42. It is in this light, that our evidence points to a duty in the national interest that we believe falls on all involved in the present consultation exercise. ***Officials, expert witnesses, news reporters, policy analysts, stakeholder representatives, academic researchers, as well as members of the public at large, all share a responsibility in the public interest of healthy policy making and robust energy strategy. This is to question both the present unjustifiably closed remit and a wider political environment, that are seriously biasing UK energy decision making, incurring massively excessive costs, and undermining UK democracy.***

E: RECOMMENDATIONS

43. A feature of the remit for the Bradwell B Pre-Application Stage One Consultation, is that c***onsideration is excluded for the comparative strategic case for nuclear power, as compared with other zero carbon energy options***. This is on grounds that such issues are adequately dealt with by national policy making processes. But it is clearly documented in this evidence, not only that this condition remains unfulfilled, but that there arise from this, important implications that are directly ***material to the Consultation findings***.

44. That this grave situation pertains, has been shown (*inter alia*) by a number of high-profile national governmental bodies with mandates directly in this field **–** including the ***National Audit Office*** and the ***House of Commons Public Accounts Committee –*** who have repeatedly ***strongly criticised Government*** for persistently breaching its responsibility in this regard in unprecedentedly protracted and serious ways.

45. A clear recommendation therefore emerges on the basis of the evidence presented in this submission. This points to a duty and a responsibility on the part of this Consultation, that is at the same time formally grounded in its own remit and demonstrably ***justified in ethical and wider substantive policy terms, as well as in the manifest interest of citizens*** in the Bradwell area and throughout the UK more widely.

46. On the grounds that the conditions justifying the Consultation remit are not in place, then, we therefore respectfully recommend that ***the present proceedings be formally suspended until Government delivers on the calls from its own responsible bodies that these conditions for the Consultation remit be fulfilled***.

Evidence provided by Andrew Stirling and Philip Johnstone to the Bradwell B Pre-Application Consultation.

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Picture: Bradwell A nuclear power station (Photo courtesy of wikimedia commons). Permission was sought but declined by developers, to use an image of Bradwell B

ENDNOTES

1. The Science Policy Research Unit (SPRU), is located in the Business School at the University of Sussex, Brighton. With over 50 years of experience, SPRU is internationally recognised as a leading centre of research on science, technology and innovation policy. The Sussex Energy Group (SEG) of which both authors are members (one of us for more than twenty five years), is one of the oldest energy research groups in the United Kingdom and has conducted policy-relevant research on a number of topics including extensive research on all areas of nuclear power policy (see Johnstone 2016 for a brief overview).
2. Since the UK's first nuclear programme in 1955, There has been no government (Conservative, Labour, or Coalition), that has shifted from a firm commitment to nuclear energy. This can therefore be considered to be the single most consistent feature of UK electricity policy for the past seven decades. As we discuss in this document, there is only one moment in this long period (as a result of an unusually exhaustive and unprecedentedly open white paper appraisal and consultation process ending in 2003), when there was ever any serious publically-documented official consideration for not commiting to nuclear power – by the Labour Government of Tony Blair. However this was quickly reversed. It is only the devolved Government of Scotland that has since 2008 eschewed commitments to new nuclear power, pursuing ambitions for 100% renewables in electricity production.
3. In 2006, Sir David King intervened with an article in The Independent outlining that "we have no alternative to nuclear power" (King, 2006). In 2014 King conceded that in fact nuclear may not be 'needed' after all (Lean, 2014).
4. Challenged on the flagship UK national radio news programme in March 2016, for instance, former UK Energy Minister Amber Rudd clearly expressed the intensity of this position, in stating that "investing in nuclear is what this Government is all about for the next twenty years" (BBC Radio 4, 2016). Elsewhere, the present Secretary of State for BEIS, Greg Clarke has said in the past that there is "no limit" on how much new nuclear capacity the Conservative Party would be prepared to build in the UK (Greg Clarke quoted in Collins 2010).
5. There are many examples of this. One is discussed in endnote 3 above. Another striking example is that of Chris Huhne of the Liberal Democrats. In 2007 Huhne stated that: "Ministers must stop the side-show of new nuclear power stations now. Nuclear is a tried, tested and failed technology, and the Government must stop putting time, effort and subsidies into reviving this outdated industry. The nuclear industry's key skill over the past half-century has not been generating electricity, but extracting lashings of taxpayers' money". In 2010, now in office as Secretary of State for Energy and Climate Change, Huhne declared that nuclear was "vital" for the UK's energy needs, and that "we need nuclear to be a part of our energy mix" (see Martin, 2014).
6. An example here, is the late Tony Benn. In his time as Energy Minister, between 1975-1979 Benn supported the UK's use of nuclear power. However his views changed. As Benn himself explains: "I advocated it as Minister of Technology. I was told, and believed, that nuclear power was cheap and

safe and peaceful. Having been in charge of nuclear power I discovered it wasn't cheap, wasn't safe and when I left office I was told that during my period as Secretary of State for Energy plutonium from our nuclear power stations went to the Pentagon to make nuclear weapons. So every nuclear power station in Britain is a bomb factory for America. I was utterly shaken by that. Nothing in the world would now induce me to support nuclear power. It was a mistake." (Benn, 2008).

7. CGN-BRB-EDF Energy (2020) Stage One Consultation Document, p.4. Bradwell B Power Generation Company Limited 2020.

8. The National Audit Office (NAO) is an independent UK Parliamentary body which is responsible for auditing central government departments, government agencies and non-departmental public bodies. In 2017 the NAO published their report on Hinkley point C (NAO, 2017). Sir Amyas Morse, at the time head of the National Audit Office, stated that "the Department has committed electricity consumers and taxpayers to a high cost and risky deal in a changing energy marketplace. Time will tell whether the deal represents value for money, but we cannot say the Department has maximised the chances that it will be."

9. The Public Accounts Committee (PAC) is a select committee of the UK House of Commons. It is responsible for overseeing government expenditures, and to ensure they are effective and honest. The PAC held an inquiry into Hinkley C following the NAO report of the same year, which raised significant concerns about the value for money and financial risks of nuclear developments in the UK (PAC, 2017).

10. As highlighted by the PAC, The Government have not considered the strategic case specifically for nuclear power since 2008. Since then nuclear costs have increased considerably while costs for renewables have plummeted (PAC, 2017). As we detail in this evidence, a judicial review and many official bodies raised serious questions about this Nuclear Review.

11. DTI (2003) Our Energy Future: creating a low carbon economy. London: Stationery Office.

12. Page 44. DTI (2003) Our Energy Future states: "Although nuclear power produces no carbon dioxide, its current economics make new nuclear build an unattractive option and there are important issues of nuclear waste to be resolved. Against this background, we conclude it is right to concentrate our efforts on energy efficiency and renewables".

13. The 2006 Energy Review concluded that new nuclear "had a role to play" in UK energy policy (DTI, 2006: 8), which signalled a decisive shift from the conclusions of the 2003 Energy White Paper which had referred to new nuclear as an 'unattractive' option that was not being pursued (DTI, 2003: 44). Steve Thomas (2016), a leading expert in nuclear policy, explores this "remarkable" policy turnaround, concluding that official arguments around climate change and energy security do not offer sufficient explanation. Without being able to find a more detailed explanation, many commentators put this policy reversal down to what Thomas calls a "failure" (page. 421) on the part of the civil service and policy making more widely, in the face of what is simply described as the effects of the nuclear "lobby" (page 421). But the nature and substance of this 'lobbying' remains opaque, with Thomas concluding that "There is a common perception that there is a strong nuclear lobby in Britain… however, it is not readily apparent who that lobby might contain." (p. 88). The present evidence bears directly on this issue. The new more nuclear-specific white paper was published in Janauary 2008: BERR (2008) Meeting the energy challenge: a white paper on nuclear power. London: Stationery Office.

14. The MoD commissioned the influential USA-based think tank (the RAND Corporation) to research the industrial and supply chain issues around maintaining the UK submarine base – particularly highlighting the skills shortages that the UK faced in this area and the associated difficulties in sustaining a nuclear-qualified workforce between submarine orders (Schank, Cook, et al. 2005). The Keep Our Future Afloat (KOFAC) campaign was launched in 2004 representing councils, industry and trade unions associated with the submarine manufacturing base at Barrow and participated in both civil and military consultations on nuclear during the crucial period between 2003 and the White paper of 2008. For example, in a Memorandum in 2006, KOFAC stated that "we support development of new proposals for nuclear generating capacity within the UK and, where possible, utilisation of the skills and expertise that exists in Cumbria at facilities such as the Barrow shipyard to design, test commission, build and operate nuclear powered electricity generating equipment" (KOFAC, 2006 submission to the DTI energy consultation, document no longer online). In 2006, the House of Commons Defence Select Committee undertook an inquiry into the Future of the UK's Strategic Nuclear Detterent (HoC Defence Select Committee, 2006). Many key actors in the submarine industrial base gave evidence and highlighted the importance of a new programme of civil nuclear power for sustaining the industrial base for nuclear submarines. For example, Rolls Royce highlighted that "the depletion of civil nuclear skills has…reduced the support network available to the military programmes" (Ev59). The Royal Academy of Engineering highlighted that: "Overall, the decline of the civil nuclear programme has forced the military nuclear programme, and in particular the nuclear submarine programme, to develop and fund its own expertise and personnel in order to remain operational." (EV107). They also stated that "Ultimately, a strong civil industry is very much in the interests of the military, and this may become the case in the future" (EV107). In early 2006, BAE Systems, the company that constructs nuclear submarines formed the "key supplier forum" to bring together and coordinate for the purposes of cost reductions and future planning among the key stakeholders in nuclear submarine construction. Then the Future of the United Kingdom 's Nuclear Deterrent paper was unveiled by Government in 2006. Around this time, the DTI unveiled plans to preserve nuclear skills and R&D capabilities as part of the National Nuclear Laboratory (NNL). The NNL also works with partners across both the civil and defence nuclear sectors.

15. As nuclear advocate Simon Taylor (2016) documents in his book The Fall and Rise of nuclear power, in 2005 a working group inside the Cabinet Office headed by John Birt conducted a review of energy policy specifically focussed on a nuclear new build programme. This was a "secret piece of work" (p.61) conducted by a small group selected by then Prime

Minister Tony Blair where "other civil servants were not involved…or even told". A crucial part of the revival of new nuclear was therefore orchestrated "behind the scenes" (p.64) without transparency even within the civil service.

16. Speaking at the CBI's annual conference Mr Blair told delegates that energy policy was back on the agenda "with a vengeance."(Eddie Newsroom, 2005).

17. This quote is from page 60 of the following report: Environmental Audit Committee (2006) Keeping the lights on: nuclear, renewables and climate change. London: Stationery Office.

18. Greenpeace won this legal challenge. This episode is reported by the BBC News (2007). Mr Justice Sullivan described the Government's energy consultation at this time as "flawed", "misleading" and "procedurally unfair". He added that "something has gone clearly and radically wrong… There was therefore procedural unfairness and a breach of Greenpeace's legitimate expectation that there would be the fullest consultation before a decision was taken" (BBC News, 2007). Additionally, it has been suggested by senior sources in the civil service that there were even more serious forms of malpractice taking place within nuclear policy making during this period. A senior civil servant working in the Office for Nuclear Development (OND) commented of this episode in an interview with one of the authors in 2011: "Well, this was an example of what not to do…this was really bad…this wasn't a good period, and there was a lot they were doing wrong with nuclear which we've learned from. The court case was a bit similar to Al Capone you know…he was committing many counts of gangsterism but then it was a small piece of tax evasion which put him behind bars." (Interview with a civil servant in the OND, 2011, see: page 181 of Johnstone 2013). There is clearly a lot more to be illuimninated about the unfolding of UK nuclear policy during this period. It is clear from this and other evidence presented here, that an important and pervasive feature seems to have been a striking level of secrecy.

19. Following the decision by the Royal Courts of Justice, the Prime Minister Tony Blair declared that the decision "won't affect policy at all" reaffirming the importance of having "nuclear back on the agenda" (BBC News, 2007). Esentially following the same revised line on nuclear power adopted in the flawed 2006 Energy Review, the further duly amended 'Nuclear Review' paper was published in 2008 (BERR, 2008).

20. The Environmental Audit Committee (2006: 64) commented that "we remain convinced that the vision contained in the White Paper—with its focus on energy efficiency and renewables as cornerstones of a future sustainable energy policy—remains correct" and that there had not been a "proper explanation of how circumstances have altered sufficiently to justify such a change" in terms of the changed position on nuclear power.

21. Across many discussions of the "nuclear renaissance", official UK energy policy documentation has generally failed to make any mention of the military rationale for pursuing civil nuclear power that is so prominent in defence policy documentation. One very rare but salient exception occurs in an external report for DECC by the consultancy Oxford Economics which stated that "the naval and civil reactor industries are often viewed as separate and to some extent unrelated from a government policy perspective. However, the timeline of the UK nuclear industry has clear interactions between the two, particularly from a supply chain development point of view."(Oxford Economics 2013. page 31). The report goes on to state that "The UK nuclear supply chain grew from investment in reactor technology to develop nuclear weapons, then into civil reactors, then submarines, a new generation of civil reactors and finally more investment in a new class of submarine. Without this synergy the UK supply chain would not have been sustainable. Therefore it is worth thinking about this interrelationship in developing the future plan for the UK nuclear supply chain."(p. 31). As we discuss in this document, the body language of UK Government began to change somewhat only from 2017, at a stage when links between civil and military nuclear industrial infrastructures became increasingly acknowledged despite previous insistence on the two programmes being distinct.

It was in 2017 for instance (following the first publication of academic evidence specifically on this issue by the authors), that a number of statements and reports began emerging in the USA, openly acknowledgeing interdependencies between civil nuclear and military submarine infrastructures. This overturned official decades-long claims by the nuclear industry and governments that civil and military nuclear were separate. Former US Energy Secretary Ernest Moniz launched a report in 2017, which stated that "a strong domestic supply chain is needed to provide for nuclear Navy requirements. This supply chain has an inherent and very strong overlap with the commercial nuclear energy" (Energy Futures Initiative, 2017: 7). The report goes on to note that "Without a strong nuclear energy program, which is by far the largest nuclear activity in the United States, sustaining the supply chain for both civilian and national security objectives will be challenging" (p.9). A Report by the Energy Innovation Reform Project (2017) on the future costs of new nuclear in the USA notes that: "A sustained decline in the commercial industry could also have a negative impact on the U.S. nuclear naval program" (Energy Innovation Reform Project, 2017:7). The pro-nuclear Environmental Progress group also now highlight the national security dimensions supposedly at risk by declining civil nuclear (Gallucci & Shellenberger, 2017). The Nuclear Energy Institute, now strongly lobbies for subsidies for failing nuclear developments, on the grounds that abandonment of these will "stunt development of the nation's defense nuclear complex" (Axios, 2017). In 2018 the links continued to be made with '75 senior US figures' writing a letter highlighting the "national security benefits of a strong domestic nuclear energy sector" (World Nuclear News, 2018). In October 2018, a symposium on 'nuclear energy, naval propulsion, and national security' was held at the Centre for Strategic and International Studies (CSIS) bringing together expertise highlighting how the fate of the USA nuclear submarine capability is "tied to the fate of the commercial nuclear sector" and to "mitigate the impacts of a declining nuclear power industry on the Navy and national security" (CSIS, 2018). As discussions around a Green New Deal emerged in the USA in early 2019, politician Representative Jeff Duncan wrote in support of constructing new civil nuclear because of 'national security reasons' outlining that "the U.S. Navy benefits from a shared supply chain with the civilian nuclear fleet" (Duncan, 2019).

A similar picture has become clear over recent years in other nuclear weapons states. The major state-held Russian nuclear construction and services company Rosatom is clear that the "[r]eliable provision of Russia's defense capability is the main priority of the nuclear industry" (Rosatom, 2017). In France, a series of policy intrigues in this area have led Le Monde newspaper to highlight "the ultimate question an expert dares asking": "What would become of the credibility of our nuclear weapons program and our position at the UN [Security Council], if France were to renounce its [nuclear power] plants?" (Bezat, 2017). If concerns should be raised in such acute and high profile ways about the diminishing critical mass joint civil-military national nuclear industrial bases in two countries ion which these are so relatively when compared with the UK, then the question is intensified as to why these is so little policy acknowledgement of this issue in the UK.

22. In 2003, the share of renewables in the UK electricity generation mix was around 4.6% (IEA, 2020). Wind contributed around 0.3% of electricity supply in 2003 and solar's contribution was negligable. Fast forward to the present day, and it can be seen that renewables generated 37% of electricity generation in 2019 (BEIS, 2019), and in the first quarter of 2020, renewables became the main power source in the UK generating 44.6% of total generation (Lempriere, 2020). While Scotland's plan for 40% renewables generation by 2020 was considered unfeasible and indeed "fanciful" by the self-proclaimed "logical and practical" Supporters of Nuclear Energy Group in 2003 (SONE, newsletter, document no longer online but image available here, 2003), for the first six months of 2019, renewables produced twice the country's domestic power requirements (Cockburn, 2019). Much of this new capacity has been built since 2010, so the transformation of the British energy system has been rapid. As this has occurred prices have fallen rapidly in the UK with onshore wind, solar, and offshore wind cheaper than new nuclear. This reflects international trends where in the past decade with solar costs reducing by 82% since 2010, onshore wind by 39%, and offshore wind by 29% (Frankfurt School-UNEP, 2020). Meanwhile costs of nuclear in the UK have doubled in the past decade (Ambrose, 2019a), and internationaly, nuclear costs have increased by 29% in the past decade (Dunai & De Clercq, 2019). Yet, despite these new realities, the UK government remains firmly committed to new nuclear.

23. Strictly speaking, the relevant time period for the lapse between the last full UK energy white paper and the present day is seventeen years. This is because it was the 2003 Energy White Paper (DTI 2003) that formed the last fully-detailed, duly consulted policy statement with balanced attention across energy strategies as a whole, that was not – as was the 2006 Energy Review (DTI 2006) – subsequently successfully challenged by judicial review. The further policy statement issued in 2008 after the Prime Minister stated that this successful judicial review "won't effect policy at all" (BBC 2007) was focused (as its name suggests – and as was the flawed 2006 paper) specifically on making a case for nuclear power, rather than on offering a fully-detailed, duly consulted policy statement with balanced attention across UK energy strategies as a whole (BERR 2008).

24. In their report on Hinkley C in 2017, the NAO recommended that Government "…reconsiders its strategic case for supporting nuclear power" and "maintain and update a 'Plan B' for achieving its objectives in the event that HPC is delayed or cancelled" (NAO, 2017. P.14). The PAC then made the specific recommendation that "The Department should re-evaluate and publish its strategic case for supporting nuclear power before agreeing any further deals for nuclear power stations" and that "the Department should ensure it publishes its 'Plan B' for achieving energy security, while at the same time delivering on its decarbonisation and affordability ambitions" (PAC, 2017. P.6).

25. The World Nuclear Industry Status Reports documents in detail the long term trends of slowing reactor construction and escalating costs. See Shneider et al (2019).

26. The UK performs strikingly poorly overall on most international comparisons related to plant performance. The UK has not sold a nuclear reactor since the early 1960s, when UKAEA sold a total of 2 to Japan and Italy. There is no UK headquartered company that is a major nuclear power utility company. The UK performs poorly in terms of international comparisons of key indicators of industry performance such as reactor performance, and the UK nuclear sector compares poorly on key comparisons of industry innovation such as the 'innovation index' and patent counts (Johnstone & Stirling, 2020). While it is clear that the UK is if anything in a disadvantageous position in terms of its nuclear industry, it is in a uniquely advantageous position with regard to renewables potential with the best renewables resource in Europe (DECC, 2011a). Yet, it is the UK that continues to intensely pursue nuclear while countries with superior nuclear industries and inferior renewables potential that move away from the technology.

27. According to the positions asserted in national data published by the global industry trade body – the World Nuclear Association (WNA), the five largest-scale prospective nuclear new-build programmes in the world are in four of the five 'official' nuclear weapons states (excepting France). India and Iran are also pursuing ambitious nuclear new-build programmes. And France is an illuminating exception, in that the scale of its existing reliance on nuclear power in itself militates against further large-scale national expansion. Of the relatively few other countries in the world presenting themselves as pursuing the most ambitious civil nuclear new-build plans, eleven out of thirteen hold the status of being major (at least regional) military powers. With regard to the next tier of stated national ambitions for nuclear power, an association between civil nuclear and military interests is also apparent. Of 23 countries widely designated as 'major regional powers' or above, only Australia has never developed, or is not seeking to develop, a civil nuclear programme. Albeit circumstantial, it is quite obvious that it tends to be the leading global military powers who are also the leaders in civil nuclear power around the world – and the most committed to large scale new nuclear build. There is no global or regional military power, that has not displayed at least some active history of strong strategic pressures to pursue civil nuclear power capabilities. Conversely, no country with a current nuclear moratorium or that is phasing out nuclear power has either nuclear weapons, nuclear submarines or plans to develop either. Countries with well-performing nuclear sectors have signalled a shift away from nuclear, including Germany, Switzerland, Spain, and South Korea. See: Stirling & Johnstone (2018) A global picture of industrial

interdependencies between civil and military nuclear.

28. A sign of this rapidly change in global energy markets is that global investment in renewable energy has for several years exceeded that in all other generating technologies put together, with the gap growing fast (Frankfurt School-UNEP 2016: 32).

29. See: Centre for Alternative Technology (2013) Zero carbon Britain: rethinking the future (Allen et a, 2013); PWC (2011) 100% renewable electricity: a roadmap for Europe and North Africa; Recent peer-reviewed articles and reports highlight the technical feasibility and economic effectiveness of global 100% renewable energy systems (Brown et al 2018 & Pam et al 2017). The UK has the best renewables resource in Europe with Scotland alone accounting for 25% of wind potential in Western Europe, so the UK should be in a leading position to enact the goal of 100% renewables transition. Other European countries with nuclear capacity, most recently Spain, have set such a target for example (Nelsen, 2018) and there is no reason that the UK could not, yet rarely is the idea ever seriously considered in UK policy and academia, despite its prevalence elsewhere.

30. This is evidenced by the fact that the UK's 16 GWe nuclear programme was justified on the basis of nuclear remaining cost-competitive with renewables for several decades (BERR, 2008), and similarly, outlined by the Committee on Climate Change (CCC) in 2013, that nuclear "…currently appears to be the most cost-effective of the low-carbon technologies" (Monbiot, 2011). Only a few years later, both the costs of onshore wind and solar (BEIS, 2016), and then offshore wind (BEIS, 2017) had fallen below that of nuclear. This highlights the problematic nature of the Government's lack of explanation regarding why nuclear is still being so intensly pursued.

31. A particular example of how out of step actual deployments of renewables have been compared to leading predictions, is that the International Energy Agency (IEA) have consistently vastly underestimated growth in solar power in particular, and the rapid reductions in cost (Enkhardt & Beetz, 2018). The same is true for the BP energy outlook forecasts (Simon, 2018). In the UK, the Committee on Climate Change in 2011 outlined an illustrative scenario for decarbonising electricity by 2030, entailing 40% renewables, 40% nuclear, 15% carbon capture and storage, and up to 10% natural gas (Monbiot, 2011). In 2019 the share of renewables in the UK electricity generation mix was around 36% and in the third quarter of 2019 renewables generated more electricity than fossil fuels for the first time whereas at the start of the decade 10 times as much electricity was generated by fossil fuels than by renewables (Evans, 2019). Analysis indicates that in the first quarter of 2020 renewables have eclipsed other forms of generation producing 44% of electricity in the UK (Edie News Room, 2020a). These are indications that renewables have far surpassed expectations that existed from official bodies at the start of the decade.

32. A host of means are available to manage intermittent wind power at a fraction of its growing cost advantage. For instance OFGEM quote UKERC (2017) when stating in their own 2017 report that "at these levels, the UK Energy Research Centre (UKERC) estimates that integration costs are between £5 per MWh and £10 per MWh of intermittent energy (up to £478 million in 2016)" (OFGEM, 2017: 8).

33. Energy systems are transforming rapidly worldwide. As Froggatt & Quiggin (2018: 2) highlight: "Rapid cost reductions in battery manufacturing, driven by increased deployment of EVs, are enabling affordable static, grid-level storage, in turn enhancing power system flexibility; Digitalization of the electricity sector will lead to significant advances in system efficiency and flexibility. Residential demand will become flexible and networks functionally 'smarter'. Machine-learning algorithms could be a game-changer, helping to manage the increasing complexity of electricity systems and identify new system-level efficiencies." Indeed, BNEF also analysed the LCOE of battery storage, revealing that it is now the cheapest new-build technology for peaking purposed in gas-importing regions, including Europe and China (Edie News Room, 2020b). The LCOE of battery storage has fallen to $150 per MWh for systems with a four-hour duration, almost half of its LCOE cost recorded in 2018. Many in the energy industry are now predicting that the energy storage sector will grow on a trajectory comparable to the solar industry during the early 2000s, as more large-scale renewable arrays come onto the grid. The UK's own National Grid has made it clear that operating 100% renewables grid is technologically feasible and that it only requires modifying business models and grid management techniques (Wood, 2019). Ways of managing the intergration of renewables include: using wind and solar to provide reserve and response services by 2020; increasing deployment of storage and its use in frequency markets; refining new ancillary services that deliver the inertia currently provide by rotating fossil plant, so that new markets for these services can be developed and put in place by 2022; improved forecasting of wind and solar, along with embedded generation; augmenting abilities to monitor and measure inertia and new network analysis tools that allow it to be modelled and different operating scenarios assessed in real time. As stated by a spokesman for the National Grid: "We know, through approaches that we have had to date, that there are customers with the right technologies that can provide these services".

34. This was evident in the Government's response to the Public Accounts Committee report on Hinkley C. The Government's 'benefits realisation plan' simply presented numbers of jobs, apprenticeships, and local investment associated with the Hinkley C development (BEIS, 2018). Yet, these are not discussed in the wider context of what jobs would be created by similar investments in renewables or energy efficiency. This is the circular logic that has dominated UK discussions of nuclear jobs. All large scale energy investments generate jobs, therefore to justify a high cost energy option on the basis that it generates jobs is irrational because jobs would also be generated by alternatives. Yet this circular logic dominates discussions on UK nuclear. For example, In a statement on the future of the energy market, Greg Clark the permanent Under Secretary of BEIS stated: "There has been some criticism of the prospective cost of the Hinkley project, but one aspect of the benefit that has not been emphasised often enough is that it restarts programme of civil nuclear power in this country and conversely the loss of much of the supply chain and the domestic skills in the civil nuclear sector was a set back which could have been avoided if we'd thought ahead. We need to have a supply chain that is active - engineers who understand

the technology, PhDs and university departments specialised in it, welders, civil engineers, concrete pourers, and more…" (Clarke, 2018). This quote highlights the circular logic of new nuclear in the UK, where it is acknowledged that nuclear is expensive but that it must be pursued in order to preserve the British nuclear supply chain and skills. This rationale is not used to justify investment in any other any technology.

35. There is no substantive reason to view the volume of jobs available from UK renewable investments to be less than that associated with nuclear power. A report by REA (2017) highlighted that there are over 125,940 people employed in the renewable energy sector in the UK. The UK nuclear sector is said to currently employ 65,000 people with industry estimates that 40,000 new jobs would be created through a new build programme (World Nuclear News, 2016). However a report in 2014 for the Office for National Statistics (ONS, 2014) found that in terms of direct jobs, there are 15,000 direct jobs in nuclear power and 43,500 direct jobs in the renewables sector. Yet UK trade unions are particularly vocal about the importance of nuclear jobs (Fairlie, 2016) and notably aggressive to those questioning the orthodoxy on prioritising nuclear jobs above job creation generated by expanding renewables (Syal, 2017). Neither UK Government nor trade unions seem to view jobs provided by renewables with the same significance however, with 12,000 jobs lost in the solar sector in 2015 following cuts to the Feed in Tariff with for example (Vaughan, 2016a).

36. Global investment in non-hydro renewables already outstrips investment in nuclear and fossil fuels combined (Frankfurt School-UNEP 2016: 32). Global renewable energy markets are growing faster than anticipated and are expected to grow by 50% in the next five years, according to the IEA (Ambrose, 2019b), an organisation that has traditionally been cautious with regards to growth in renewables. A recent report by Lazard highlights that wind and solar have been beating coal and nuclear on costs for a few years now, but the Lazard report points out that both wind and solar are now matching both coal and nuclear on even the "marginal"cost of generation, which excludes, for instance, the huge capital cost of nuclear plants (Parkinson, 2019). With these astonishing trends set to continue, even companies tied to the fossil fuels industry concede that renewables will be the main source of power globally by 2040 (Mechant, 2019). Meanwhile, financial experts, expect a continued decline in global nuclear energy markets (Goldsmith, 2018). Given this reality of expanding global renewable energy markets and declining nuclear markets, combined with the lack of UK industrial strength in civil nuclear power, it is evident that UK export opportunities and future job prospects are more favourable with regards to renewables than nuclear.

37. Most notable here is the case of Germany. Despite having a far superior nuclear industry to the UK in terms of innovation, international market share, and performance of reactors and an inferior renewables resource to the UK (see Johnstone & Stirling, 2020), is on course to phase out nuclear by 2022.

38. During his maiden speech as Prime Minister, Boris Johnson declared his support for a "nuclear renaissance" on July 25th 2020 (World Nuclear News, 2020). Ideas of a nuclear renaissance began circulating in the UK since the early 2000s and intensified between 2003-2006 as Prime Minister Tony Blair made a spectacular U-turn on nuclear and declared ambitions around a 'nuclear renaissance' in 2006. The original aims of the UK's nuclear renaissance was to have several plants constructed "significantly before 2025" (DECC, 2011b), so given no new capacity will be operating before this date, perhaps Johnson was calling for a 'new' nuclear renaissance to replace the failed initial nuclear renaissance.

39. The loan guarantees announced in 2015 were another example of the exceptional privilege that the nuclear sector receives on the part of the UK Government. The Global Subsidies Initiative (Bridle, 2016), reviewed the cost of all subsidies for Hinkley Point C in 2016, highlighting that the project was subsidised not just by the generous guaranteed 'strike price' but also loan guarantees worth £2 billion announced by George Osborne in 2015 (Phillips et al, 2015), waste disposal costs that are capped by government so tax payers will pick up the tab if costs soar (Doward, 2016), and Decommissioning costs where the government will be liable to pay beyond the initial £5 billion covered by EDF, as well as a de facto insurance against a nuclear accident. Global Subsidies Watch calculated that these subsidies were greater than £40 billion, and this was before costs of Hinkley rose significantly again in 2017.

40. Labelled by some commentators as "the worst period for environmental policy in three decades" (Vaghan & Macalister, 2015), several green policies were axed during this period. This included scrapping support for onshore wind; the sharp reduction in solar Feed-in-Tarriffs; removal of the biomass conversion subsidy; 'killing' the green homes scheme; selling off the green investment bank; watering down incentives to buy greener cars; giving up the zero carbon homes policy; and abandoning the green tax credit. Since then, other proposals have also been abandoned such as plans for a Tidal Lagoon in Swansea (Vaughan & Morris, 2018).

41. Former US Vice President and climate campaigner Al Gore commented that he did not understand the retraction of renewable support measures and described the UK's energy policy decisions as "puzzling" (Harvey, 2015). Jaqueline McGlade, Chief Scientist at the UN Environment Programme also criticised these decisions and commented that they were giving the "wrong signal" and were out of step with international developments (Clark, 2015).

42. The latest developments at the time of writing, is that China has threatened to remove its support of new nuclear power plants in the UK after Boris Johnson approved plans last week to develop 5G network alternatives to Huawei (Kennedy, 2020). Given China General Nuclear Power Group (CGN) is being lined up as a partner in similar schemes planned for Sizewell in Suffolk, and Bradwell in Essex, these new tensions could further jeapordize the UK's already severly troubled 'nuclear renaissance' (Oliver, 2020). Japanese investors have already pulled out of the Wylfa B project in Wales and EDF are already heavily invested in UK nuclear but require additional investors. There are so few players left in the reactor construction business, and the company that dominates global reactor construction outside of China is Russian state-owned Rosatom who have already been ruled out as being allowed to invest in UK nuclear (Macalister, 2016). The UK is running out of options of how to sustain its new nuclear ambitions. The USA has shown signs that it is willing to step in to assist

the UK in financing and constructing new nuclear reactors instead of China (Sheridan, 2020), yet the US nuclear industry is in a precarious financial position itself. Regadless, what this episode shows is how deeply entwined nuclear decision making is with the most sensitive areas of geopolitical strategic thinking.

43. In 2017, in an "astonishing hammer blow to the industry" Westinghouse, the original developer of the Pressurized Water Reactor (PWR), filed for Bankruptcy, while Toshiba – the parent company of Westinghouse – admitted that there was "substantial doubt" that it could continue its nuclear operations (Pearce, 2017). By 2018 it was reported that Toshiba was scaling back its nuclear activities to shift towards renewables (Asada & Hanada, 2018), and in 2019, Toshiba withdrew its investment in the proposed Wylfa nuclear project in Wales citing that the decision was based on "economic rationality" (BBC News, 2019). Meanwhile, the French nuclear industry is said to being "financial turmoil" (Ward & Keohane, 2018). In 2017, French nuclear giant Areva, after suffering heavy losses due to the Olkiluoto project in Finland, was bailed out by the French state and folded into EDF. However the development of the European Pressurized Reactor (EPR) has caused huge financial pressure for EDF, and in 2016 the then finance director of EDF Thomas Piquemal resigned after advising that the financial burdens of the Olkilouto, Flamanville, and Hinkley C new build projects would lead to the bankruptcy of the company (Stothard, 2016). With substantial debts, at the end of 2018 the French state began a process of restructuring of EDF in an attempt to alleviate significant financial pressures (Keohane, 2018). Other leading nuclear companies have already left the nuclear power business behind. In 2011, Siemens wound up its nuclear operations to focus on renewables (BBC, News, 2011). With the traditional nuclear giants in the West facing immense financial challenges, the state-owned Russian company Rosatom now dominates the international nuclear power station export market (Economist, 2018).

44. In the absence of global orders it has been reported that nuclear companies have "flocked" to the UK (Vaughan, 2017a). In understanding why the UK is such a focus for international nuclear companies, Peter Atherton from the energy consultancy firm Cornwall Energy puts it simply: "We are the only people building new nuclear power stations and we have by far the biggest new nuclear programme outside China for the next 10 years…the civil nuclear programme globally doesn't have any orders." In relation to the relative size of the UK electricity system, then, this nuclear attachment is internationally disproportionate. As Nuclear expert Michael Schneider comments in the same article, the UK is nuclear's "last hope" in the West.

45. British submarine reactor manufacturer, Rolls Royce, has proposed the construction of entirely untested small modular reactors (SMRs) for civil energy production and have received significant government support. Rolls Royce has no previous experience of building reactors for civil energy production, yet speculative claims are made about the affordability of these reactors and that they can be operating by the early 2030s and that SMRs will be 'cheaper' (Energy Technologies Institute, 2016). Unfortunately these claims are often simply repeated as if they are matters of fact by influential media outlets in the UK (see Meechan, 2019). Elsewhere, the diversity of proposed nuclear projects as part of the UK's 'nuclear renaissance' in the UK is staggering. This includes the construction of EPR reactors at Hinkley point C and Sizewell C, ABWR reactors at Wylfa, HPR1000 reactor at Bradwell B, and until recently, an AP1000 in Cumbria. Only with Hinkley C has official construction begun.

46. The prohibitive costs of nuclear have been highlighted by analysts for decades, for example, Steve Thomas, The Realities of Nucler Power (1988); Gordon Mackerron , "Nuclear costs why do they keep rising?" (1992). The Independent expert review of UK energy undertaken by the Performance Innovation Unit (PIU) at the request of the Cabinet Office also highlighted the economic problems associated with nuclear and concluded that new nuclear should not be constructed (PIU, 2002), yet this expert advice was later ignored by Government.

47. For several decades, energy policy researchers have highlighted the vast potential of UK renewables to contribute to electricity production, often basing analysis on official data from relevant UK governmental departments. See Stirling (1994) Power technology choice: Putting the money where the mouth is?; Grubb, A. (1990) "The Cinderalla options: a study of modernized renewable energy technologies part 1-A technical assessment" Energy Policy, 18, pp 525-542.

48. Since the 1970s, the problems of nuclear waste in the UK have been highlighted leading to the influential Flowers Report in 1976 by the UK Royal Commission on Environmental Pollution. The same problems persisted and were flagged up by the independent Performance and Innovation Unit (PIU) as a reason the UK should not proceed with a new fleet of nuclear power stations (PIU, 2002). Despite the declaration by DECC that there is a 'solution' for UK radioactive waste (BERR, 2008), no site has been found for the construction of a Deep Geological Disposal Facility (GDF) (DECC, 2014). The cost of dealing with the UK's legacy waste is £121 billion according to the National Audit Office (NAO, 2018). The nuclear waste and reprocessing facility at Sellafield is widely considered to be the most 'hazardous industrial site in Europe' (McKie, 2009).

49. There are many ways in which the UK Government's appraisal of nuclear is seriously out of step with emerging energy trends. In fact, the UK government's approach to nuclear is out of step with its own original justificatory rationale based around climate mitigation, low cost energy, and energy security. New nuclear has not delivered on climate mitigation or energy security "significantly before 2025" as initially planned. Since 2016, the Government's own figures have shown that renewables including onshore wind and solar are lower cost than new nuclear (Vaughan, 2016b). By 2017, costs for offshore wind were down to 55 £/MWh and still falling rapidly (BEIS, 2017). Costs for renewables including onshore wind and solar are considerably cheaper than nuclear power according to the Government's own data. Nuclear power is above the comparable cost ranges for both large-scale solar PV (£65-92/MWh) and onshore wind (£49-90/MWh) as noted in the Government's 'value for money' statement on Hinkley Point C (BEIS, 2016). More recently, onshore wind has been revealed to be cheaper than gas and could be delivered at a maximum of 50-55 £/MWh across 15 years (Vaughan, 2017b). The costs of offshore in the UK are expected to fall considerably more over the next decade

in the UK, accentuating further the high costs of new nuclear (Aurora, 2018). The UK Government is also increasingly out step with key advisory bodies. The UK's National Infrastructure Commission (NIC) stated that "we're suggesting it's not necessary to rush ahead with nuclear", highlighting that wind and solar could deliver the same generating capacity (Vaughan, 2018).

Furthermore, the UK Government remains attached to the idea of 'baseload' that many energy experts feel is no longer a relevant paradigm for understanding the functioning of electricity grids as they evolve with increased renewables capacity and demand side measures. For example, Steve Holiday from the National Grid Company identifies 'base load' to be an "outdated" concept (Beckman 2015). This is becoming a trend internationally, as McArdle writes, "across the world it is hard to find a grid operator that doesn't admit that the future of "base-load" in the world's grids is either lousy or non-existent." (McArdle, 2019).

50. Previous UK nuclear programmes have not delivered on their originally stated targets. For example, the 1964 programme was significantly scaled back and in the end dubbed one of "the major blunders of British industrial policy" (Brown, 2008). In 1979, one of the first major policies announced under the new Thatcher government by Geoffrey Howell, the minister for energy, was the construction of 8 new nuclear reactors within a decade that were an apparent 'necessity' with 15GW of new capacity planned (Hansard, 1979). In the end one new reactor was constructed (Sizewell B). The case for nuclear power collapsed in 1990 when it became apparent that Hinkley C could not be constructed and operated in a privatised electricity market. Nuclear had to be ring fenced from privatisation and given what was essentially a form of subsidy through the Non-Fossil fuels obligation which was dubbed the 'nuclear fuels obligation' (Pearson & Watson, 2010). Attempted privatisation of the nuclear industry did not take place until the late 1990s with the creation of British Energy, but this experiment did not last long as British Energy had to be bailed out by the UK government to the tune of over £650 million in 2001 and guarantees were given that the tax payer would take on the costs of future liabilities arising from the operations of British Energy. This is only with regards to conventional civil nuclear power generation but the same historical pattern of under-delivery, delays, and escalating costs plays out with Fast Breeder Reactors, reprocessing facilities, and MOX plants (Cox et al, 2016). The UK's 'nuclear renaissance' is facing the same fate, with new nuclear set to make no contribution to new low carbon generating capacity till at least 2026, despite promises of several new reactors in operation by 2020 (Porter & Clover, 2008). While renewables costs plummet, nuclear costs have increased markedly in the UK. Instead of reconsidering options or outlining a Plan B (as suggested by the Public Accounts Committee), the Government has announced even more eccentric proposals around new nuclear such as the Regulated Asset Based model of financing new nuclear that could see consumers paying upfront for inevitable cost overruns, as well as proposals around entirely untested Small Modular Reactors (SMRs).

51. For example, Professor Sir David Mackay, then Chief Scientific Advisor to the Department of Energy and Climate Change (DECC), continually emphasised the "worrying limitations on our sustainable energy options" (Mackay, 2013). He stated in 2013, for instance, that "if you do want renewables to make a substantial difference, for a country like the United Kingdom, on the scale of today's consumption, you need to be imagining renewable facilities that are country sized…" (Mackay, 2013). Remarkably, developments over only a few years since this statement are already highlighting deep flaws in this reasoning. Despite being so assertively voiced, MacKay's analysis fails (for instance) to consider that: the area between turbine towers is little more consumed by wind power than is land between power stations, and offshore wind does not involve consumption of land at all.

52. Several myths have been perpetrated against renewables by the nuclear industry over the years including renewables being more expensive than new nuclear, renewables not being ready to replace fossil fuel generation, renewables diffusion requiring a large land mass, and the necessity of baseload power meaning renewables are unworkable (Diesendorf, 2016).

53. See Johnstone, P. Stirling, A. (2020) "Comparing nuclear trajectories in Germany and the UK" Energy Res. & Social Science 59, 101245 ; Johnstone, P. Sovacool, B. Stirling, A. (2017) "Policy mixes for incumbency: Exploring the destructive recreation of renewable energy, shale gas 'fracking', and nuclear power in the United Kingdom" Energy Res. & Social Science, 33, pp. 147-162.

54. See Stirling, A. Johnstone, P (2019) "Are Hidden Military Pressures for Cross-Subsidies Driving Major UK Energy Infrastructure Decisions?" Written evidence to the BEIS inquiry on Financing Energy Infrastructure, June, 2019. Stirling, A. Johnstone, P (2017) "Written evidence from the University of Sussex, Science Policy Research Unit (BRN0015)" Department of Business, Energy, and Industrial Strategy (BEIS) Brexit and the implications for UK Business: Civil nuclear sector inquiry, submitted, October 2017; See Stirling, A. Johnstone, P (2017) "Some Queries over Neglected Strategic Factors in Public Accounting for UK Nuclear Power:evidence to the House of Commons Public Accounts Committee Inquiry on Hinkley Point C" Public Accounts Committee (PAC) Hinkley Point C Inquiry, submitted 25th September, 2017.

55. See Harrabin, R. (2019) "Nuclear: energy bills 'used to subsidize submarines'" BBC News, 5th June, 2019; Osborne, S (2019) "Homeowners being forced to pay higher energy bills to subsidise Britain's nuclear submarines, MPs told" The Independent, 5th June; Watt, H. (2017) "Hinkley point: the 'dreadful deal' behind the world's most expensive power plant" The Guardian, 21st December; Watt, H (2017) "Electricity consumers to fund nuclear weapons through Hinkley C" The Guardian, 12th October.

56. Without the research, engineering and skills infrastructure provided by a continuing civil nuclear industry, it would be impossible for the UK to maintain this platform for its nuclear deterrent and its associated 'top table' standing at the UN. It is widely discussed that ambitions to sustain Britain's position at this 'top table' may be a driving factor in motivations to maintain a recognised militarily-credible nuclear weapons capability (Barckham & Norton-Taylor 2010). Such a view, for instance, has been emphasised by Britain's key ally the United States, with a rare intervention by US Defence Secretary Ash Carter holding that the UK needs to maintain its nuclear

weapons capability in order to continue its "outsized role in the world" (Press Association 2016). Tony Blair was clear in his autobiography that with regard to nuclear weapons "the expense is huge and the utility…non-existent in terms of military use", but that giving it up would be "too big a downgrading of our status as a nation" (quoted in Norton-Taylor, 2015).

57. Statements from UK nuclear submarine industry sources are very clear about the importance of crucial interlinkages between defence and civil nuclear – explicitly noting incentives to "mask" the costs of this military programme behind the related civilian industrial infrastructure (Ireland, 2007: 25). The Keep our Future Afloat Campaign (KOFAC), a lobby group representing industrial interests around the Barrow shipyards that construct nuclear submarines stated that "The decline of the UK civil nuclear programme has forced the military nuclear programme, and in particular the nuclear submarine programme, to develop and fund its own expertise and personnel in order to remain operational" (KOFAC quoted in House of Commons North West Regional Committee 2010: 109). The Dalton Institute has noted that "The UK is not now in the position of having financial or personnel resources to develop both [civil and defence] programmes in isolation. For example, reactor physicists on the military programme can develop their skills and knowledge by researching civil systems, and then only when necessary divert to classified work to follow a specialist career path" (Innovation Universities Science and Skills Committee 2009: EV419). In the same year, Rolls Royce notes that "Skills are considered to be transferable between military propulsion and civil programmes", where "a larger involvement in the broader [civil] industry will also have a spillover benefit to military capability through skill development and experience exchange". More recently, UK naval reactor manufacturer Rolls Royce dedicate an entire section of a recent report advocating ostensibly civilian small modular reactors to the detailing of "advantages to the UK's nuclear deterrent programme". They state that a civil Small Modular Reactor (SMR) programme would "relieve the Ministry of Defence of the burden of developing and retaining skills and capability. This would free up valuable resources for other investments." (Rolls Royce 2017: 11).

    In a secret report only obtained through a Freedom of Information request by journalist Rob Edwards (Edwards, 2017), Sherry et al note that "the MOD's programme had been underwritten by civil nuclear research" but with a declining civil nuclear industry "the expertise these activities generated has atrophied." (Sherry et al. 2014: 59) Thus emphasis has been placed by Government and industry on strengthening the overlaps between defence nuclear sector and the UK's civil 'nuclear renaissance'. The nuclear sector deal is particularly focused on facilitating 'mobility' between the civil and defence nuclear workforce as a key strategy to manage the skills challenge (Nuclear Industry Council, 2017). It is stated in "The Nuclear Sector Deal" that "the sector is committed to increasing the opportunities for transferability between civil and defence industries and generally increasing mobility to ensure resources are positioned at required locations" (p.36) and that 18 percent of projected skills gaps can be met by 'transferability and mobility'. The document also states that the skills gap can be met through "greater alignment of the civil and defence sectors with increased proactive two-way transfer of people and knowledge. As the military service sector tends to be age and nationality limited, we propose that we actively seek a recognisable career pathway between the civil and sectors to ease transfer between the two"(36).

58. As eloquently expressed by Ernest Bevan, a leading figure in the Attlee Labour administration (1945-51) that made crucial decisions in this regard: "We've got to have this thing over here whatever it costs [and] we've got to have the bloody Union Jack on top of it" (Jack, 2016).

59. As reported in the Financial Times increasingly comments are being heard from senior officials in the Royal Navy and the MoD "about the disproportionate impact the deterrent has on the overall defence budget" where "some people are asking, 'can we really justify this?'" (Bond & Pfeifer, 2019).

60. A telling statement on this point is in a 2008 a report on the UK's strategic nuclear deterrent by the NAO where it is stated that "[o]ne assumption of the future deterrent programme is that the United Kingdom submarine industry will be sustainable and that the costs of supporting it will not fall directly on the future deterrent programme" (NAO 2008: 28). The key question that follows from this, is that: if the costs of supporting the nuclear submarine industry do not fall directly on the future deterrent programme, where do these costs fall? The evidence strongly suggests it is through civil nuclear investments and supply chains that some of these costs will be covered.

61. One widespread initial reaction to the authors raising of these questions about civil-military links in UK nuclear policy, were widespread accusations that the analysis amounts to a "conspiracy theory". Indeed, a number of commentaries were written which explicitly voiced this criticism (Jewell, 2015 & Lovering, 2016)? One such critic (among many others) was the US Breakthrough Institute, then led by prominent nuclear advocate Michael Shellenberger.

    But what then became striking, was a series of high profile reports in the US that began – for the first time in the history of official documentation in this area – openly to emphasise exactly dynamics drawn attention to in the analysis. Starkly contrasting with the official non-engagement on the part of official bodies and the mainstream media in the UK, a series of US report acknowledged the military pressures to maintain civil nuclear power at whatever cost, in order to support the nuclear navy. With the 'conspiracy' thus openly acknowledged as a high-level policy prescription, public accusations of conspiracy theory have become muted.

62. In a parliamentary debate on the nuclear sector deal on the 11th of July 2018, Richard Harrington, the Parliamentary Under Secretary for BEIS, stated that "I want to include the MOD more in everything we do. It is quite time enough, and the hon. Gentleman made a very good point, supported by some of my hon. Friends. Because the MOD is a member of the Nuclear Industry Council, it is time that that artificial distinction…[between civil and defence nuclear]…came to an end, and I will do my absolute best to bring that about." (Hansard, 2018).

63. The PAC itself heard and published evidence for this subsidy more than two years ago. And this formed the basis for a

significant question posed by PAC Chair Meg Hillier of a crucial witness in October 2016. This witness was the most senior civil servant in the Ministry of Defence, Stephen Lovegrove. When asked if there are links between civil and military nuclear programmes, Lovegrove remarkably confirmed the necessity for exactly the "concerted government action" represented by the subsidy. Yet the PAC has yet to investigate this civil-military link – or, indeed, say anything further at all (Watt, 2017).

64. Since 2015, the authors have written several commentaries including in the Guardian (Johnstone & Stirling 2015; Stirling & Johnstone 2018). A further blog post in The Conversation (Johnstone & Stirling 2015) and a two part blog for the Oxford Security Group (Johnstone & Stirling 2017a; Johnstone & Stirling 2017b). None of the arguments presented in these well-publicised commentaries have been refuted. This isn't to say there hasn't been some critical feedback. Mike Clancy (2018) from Prospect union recently wrote a letter in the Guardian criticizing our 2018 Guardian commentary, however this letter did not either address or refute any of the specific points of evidence that we raise.

65. The issue remains unacknowledged in governmental policy or parlimentary scrutiny in Westminster. Only in the Scottish Parliament, where there is no new nuclear build programme, has this issue been raised in a motion by Bill Kidd MSP (Kidd, 2019). Yet, in Westminster, which oversees the new nuclear programme the issue has not been discussed in the context of energy policy. However, it is also the case with regards to energy expertise and academia that the military issue remains largely undiscussed. Indeed, what is also remarkable about mainstream UK policy debates on nuclear issues, is not just the absence of discussion on military drivers, but how often even those experts with a relatively independent or past critical perspectives, are pressured by media interpretations or policy patronage, into expressing positions that reinforce the idea that nuclear is somehow especially difficult to exclude. In this picture, it is as if there can be no realistic circumstances under which nuclear power might reasonably be entirely omitted from the pursued portfolio of UK electricity supply options.

66. It is not necessary to be a critic of nuclear technologies to recognise that – as with any policy choice – advocacy of these strategic directions rather than others are most credible, when supported by reasoned argument and policy debate. If the unfolding of events is being driven by invisible pressures, then the asking of questions and shining of light are non-partisan interests.

67. One aspect of this secrecy is reflected in a lack of transparency concerning the basic question of why the UK is so intensely committed to new nuclear power despite high costs and the presence of cheaper renewable alternatives. This was a point raised by the Citizen's Advice Bureau stating that:"We note that the government appears very committed to new nuclear, eg that it is entering into a sector deal with it, despite the headline cost (strike price) of such projects appearing unfavourable when compared to many scale renewable technologies. If this remains the case, we would encourage BEIS to publish the thinking and evidence that underlies this commitment, as to an external audience this decision currently appears sub-optimal if it is seeking to keep down consumer cost" (Hall 2017: 4-5). The NAO referred repeatedly to the importance for Government of other "wider strategic" considerations beyond the officially-stated "energy trilemma" around 'affordability', 'climate change' and 'energy security' (NAO 2017). However it is not clear what these wider strategic benefits of new nuclear are. It was noted that "[t]he Department has not formally reviewed and consulted on its published strategic case for nuclear power since the publication of the 2008 white paper" (p.19). Ultimately, energy bill-paying citizens should have the right to know the reason why a particularly expensive source of energy is being priviledged at a time when UK and global energy trends highlight the affordability and practicality of alternatives.

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