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With current controversies around the Hinkley Point C project simply one further specific twist in the plot (Ruddick & Grierson 2016), the story of UK nuclear power is a fascinating one. Albeit in many changing ways, the UK Government has long professed to be planning to build up to 16 GWe of new nuclear electricity generation capacity - a proportional level of support for new nuclear power unparalleled in any other liberalised energy market (World Nuclear Association 2016e; Kee 2015). Despite many challenging developments, these general attachments show no sign of easing.

With many alternative (arguably preferable) strategies available for delivering economically viable, politically and technically secure, low-carbon energy services (Liebreich 2016; National Audit Office 2016; Environmental Audit Committee 2006; IRENA 2016; Frankfurt School-UNEP 2016), it is difficult satisfactorily to explain the historic intensity of these commitments solely in terms of officially-

elite cultures spanning disparate technological systems and penetrating some of the highest and deepest parts of the UK State and strategic national industry (Stirling 2014; 2016). By reference to an established body of analysis in political science and institutional theory (Grover & Peschek 2014; Fraenkel 2010; Glennon 2014; Temples 1980; Wedel 2014; Skogstad 2008; Feenberg 1999; Söderbaum 2004; Stone 2002; Jordan 1990), the study argues that such a

In illuminating the importance of these undeclared non energy-related drivers in official UK commitments to civil nuclear power, the findings of this study may be judged to hold some policy salience in this important policy area. The fact that these evidently formative factors have for so long remained so remarkably under-discussed in wider UK energy debates, might be thought to extend this significance beyond the energy field alone: also raising important questions about nuclear commitments more widely and the general condition of UK politics and democracy.



Of course, some other western democracies are also planning new nuclear power as part of their electricity  
°\$Ω\$ο†ύΩ° ΨΠЪ . Йў ў'І\$ \$Y 1σ ЙΩηξЙ\$ 1Ω σŮ †ŌŮηΦ\$РЫ μЙησσЙηΩ° σЙŌ'І †Ω †ΨŌηηŮЙσ ŮŮοΨ ŮŮ (Vaughan  
2009). Elsewhere in the world, other important and fast-growing economies are also undertaking nuclear programmes  
that are even bigger in absolute terms (IAEA 2015b). But in cases like China (World Nuclear Association 2016b; Guo  
& Guo 2016) and India (Garg 2012; World Nuclear Association 2016c) this typically takes place against the backdrop  
of significantly larger rates of growth in other energy technologies (Chabot 2016; Frankfurt School-UNEP 2016; IEA  
2015c). So, compared to other European countries<sup>2</sup> and with the prevailing general picture around the world<sup>3</sup>, the  
relative scale of UK commitments to nuclear power by contrast with other low-carbon energy options, does remain  
quite strikingly distinctive. And, as we discuss further in section 6a, other ambitious nuclear new build plans around  
the world are also understandable in relation tl

(IEA 2015b; IEA 2015a)

Nor does the particular history of UK civil

Grierson 2016). However for reasons that remain unclear at the present moment, the new UK G

Of course, the background picture sketched here is complex and begs many questions. These can be interpreted from many different standpoints – in ways that will be addressed in detail in this paper. It will remain possible to approach the variabilities and uncertainties from divergent evaluative perspectives and draw contrasting interpretations over the general pros or cons of nuclear power. Indeed, to raise such questions need in no way be taken to imply a blanket negative position on nuclear power. It is perfectly possible to advocate or accept a case for nuclear power as part of a low-carbon electricity supply mix, and yet at the same time ask about the distinctive intensity of the UK position. Indeed, understanding this pattern might be thought especially salient for nuclear proponents, seeking to understand the conditions under which their favoured technology might prosper (Guyer & Golay 2015). But when all the above factors are considered together, it is difficult not to conclude that the distinctive intensity of UK government commitments to civil nuclear power is at least a phenomenon that requires some kind of attention and explanation. And, as we shall see, the more that is known about the historical, political, economic and technological background, the more salient such questions become. It is therefore not the posing of such questions that would be partisan, but their denial or avoidance.

So, the key questions are:

- 1) Exactly why have official UK nuclear commitments remained so disproportionate and persistent when contrasted with many other comparable countries over the years?
- 2) Why has this support extended so relatively widely (by international comparisons), across such an otherwise divided political spectrum?
- 3) Why have these attachments proven so resilient in the face of such repeatedly serious economic and political disappointments in the domestic nuclear sector?
- 4) Why have contemporary international market trends and policy initiatives in other countries evidently tended to exert such little influence on UK Government energy strategies?

Despite their broad salience, these questions are all the more remarkable, for being so relatively neglected in UK policy literatures (Toke 2013). This is so, equally in policy documents themselves and in academic analysis or even some critical commentaries (Atherton 2014). Official policy rationales refer to evaluative frameworks

served in some quarters to suppress the kind of active critical NGO engagements that were experienced in the past (Purcell 2006; Hall 1994; Vetter 2004; Vynnycky 2010; P. 6015.8(1979) 1 0 r o w h i 2 h 0 0 9 i 7 0 4 1 2 6 f e v 7 5 4 4 5 6 0 1 5 8 (n) al my( a)-5(t countries (Deutsche Welle 2011). Although there are exceptions (Ecotricity 2016; BBC News 2011), some of the most visible and effective challenges to UK civil nuclear policy in recent years have come from within environmental movements based in Germany and other countries (World Nuclear News 2015; Neslen 2015) 14(d)-4( les)8T 5A Tsone)9855d4vmt5ooversAsTracleS(fsdq)3atonsItal(a)Sedp2ac in the UK in ways that are less actively critical of nuclear power (Reuters 2015).

So, conventional responses to the internationally-distinctive persistence and intensity of elite UK nuclear commitments, tend to take this overbearing official bias for granted. Analysts may disagree with the stated policy rationales. But so strong is the UK policy climate under which criticism of nuclear is taken to be unacceptable, that it is more expedient simply to accept these at face value, resigned to an understanding that the real motivations lie in deeper and less be

Based on the picture sketched above concerning the distinctive intensity and persistence of UK policy attachments to civil nuclear power, a very simple question lies at the heart of this study. How can we best understand the drivers of this apparently anomalous pattern of commitment to nuclear power, as distinct from available viable alternative bases for low carbon energy strategies? In asking this, this research relates to a wider ESRC-funded project as part of a European research consortium concerned with investigating a more general question about the ways in which sociotechnical systems (Geels 2002) of all kinds



As justified in the last section, the central question in this study, concerns how best to understand the evidently internationally-unusual intensity of UK policy commitments to civil nuclear power. So, the aim is to comprehend the course of high-stakes developments in elite policy making involving highly structured interests. First and foremost, then, the main focus of any attempt like this is on the dynamics of power.

But power is a very tricky business. And this is so, in many different senses of this phrase – no less in Giddens (1984), that power is not just at the object end of academic enquiry, but can also condition the subject. Power of different kinds can not only drive, steer and constrain the kinds of actions that are taken, but shape the understandings that inform and respond to these actions – the sorts of assumptions that tend to be made, those interpretations that are prioritised and even which questions are asked (and not asked) in ostensibly neutral analysis. Not least, these pressures in policy analysis can tend to discourage too much attention to power itself – perhaps even to the point of overlooking its role in the process of policy-making about (Stirling 2015). If credibility is to be maintained in conventional policy debates, particular pressures bear against representations of power dynamics that might be caricatured as too simplistic or too obvious (Sunstein 2014; Runciman 2016; Fredheim 2016; Jewell 2015). Indeed, the need to maintain a certain level of credibility in policy debates (Woods 2006), an understanding of the dynamics of political and economic power around long-lived, large-scale technological infrastructures, is particularly pronounced in this field (Stirling 2014).

A large literature on variously-named general socio-political power dynamics (Loeb 1986) (Patterson 1977) (Hecht 2010), (Jasanoff & Kim 2009) explores how the global nuclear sector is a particular arena within which these conditioning effects by power are especially intense, pervasive – and under-attended to in mainstream policy debate (Temples 1980). So it could be that such pressures are implicated in the noted relative dearth of critical scrutiny for the central question of this present study? This remains to be substantiated. Either way, it is for the moment, doubly important to frame this enquiry with careful consideration for the nature of the dynamics of power.

Arguably " (Dahl 1957) and " (Cerbaro 2011), power is surely " (Martin 1971) and so on. Significant distinctions (Massumi 2009), it can be addressed in many notoriously diverse ways. For instance, vigorous debates persist in the literature on the nature of power (Harrison et al. 2015) (Arendt 1970) (Smeed et al. 2009) (Abensour 2011); (Spencer-Wood 2004) (Mansbridge 2001) and so on. Significant distinctions (Foucault 1977) (Bohman 2016); (Lukes 2005) (Nye 2004) (Massumi 2015) or (Galbraith 1993) (De Certeau discussed in Feenberg 1999, p.112) (Agamben in de la Durantaye 2009, p.234) (Guzzini 2009) (Galbraith 1996) (Collins 2004). Without the space here to (Bachrach & Baratz 1962)

can be seen in principle to be potentially relevant to this inquiry. All represent aspects of ways in which interests and commitments in nuclear power (as distinct from alternative infrastructures) are constituted,









incumbency are recognised to span public, private and academic sectors, including (crucially) the highest levels of government, civil service and corporate ownership. Mediated by opaque elite networks and agency, these are nonetheless embodied in and conditioned by many kinds of structure cross-cutting typical notions of individual sociotechnical regimes. {Ů ŦŮ1ŮŦ°1 Ů1\$ 1bμŮŮ1\$σŮ ŮŮ Ŧ Š\$μ μΩŮŦΨŮ\$ΩŮb ŮŮΨμ\$Ŧ μ ΩŮΦ\$Ŧ ŦΩŠ innovative in precisely the terms presented here, it is nonetheless grounded in a considerable body of prior empirical research specifically focusing on the UK, as well as on other geopolitical settings.

As such, it can be argued at least for the purposes of prima facie hypothesis development, that a concept of deep incumbency

As outlined in general terms in the introduction and discussed in the previous section, the hypotheses considered for this study are drawn by reference to diverse frameworks for understanding different notions of incumbency variously developed in political science (Baumgartner & Leech 1998; Pierson 2000), political economy (North 2006b), policy analysis (Roe 1994), management science (Chandy & Tellis 2000), organisation theory (Tushman et al. 1985), institutional theory (Steinmo et al. 1992), multilevel governance (Young et al. 2008), practice theory (Shove 2003), energy policy (Finon & Midttum 2005), innovation research (Walker 2000), technology studies (Unruh 2000) and transition management (Geels 2004). With each hypothesis informed by a number of frameworks, each displays different strengths and weaknesses. A few are quite obvious. Many are relatively well explored in other.





A third and final step relevant to this stage of the methodological design

constitute the critical juncture when these dependencies are visible. This will be the pivotal proposition in  
ύ'1ΐσ σύΨΐΣβι Χ'1ΐΐΐ'1 Χ\$ ο\$ΐΐ\$ο ύΐ ισ ύ'1\$ (H4d

To test this final proposition (discussed in section 8), we created a timeline for all major policy initiatives, reports, commercial developments and campaigning activities relating to UK civil nuclear energy, nuclear new-build, nuclear propulsion and nuclear submarines manufacture, from the mid-1950s until the inception of this paper at the beginning of 2015. Firstly, systematic Google searches were carried out by adding the word  
μύΨΐΐΐβι ύΐ \$ΐΐΐ'1\$ Ι· σύΨΐΐ 2 ύ ΜΧ\$ # .





tackle climate change). Yet over a succession of four distinct very large announced programmes following this pattern, the envisaged level of new build has either not materialised at all, or remained very far short of what

As is amply demonstrated by current high-profile policy controversies over the replacing of the existing UK Trident ballistic missile submarine fleet (Dorman 2016; Beale 2015; North West Evening Mail 2016; Edwards 2014; Mortimer 2015b), the retention of nuclear-propelled submarines has also long been seen by both major



the world was strongly emphasised when she stated:

(Thatcher quoted in Jack, 2016).

Enthusiasm for Trident continued under Prime Minister John Major in the 1990s. By this time any remaining Parliamentary debate around the topic was confined to whether to

order to construct, operate and maintain this infrastructure, is a very demanding undertaking especially for a country that is in other respects increasingly losing its manufacturing base (Meek, 2014) or seeing this become tangled in the capabilities of other countries (ibid.) So, with these capabilities so central to the credibility of one of the most treasured aspects of British political identity, anxieties are growing.

Accordingly, rhetorics have intensified the UK's role as a sea deterrent, and its relation to British identity on the world stage. For instance, politicians expressing criticisms of this technology are rare. Members of the Government (Mortimer 2015b). Prominent members of the British military declare that the UK's nuclear deterrent is essential for its security when they come to power (Mortimer 2015a). Politicians who question the tactical logic of Trident are accused of undermining the UK's security (Mason & Asthana 2016). Despite the nuclear weapons issue continuing to be contested in various forms over recent years, the UK has continued to contemplate opposition towards Trident (Peter Mandelson and Neil Kinnock quoted in BBC News, 2016). The opposition of the current leadership to Trident renewal is one of the most frequently cited issues in the rebellion of the Parliamentary party, that is currently held to threaten the entire future of the British Labour Party (Walker & Stewart 2016). That the recent vote in Parliament on constructing a new fleet of nuclear submarines for the next 30 years was carried with a majority of 355 (Mason & Asthana 2016), show how entrenched these commitments are – spanning British Party divides.

Another point to make with regard to the sustaining of Trident and the associated British nuclear engineering skills base, is that in recent years, developments in non-nuclear options for submarine propulsion have raised the question as to whether conventional submarines could be used as an alternative to the very expensive and complex nuclear propulsion systems. Indeed, in recent years there have been important breakthroughs in different forms of diesel-electric and fuel cell submarines (Hobart 2016). However it was concluded by the MoD in the Defence White Paper 2006 that

(HM Government 2006: 38). Similar to the conclusions reached by the Royal Navy in 1950, nuclear propulsion is still widely regarded in expert circles as being a superior technology in its own right because of its ability to provide a submarine with a virtually unlimited range and endurance. [t]

(UCL IEPL Australian submarine options report 2013: 12). It is for these kinds of reason that, as Ian Jack (2016) observes

The superiority of nuclear propulsion over conventional submarines designs is also recognised internationally. For example, Singh (2016) outlines that

Planalto 2014).

Having established that UK policy commitments to civil and military nuclear infrastructures are each very strong, it remains to explore whether and to what extent these imperatives might be linked. One first perspective on this picture, is to consider the international context. Here it has already been noted how

Despite the many complexities and ambiguities, the evidence summarised schematically in Figure 3 does suggest a number of possible general patterns in international military and civil nuclear commitments. Before discussing these, several particular caveats are necessary. First, there is the somewhat arbitrary figure of 6 D'Š ŮŮo ů'1\$ μo\$ŮŮo\$ P\$QΦP ŮŮ ŮŮoΨPb μP†ΩŮ\$Ś Ω\$X ΩŮŮP\$to đŮŮPŚ †Ů X'1ŮŮ'1 ŮŮ Śo†X † ŚŮsoŮΩđŮŮŮŮ đ\$ŮX\$ŚΩ P†o°\$ ŮŮ ΨŮŚ\$Ůo†Ů\$ ŮŮ oσ††P ŮŮŮP ΩŮŮP\$to μoŮ'o†ΨΨ\$σ bŮŮ P\$†so ů'1Ůσ μ†bσ ΩŮ †ŮŮ\$ŮŮŮŮŮŮ ŮŮ ů'1\$ σđ†P\$ ŮŮ \$Ů\$Ůo°y or finance markets in the country in question. Nor does it attend to the ambiguities and conditionalities in which scales of plans are often expressed. But this figure does nonetheless offer a valid broad illustration of a basic difference between plans amounting to a scale not far different from a single modern large scale power station (with twin reactors rated at 3.2 GWe) and markedly large programmes representing some multiple of this scale. Likewise, the distinction drawn by the German Institute of Global and Area Studies (GIGA) đ\$ŮX\$ŚΩ Ψ†ŮŮo o\$°ŮŮŮ†P †ŮŚ other levels of military power (Nolte 2010), is also a function of many different variables. Yet it nonetheless serves usefully to identify those countries around the world that find themselves most motivated and able to invest most heavily in military capabilities of all kinds. And, of course, all the categories employed in this picture are subject to change over time. So attention is required to retrospective circumstances and prospective possibilities.

historically developed at least some

(comprising China, France, Russia, the UK and USA). And the significance of this is underscored in the discussion in the last section of strong policy statements in Brazil, explicitly linking these issues.

Perhaps reflecting strong military perceptions of the uniquely credible status of nuclear-propelled submarines

ΕΙΣ ΤΟΤΕ ΟΙ ΠΡΩΤΟΨΗΦΟΙ ΔΙΕΣ ΣΥΜΦΩΤΟΥΝΤΟΝ ΤΩΝ ΕΣΟΤΕΡΙΚΩΝ ΘΕΛΟΥΣΑΝΤΩΝ ΑΠΟΨΕΩΣ ΤΩΝ ΎΛΙΩ ΧΥΟΣΤΑΝΤΩΝ-standings and highest-profile intergovernmental technology-regulatory bodies (World Nuclear Association 2016f): the International Atomic Energy Agency (IAEA 2015a) and Euratom (European Commission 2014). The focus of this



This chimes with other sporadic remarks from





research and development and skills and training provision across military and



<sup>17</sup> In private discussions, informed individuals are also not reticent about noting the formative effects of these linkages. One senior figure in the civil nuclear sector told this study:

Εἰς τὴν τοσοῦτον ἀποδομένη ὅτι ψυχοποιεῖται ὁ κόσμος πρὸς τὰς ἐκείνων πολιτικῶν πράξεων· εἷς τὸ φανερόν, ὡς οὐ γάρ ἐστι γεγονός, ὅτι καὶ αὗτοι οἱ πολίτες ποιεῖται.

However, it is important to note that these kinds of linkage can also present challenges. For instance, the MoD and parts of the military supply industry have expressed concerns that a vibrant civil new build program could attract skilled individuals from the defence sector, thus acting as a drain on key skills and capabilities<sup>18</sup>. Such risks are amplified by general concerns regarding the poor state of the nuclear skills base in the UK (BIS 2013; Cogent 2011; DECC 2015).<sup>19</sup>

pointed out that, in the context of the strategic decision in the 2005 Defence Industrial Strategy to retain all the capabilities unique to submarines and their nuclear reactors, the sector remains dependent on a continuous flow of MoD business to maintain capabilities and preserve skills (NAO 2008).<sup>22</sup> Here, one senior figure in the civil sector told us:

. (Code 3, 2015)<sup>23</sup>

From the discussions above (and the extended quotes in the endnotes), then, it is clear at least on the military side that there are strong formative pressures acting to reinforce UK government commitments to maintaining a civil nuclear power industry. In short, without a healthy industrial base of nuclear engineering companies and skills and training organisations to fulfil at least second tier roles in new nuclear power programmes, the UK could not realistically hope to maintain its cherished status as a militarily-credible nuclear power.

One crucial way to interrogate the emerging findings that





(2016)

This by no means stands for concrete evidence, however it nonetheless emphasises the significant increase in activities surrounding nuclear power in the crucial period of study. Such processes are notoriously difficult to investigate, especially in any rigorously critical fashion. To illuminate the background to this policy turnaround, we therefore conducted a t

The picture is therefore again very clear. The otherwise unexplained and unprecedented reversal in UK civil nuclear policy occurred in precisely the same short time interval as an equally unprecedented and well-documented crisis in UK military nuclear policy. Indeed, just this kind of unique reversal in civil nuclear policy is repeatedly and openly acknowledged in the military policy literature to present a significant part of a solution to the perceived crisis in key military capabilities occurring at that time. Observed even by proponents of the reversal at political levels, then, the 2003-6 reversal in UK energy strategy is thus very strongly circumstantially associated with evidently massive concurrent pressures asserted by military nuclear interests.

Given the clarity of the policy documentation on the military side in this period, it is quite remarkable that the significance of these pressures is virtually entirely unacknowledged in the civil nuclear policy debates either at the time or subsequently. Whatever the formative influences may have been, the acknowledged secrecy of the reversal (and the first hand testimony) remain little more than circumstantial. Yet there are a few further specific ways in which the evident importance of military policy drivers in this period can be resolved to a further level of detail that offers to clarify the picture somewhat beyond this. These emerge when attention is given to quite how much of the literature reviewed earlier in this study in establishing general influences of military on civil nuclear policy, actually fall into the exactly the period of 2003

policy consultations, highlighting the importance of a shared skills pool for the military and civilian nuclear sectors (KOFAC submission to the Energy Review, 2006) and made the positive case for nuclear power in the

As highlighted from the outset, the main purpose of this paper has been to explore systematically a hitherto virtually unaddressed possible reason for the otherwise unexplained intensity of official UK policy attachments to nuclear power – and especially the unprecedented reversal of a brief interruption to these commitments in the period 2003-6. This possible contribution to understanding these events is, that it is perceived imperatives to maintain national UK capabilities to design, build and operate nuclear-propelled submarines, that have exercised a crucially formative influence on the intensity of parallel policy commitments to civil nuclear infrastructures. The potential importance of this particular factor is all the greater, because it remains so undiscussed in debates over UK energy policy.

It is not the purpose of this study (nor does length permit us) to offer a similarly detailed exploration of all the alternative contrasting hypotheses discussed in Section 2 as addressing potentially converging contributory factors in explaining the intensity of UK policy attachments to civil nuclear power. These were:

(H1);

(H2);

(H3); as well as

(H4) Nor is it

necessary for the substantiation of the present argument to explore each of these in equal length. The point here is not that perceived imperatives in elite UK policy cultures to maintain nuclear submarine capabilities, form a sufficient basis for understanding the distinctively pro-nuclear character of UK energy strategies. The argument has rather been, that this perceived military nuclear imperative is clearly salient in principle – and that occurring between 2003 and 2006.

So the relevant test at this point for the alternative hypotheses (H1; H2; H3) returned to now is somewhat less demanding. Here, the crucial question for the present analysis is not about the relative salience of the different hypotheses, but about whether any of them might be judged to be so clearly sufficient in its own right – or whether they are collectively so compelling – such as to so fully explain the pattern of events that the relevance of parallel military drivers is rendered effectively redundant. In seeking to address this final task, it is very helpful that there exists a quite voluminous policy literature on some of these alternative hypotheses. What needs to be asked of this evidence, is simply whether these alternative hypotheses offer – individually or collectively – such a clearly sufficient basis for understanding, that resort to the present (acknowledgedly less explicitly documented) military nuclear imperatives is rendered unnecessary.

This section will therefore quickly review the evidence in relation to this criterion for each possible alternative kind of explanation in turn. Then – by reference to the theoretical discussion in Section 3 – the following (penultimate) section will focus in detail on the fourth hypothesis concerning the extent to which the policy dynamics discussed here warrant consideration as a possible instance

The remarkable uncompromising and unqualified rhetorical intensity of such assertions are in themselves both a clue as to their political nature and an indication as to their underlying substantive weakness. Without taking a position one way or another on the relative pros and cons of nuclear power as compared with other low carbon energy options, it is abundantly clear from longstanding official UK government appraisals and analysis by leading energy policy consultancies on which these often depend, that there emphatically does exist a wide variety of viable low carbon alternatives to nuclear power in the UK. Whilst it remains legitimate to interpret



The final hypothesis to be considered in this section is the highlighting the relevance of individual agency and interpersonal networks, this kind of explanation focuses on the detailed ways in which the decision for new nuclear build was made, involving powerful elite actors around civilian nuclear power interests both in government and industry. As we have discussed above, evidence for this can be found in accounts like that of Stephen Taylor, who points out the nature of the conflicts between Margaret Beckett, Patricia Hewitt and others (Taylor 2007). Other indicators of this more individualistic and networked understanding of political processes might also refer to media concerning Freedom of Information requests by Rob Edwards published in

A further indicator of the relevance of network interactions between elite individual policy actors is the manifest role played by senior politicians in nuclear policy, in which senior politicians often take key roles in nuclear lobby groups and then later return to politics, a practice that is considered to be particularly endemic in the nuclear industry<sup>25</sup>. As part of the Contracts for Difference (CfD) framework, for example, were reported to have involved processes of this kind (Vidal, 2014). Implicating many prominent individuals, displaying curious reversals of positioning on nuclear power and including the role of the brother of Prime Minister Gordon Brown as a nuclear lobbyist (Wheeler 2007) there can be little doubt as to the importance of these kinds of dynamics. Indeed, some key experts go as far as invoking them in postulating that the French nuclear utility EDF effectively managed completely to outmanoeuvre the UK Government by this kinds of means, enabling them to secure UK nuclear assets as a means to channel revenues from British electricity consumers into payment for French nuclear decommissioning costs<sup>26</sup>.

Further particular versions of this elite actor-network hypothesis variously invoke a range of supposedly decisive roles played by different purportedly key individuals, including Tony Blair himself (Taylor 2016). Brian Wilson (Wilson quoted on BBC Newsnight, 2008), David King (King quoted in Leake 2008) and Sue Ion (Ion quoted in Taylor, 2016) are all variously quoted as asserting their own personal importance in the policy turnaround in the period 2003-2006. An emphasis on the role of elite actors was also encountered in this study during interviews and conversations with several key experts. An example of this kind of argument, is that it was the interactions between elite individuals like those named above during the critical juncture 2003-2006 that persuaded Tony Blair of the need to (rather ignominiously) reverse his then

the necessarily opaque nature of interpersonal communications and relations make it difficult to be sure either way. Whatever formative roles they may play, then, individual actors and networks are clearly subject to wider conditioning pressures that confer greater continuity in the observed pattern events, than is evident in their own individual careers. It is for this reason, then – as well as healthy general scepticism about the sufficiency of under-corroborated observations – as well as healthy general scepticism about the sufficiency of under-corroborated observations (Clarke 2015)(Sunstein 2014) that it seems that this final alternative hypothesis (while salient) also cannot be considered sufficient in itself.

This brings us to the final question of this study, whether the evident influence on UK civil nuclear policy of elite policy commitments to military nuclear capabilities can be considered to reflect a phenomenon that might be expected to be important to emphasise again what has, and has not, been argued in this present section. In a field as complex, dynamic, uncertain and secretive as civil and military nuclear policy, it would be unwise in the extreme to seek to assert definitive conclusions, or unitary understandings. All of the hypotheses reviewed here are likely to hold some value in helping to understand particular aspects in the observed course of events.

To take each in turn, the determinants of UK civil nuclear policy criteria that are declared in official documentation are all evidently important and valid in principle – it would be difficult to claim that policy processes are so disingenuous that they exercise no influence at all (H1). Likewise, it would be naïve to argue that there do not exist significant pressures from entrenched interests in UK civil nuclear sector – even though this may be relatively small and weak. And – as has just been explored – elite policy actors and their networks are undoubtedly deeply implicated in the forming of policy commitments of all kinds. The analysis summarised here, is simply that none of these well-recognised factors can reasonably be considered to be sufficient in itself. Nor – for the reasons discussed – is it persuasive to assume that all these taken together are fully sufficient on their own. It does appear some other factor is involved.

It now falls to this final concluding section of this study, to review carefully the series of systematic stages in the hypothesis testing process that has framed the reasoning throughout this paper. The first step in the argument was to establish a case for identifying the unusual intensity and persistence of official UK policy commitments to civil nuclear power and for raising questions over what might be driving this. This case was established in

But the findings in Section 9 of this paper are nonetheless also quite clear in another respect

adversity. So neither can be seen merely as an artefact of selection on the part of the present research project, nor of background noise in a volatile policy discourse. The deep incumbency hypothesis might therefore on these grounds, be judged at least to be .

The next step was to test the proposition (beyond a mere conjunction in intense UK military and civil nuclear commitments), that more generally manifest and substantive linkages are actually observable between these UK Government attachments to renewing civil nuclear power and maintaining national capabilities to sustain nuclear propulsion infrastructures for military submarines. explored various dimensions of this issue. For instance, on one obvious aspect: the general international context was found to display (as summarised in Figure 3) broadly recognisable patterns of association between commitments to civil nuclear power and military nuclear status



features in UK energy policy. At the very least, the case does seem sufficiently strong, that the onus of any further argument or a



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<sup>1</sup> Investment in power capacity – Renewable, Fossil-Fuel and nuclear (2008-2015 \$billion)

Source: Frankfurt School-UNEP (2016).

<sup>2</sup> Despite many in the UK pointing towards Germany as an exception, it is actually developments in the UK that fail more to fit the general pattern of nuclear policy in Europe. As can be seen below, the scale of the UK's stated nuclear new build ambitions are clearly exceptional in Europe. And it is worth noting that major current new build projects at Olkiluoto in Finland and Flamanville in France are facing significant challenges. These projects are both vastly over budget and behind schedule by 6 years in the case of Flamanville, and 10 years in the case of Olkiluoto.

|                                                     |                                                                                       |
|-----------------------------------------------------|---------------------------------------------------------------------------------------|
| Ambitious nuclear new build                         | UK                                                                                    |
| Tentative new build plans (1 or 2 reactors planned) | Finland, France, Germany, Italy, Japan, South Korea, Sweden, Switzerland, Taiwan, USA |

<sup>4</sup> Several episodes in the history of the UK nuclear fuel chain infrastructures illustrate this reference to a generally negative record of national nuclear performance. It might reasonably be thought that these distinctively poor outcomes from previous ambitions, might help dissuade policy makers from further similar aspirations, especially given the emergence in recent years of manifestly viable alternative low-carbon energy technologies. However, the UK's nuclear ambitions remain far more ambitious than those of other countries with less chequered histories regarding nuclear cost overruns, accidents, and significant technical errors. Some of the major current and historical UK nuclear challenges include:

The 1957 Windscale Pile No. 1 fire was the worst nuclear accident in the UK and one of the most significant nuclear accidents in the world. It resulted in the release of radioactive materials (notably iodine-131, strontium-90, caesium-137, as well as polonium-210) were released into the surrounding environment (Arnold 2007). Resulting concerns led to precautionary bans in the sale of milk. It is estimated that around 10% of the population in the surrounding area were exposed to radioactive materials. The accident also led to the development of the Magnox process for plutonium production for nuclear weapons (ibid) meant that much associated information was kept secret by government. The damaged piles have remained a significant challenge to this day, requiring continual monitoring during the long ongoing process of decommissioning (World Nuclear News, 2013).

The Advanced Gas-cooled Reactor (AGR) programme was a major success for the UK, with the first AGR, Dungeness B, which took 18 years to construct and had a lifetime load factor of 43% (IAEA Reactor Database, 2016). Despite the great hope of a global market for AGRs, no reactor of this type was ever bought or constructed outside of the UK (Birmingham Policy Commission, 2015).

Fast breeder reactors were once a great hope of the British nuclear industry with announcements made in the early 1970s by the UK Atomic Energy Authority that by the year 2000, over 75% of electricity generation would be coming from nuclear power, with over half of the nuclear contribution coming from fast breeder reactors (Cochran et al 2010). In fact, by the year 2000 the UK share of nuclear was 25% and the fast breeder programme had long been abandoned. In fact, operational experience of fast breeder reactors in the UK was limited to the demonstration reactor at Dounreay on the north coast of Scotland. Nearly £5 billion of R&D was spent on fast breeder reactor development from 1974-1995 (IEA 2016). The Dounreay reactor was beset by technical difficulties, however, with a life time load factor of just 26.9% (IAEA 2016). The facility has been shrouded in controversy due to radioactive leaks occurring over the past two decades with dangerous radioactive particles found in the surrounding environment (Edwards 2011). There are particularly challenging technical aspects to the decommissioning of Dounreay and the process is expected to take several decades (McKenzie 2014).

Despite official declarations of 'no more' for UK radioactive waste (BERR 2008), no site has been found for the construction of a Deep Geological Disposal Facility (GDF) (DECC 2014). Radioactive waste is currently stored on an open site at Sellafield. The cost of storing and reprocessing waste is £110 billion (Gosden 2014). The nuclear waste and reprocessing facility at Sellafield is widely regarded as one of the most technically challenging and expensive aspects of the overall nuclear programme. Other key hazards at the site include significant amounts of radioactive material circulating in fuel storage ponds. The exact contents of the ponds are not known, leading to significant problems in terms of the practicalities of keeping accurate inventories of the different classifications of waste at Sellafield (Pearce 2015). These ponds are considered an acute safety risk and keeping them safe and secure is one of the most technically challenging and expensive aspects of the overall



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<sup>7</sup> The White Paper 'Defence and the Economy' presents the case for a new submarine fleet. It states that the current fleet is 'outdated and expensive to maintain' and that a new fleet is 'needed to ensure the UK's security'. This security case further:

<sup>8</sup> It should be noted that these discussions were not without controversy, much of which surrounded the high costs of building a replacement nuclear submarine fleet (Sims 2016). The major Scottish political parties and many Scottish MPs are generally opposed to the fleet being based at Faslane. In 2007, a major House of Commons vote saw a number of Scottish Labour MPs rebel against the government, although the house backed plans for Trident renewal by a substantial majority of 409 to 161 (ibid).

<sup>9</sup> As stated in the Namtec-commissioned report on the supply chain for a nuclear new build programme:

(Court 2009: 51)

<sup>10</sup> Using the methodology shown in Section 4a numerous passages from key documents were identified which indicate linkages between developments in the fields of UK civil nuclear power and submarine nuclear propulsion, a small selection of which are shown in section 5.2. These quotes are shown in full detail here:

(House of Lords

Select Committee on Science and Technology 2011: 18)

(ONR 2015: 6)

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(HoC 2009: 70, Written Evidence from AMEC)

(NIRAB 2014: 26)

(HoC 2009: 107)

<sup>11</sup> The full quote from INucE and BNES



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(BIS 2013: 79)

<sup>19</sup> The following extracts illustrate concerns about the state of the nuclear skills base in the UK as the result of reductions in R&D budgets over the past 20 years:

(HoC 2006:EV59, written evidence from BAE)

(HoC 2006: EV107, written evidence from RAEng)

<sup>20</sup> Some quotes highlight that rather than being a disadvantage in terms of competition, skills cross-overs could be seen as a further opportunity for the defence sector:

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the Nuclear Industry Association (NIA) and government, and more recently Tom Greatex has moved from being in Government to chairing the NIA. In reference to the NIA's role in the industry, the NIA's 2007 Public Administration Committee report states the following: -

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