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The role of place in energy transitions: siting gas-fired power stations and the reproduction of high-carbon energy systems

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Abstract

Analysts of the spatial dynamics of energy transition have given insufficient attention to the obduracy of fossil fuel-based energy systems, and understanding such persistence requires greater analytical attention to the role of place. This paper responds to these concerns through a distinctive longitudinal, whole sector analysis of the siting decisions of 111 gas-fired power station projects in England and Wales, from 1988 to 2019. Evidence shows that over 67,000MW of new capacity has been consented, with few insurmountable siting problems, with place providing an important explanatory element. The fact that many projects were able to re-inhabit sites of former coal- and oil-fired power stations enabled developers successfully to mobilise arguments that gas power was a net environmental improvement, while obviating or deflecting objections based on place and landscape. The combination of site choice and consenting rules also helped gas-fired power stations nullify challenges based on the systemic risks of burning gas, and negotiate climate change policy constraints. Researchers need to theorise how ‘systems of places’ shape the reproduction of dominant socio-technical systems for energy, by mediating the extent and efficacy of public engagement in decision-making and problematising political challenges to the social order.

Key words: energy, transition, gas, social acceptance, place, siting

1.0 Introduction

In energy as in other sectors, researchers now widely recognise that moving towards more just and sustainable systems of provision is a challenge with fundamentally spatial properties (e.g. Bouzarovski et al 2017; Bridge et al 2013; Calvert 2016; Frántal and Novákova 2019). Numerous researchers have sought to better understand how the creation and deployment of newer, low carbon energy generation technologies co-evolves with socially, politically and physically heterogeneous terrain (e.g. Devine-Wright and Howes 2010; Van der Horst and Toke 2010).

While it is unsurprising that technological innovations such as renewable energy have attracted much research, there is a flipside to transition processes that has received much less attention – to understand how *un*sustainable, mostly fossil-fuel-based energy systems reproduce and, over time, diminish. Explaining these processes of adaptability and persistence is vital because, after Shove and Walker (2007, 764), if we wish to mainstream new pathways we must also 'figure out how currently dominant socio-technical regimes might be dislodged and replaced'. Applying this to energy geography research, Bridge (2018, 18) notes that the processes fostering the 'active disassembly of carbon-intensive energy networks', or resistance to them by incumbent interests, are seriously under-studied. Bouzarovski et at (2017) likewise, called for better understanding of the places and spaces associated with increasing greenhouse gas emissions.

This paper responds to these calls by analysing the siting dynamics of gas-fired electricity generation; a subject that exemplifies this asymmetry in energy transition research. While novelty and the evident potential for social conflict has driven considerable study of the advance of wind energy, in many countries since the 1990s it is gas-powered electricity that has experienced greater expansion, yet its growth has received minimal academic attention (for exceptions, see Mounfield 1990; Garrone and Groppi 2012). World production of natural gas (gas extracted straight from the ground) tripled between 1973 and 2018, from about 1200 billion cubic metres to 3900 billion cubic metres (BP 2019). Globally, gas use for electricity generation doubled from 1992 to 2016, from 750 billion to 1500 billion cubic metres (IEA 2018). Partly as a result, many national governments have positioned gas as a 'bridging' fuel to more fully decarbonised electricity systems of the future, with the prospects of extended use (e.g. Lindseth 2006; BEIS 2019; GlobalData 2019).

Siting dynamics offer a useful analytical focus for understanding the evolution of energy systems, because decisions about sites and consenting processes for infrastructure projects are integral to the development and reproduction of energy pathways. To this end, there is undoubtedly an important phenomenon to explain – the relative siting 'success' of gas-fired power station projects in the UK. As the analysis below will show, only a very small percentage of applications for gas-fired power stations in the UK have failed to receive consent – less than 5% - with few projects encountering insuperable problems in the planning process. This is a marked contrast with onshore wind energy in the UK, which has experienced 'acceptance rates' of only 44% of submitted applications, biomass (52%) and solar power (74%) (Harper et al 2019). Explaining these outcomes is an important task in its own right, but also offers important insights into how high-carbon energy systems reproduce over time.

In constructing an explanation, the analysis makes an argument for giving greater attention to the role of place in the theorisation of energy transitions, not just in terms of the spatial distribution of 'what happens where' but in explaining rates and directions of system change. On a *prima facie* basis, the insights look clear. As Huber and McCarthy (2017) explain, 'struggles over land are central to the extraction and distribution of energy' (2017, 657); thus one should not be surprised that greater conflicts attach to the exploitation of 'spatially extensive' renewable energies like wind, compared to fossil fuel systems characterised by 'intensive vertical reliance upon subterranean stocks of energy that require relatively little land to harness' (*op. cit.* p.855). However, while land is indeed integral, a reductionist focus on physical space risks ignoring the diverse ways in which beliefs about place, as locations imbued with meaning, and shot through with judgements about permissible activities, permeate the (re)construction of the social order (Cresswell 1996). The analysis presented here draws on the notion that pollution is 'matter out of place' (James 1952; Douglas 1966), to show how systems of places can exert powerful effects on the fate of different energy pathways.

In sum then, this paper seeks to advance our understanding of the role of place in energy transitions by presenting research that explains the minimal consenting problems experienced by gas-fired power stations in England and Wales. It is structured as follows. The next section examines the interface between energy transitions, infrastructure and place in greater detail, noting how neither energy transitions analysts nor facility siting researchers have sufficiently theorised the systemic effects of place on transition processes. The research methodology is then outlined. This is itself distinctive, being the first whole sector analysis of the consenting process outcomes for the 111 major gas-fired power station projects that have been submitted since 1988 in England and Wales. The key findings of the siting outcome analysis are presented followed by an explanation, which details how the material qualities of gas-power intersected with systems of places produced by previous fossil fuel investment, and the rules of the consenting process, to enable the vast majority of developers successfully to avoid, answer or nullify challenges to their projects. The concluding section discusses the findings and reflects on the wider implications.

2.0 Place and siting in energy transitions

2.1 Transition theory and 'systems of places'

From 2012 onwards, growing numbers of researchers have begun to engage more closely with the spatial dimensions of sustainability energy transitions, exploring the interface between transition processes, space and scale (e.g. Coenen et al 2012; Hansen and Coenen 2015; Murphy 2015. Much of this attention has sought to elaborate the 'multi-level perspective' (MLP) on socio-technical transitions (Geels 2002). A central concept in this perspective is 'socio-technical regimes' that – as with energy – characterise particular systems of provision and are constituted by economic processes, consumption practices, regulatory arrangements and infrastructure. Such regimes are seen as 'dynamically stable' (Geels 2011), but change may be triggered by 'niche' innovations, where they coalesce and challenge the socio-technical regime. Key spatial perspectives identified as warranting further attention include: better understanding of the spatial unevenness of transition processes, through improving our grasp of their spatially embedded nature; and better conceptualisation of the multi-scalar nature of transition trajectories (Coenen et al 2012).

Researchers have developed these perspectives to elucidate the salience of place to transitions. Thus analysts have argued that 'niches' –as notionally 'protective spaces' in which there is more scope for novelties to emerge – should be recognised as relationally constructed from multiple elements, some locally embedded but others, like financing, arising from actions in other arenas such as national government (see Raven et al 2012). However, as Murphy (2015, 81) notes, the role of place in transition thinking has still been more as 'a site', rather 'than a more situated and affect-laden construct'. In his own analysis, Murphy (2015) sketched how place could be drawn into the struggles that permeate transition processes, such as the mobilisation of competing visions for the future of places.

There are useful insights here on the ontological constitution of place but - in viewing places mainly as the localised context for potential technological and social innovation – researchers have tended to reinforce wider emphases in transition thinking on innovation as the main driver of change (Hansen and Coenen 2015; Geels 2011). Although alert to the importance of the contextual embeddedness of dominant socio-technical regimes, less analytical attention has been given to how spatiality is implicated in the durability of incumbent systems (Lawhon and Murphy 2011; Coenen et al 2012). One might deduce a tacit inference in some transitions thinking that regimes are inherently less exposed to the diverse exigencies of context than niches. However, post-structuralist analyses of technology and politics have observed that the various elements that constitute regimes (markets, infrastructure, regulatory rules) are always a potentially fragile abstraction from the multiplicity of elements, forms and processes beyond the system, which they interact with (e.g. Barry 2001), and with which they are in 'contingent, uneasy and unstable interrelationships' (Ong and Collier 2005, 12; Bouzarovski et al 2015). Like niches, aspects of regime reproduction and development may also thus require 'protective spaces' that provide some insulation from potentially disruptive processes, like political critique. It is here that a fuller engagement with concepts of place can enhance our capacity to explain transitions.

Amidst geography's voluminous discussion of place, the aspect that warrants foregrounding here is place as a constituent element of the social order, encapsulated by the aphorism that pollution is 'matter out of place' (James 1952; Douglas 1966; Bickerstaff and Walker 2003). In Mary Douglas's discussion of this idea, she explains how a society's conceptions of purity and contamination are integral to the maintenance of social order. Picking up the reference to 'place', geographers have noted how beliefs about what is appropriate - be it behaviour, substances or categories of built development – are interwoven with place and space, as a set of ordered relations, which seek to preserve the undefiled and resist potential contraventions by arranging them spatially (Cresswell 1996; Hinchliffe 1997). Suggestively for the understanding of place and energy transitions, Douglas asks whether the adherence to ideas about purity and contamination (and perhaps thereby the concepts of place that inform them) contributes to social rigidity – in transitions terms, we might say 'lock in' (Unruh 2000) – through rationalising resistance to change and in legitimising actions that police potentially threatening, transgressive activities. As Cresswell (1996, p16) notes, systems 'of places provide historically contingent but *durable* schemes of perception' (emphasis added).

Taking this forward, one might suggest that a key facet of sociotechnical regimes and their capacity to maintain their dominance is a 'system of places', which legitimises particular beliefs about the appropriate relationship between energy technologies, places and people, governs the logic of acceptable change, and defuses or disables existential challenges. Such systems of places are not neutral facets of nature, but subject to active social production and construction (Massey 2005; Unwin 2000). Linking together key dimensions of place, one can envisage three main axes of contestation:

- *Differentiation.* Systems of places may be rooted in and seek to amplify distinctions between locations. As Cresswell (1996) argues, the notion of something being 'in' or 'out of place' can be constitutive of wider judgements about the rightness of a state of affairs.

- *Filling and emptying.* In defining place as a concept, the distinction is commonly drawn between social relations to territory that are lived, embedded and the subject of emotional affect – referred to in terms of 'place' – and relations that are abstract and disembedded from the full richness of experiential social contexts – discussed in terms of 'space'. However, this intellectual demarcation may, in the real world, be subject to struggles *inter alia* to empty spaces of social relations that might thwart particular activities or to imbue places with particular meanings and to have these recognised.

- *Localising and extending.* Transition theorists are alert to the multi-scalar, multi-element nature of place construction (Coenen et al 2012, 976; Murphy 2015), with place as a 'nodal point within a complex web of social interactions which may stretch over local, regional and national boundaries' (Devine-Wright 2009, 427). However, constructing places can bring with it boundary-making activities, that serve to elevate or delimit the salience of processes that flow to and from places to a wider area.

As Murphy (2015) observes, the dimensions of place are cognitive-subjective but also structural, to the extent that they are institutionalised in rules and regulations. Herein lies a basis for considering how systems of places may attain relative durability and underpin regime reproduction. The relevance of this becomes clear as we turn to consider the relationship between energy facilities siting research and energy transitions.

2.2 Place, social acceptance and the regulation of change

There is a considerable literature on energy infrastructure siting and public responses, a section of which has explored the explanatory power of place (Calvert 2016). Attitudes to new facilities like wind farms and the likelihood of opposition are seen as shaped by whether such facilities resonate with or disrupt publics' place attachment (Devine-Wright 2009; Huber et al 2012). A common pattern in many countries surrounds conceptions of 'the rural' and 'the urban', with energy facilities likely to attract opposition where they are represented as threatening this spatial ordering by 'industrialising' places seen as rural and natural (e.g. Woods 2003). Here we see place differentiation as integral to judgements about the rightness of activities. Processes of filling and emptying place have also been observed. Analysts have differentiated place-sensitive approaches to the development of infrastructure from those that treat locations as mere sites, characterised by abstract dimensional qualities like size, proximity to dwellings, access etc. (Devine-Wright 2011).

However, although much effort has been expended on seeking to explain public responses to new facilities, and on how more positive responses might be generated (see for example Firestone et al 2018), few siting analysts link their work to wider energy transitions. Many generalisations in this field are extrapolated from new renewable energy technologies (reflecting the wider innovation emphasis, noted above), especially studies of wind power, which may embody a very particular set of potentially 'place disruptive' characteristics (Cowell and Devine-Wright 2018). Less attention has been given to how siting issues shape the persistence or adaptation of incumbent fossil fuel technologies, or those circumstances in which the siting of major new infrastructure - despite potentially significant impacts - engenders little public reaction. Certainly, various studies have identified the social, economic and political processes by which places become dependent on environmentally risky industrial activities (Blowers and Leroy 1994; Crenson 1971), forming 'pollution havens'. Work on environmental justice charts the spatial association between environmentally undesirable activities, including fossil energy infrastructures, and disadvantaged social groups, which may lack the will or capacity to challenge projects successfully (Walker 2011; Bickerstaff 2012; Frántal and Nováková 2019). However, while place is incorporated into such analyses, how such spatial patterning might become constitutive of development trajectories has been little considered.

Where links are made between siting and transitions, it is often just to assert that adverse public reactions, sometimes phrased as insufficient 'community acceptance', can be a barrier to progressing more sustainable energy systems. Yet tracing how patterns of public responses to energy projects actually relate to development outcomes requires attention to issues of efficacy and power (Aitken 2010), across the complex of factors governing the operation and evolution of energy systems (Wüstenhagen et al 2007). Analysts of energy infrastructure siting conflicts have often treated the 'rules' governing project consenting as a static, contextual backcloth to the analysis of social responses and underplay its agency (Wolsink 2018).

Whatever publics may feel about new energy projects and their impacts, any actions they might take do not unfold across a blank sheet of paper, but within arrangements for decision-making that shape which claims about place, publics, infrastructures and environment can bear legitimately on decisions (Brannstrom and Fry 2017; Cowell and Devine-Wright 2018). Many of these effects reflect the axes of contestation around place introduced above. Thus, land use planning systems, classically, serve to differentiate territory into areas suitable for certain kinds of activity: some for protection, on landscape, heritage or ecological grounds; some for accommodating development. Various analysts have shown how planning can work as an abstracting process, by simplifying, sorting and allocating spaces into particular uses, elevating criteria that are relevant to decision-making (and which are not; Aitken 2010; Cowell and Owens 2006), and thereby creating representations of space that are dis-embedded from the richer social milieu of place (Lennon and Moore 2018).

In defining which issues are legitimately up for discussion, consenting procedures can also embrace or delimit relations between projects, places and wider effects. Standards and site designations enshrine judgements about whether impacts are acceptable or safe, be that for pollution, noise or ecological effects. Rules may make developers legitimately responsible for emissions from their own plant, but not necessarily for cumulative effects with other sources, thus containing developer responsibilities. Institutional arrangements may seek to govern how far the ‘need’ for new energy infrastructure can legitimately be questioned. Publics or pressure groups may doubt whether a power station serves the purposes of efficiency, energy security or decarbonisation, but project consenting processes may regard such questions as *ultra vires*, deferring them to national policy or markets. Indeed, there has been a growing tendency of governments to institute ‘fast track’ processes for determining major infrastructure, including energy facilities, which seeks to reduce ‘delay’ by *inter alia*, preventing ‘generic’ issues like need from ‘contaminating’ the determination of individual projects (Marshall and Cowell 2016; Garrone and Groppi 2012).

Consenting procedures thus occupy an important but under-examined position in the persistence or transformation of energy systems (Cowell 2017). We might see them as constitutive of socio-technical regimes, because they permeate systems of places, their production and construction, and thereby of the legitimacy of activities within them (Calvert 2016). As transitions theorists have noted of ‘places as niches’, we can also see how ‘places as locations for infrastructure’ are not purely locally constituted, but configured by regulations and policies that emanate from regional, national and international government arenas (Lindseth 2006).

Of course, the rules governing project consenting can themselves be contested. Societal concerns may emerge that environmental standards are inadequate, that particular risks have been neglected, or the scope for engagement is too limited, all leading to pressures for regulatory change (Barry 2001). Consenting processes may be a particular target for such concerns, because they often incorporate some opportunities for public engagement and publics often get more engaged when faced with specific infrastructure projects, more tangible in their consequences, than in response to underlying policies (Cowell and Owens 2006); hence '(a)ntagonisms over siting can be manifestations of deeper societal tensions around future energy pathways' (Calvert 2016). However, whether project-specific conflicts drive wider institutional change depends much on whether opponents are able to generalise their concerns, perhaps linking to wider collectives such as political parties (Boltanski 2011; Rootes 2013), such that controversies 'overflow' (Callon et al 2009) the prescribed channels of project decision-making to exert wider leverage. This does happen. On-shore wind in England is one example: a coalescence and 'jumping scale' (Cox 1998) of place-connected project protests contributed to the shifting of political party stances and the curtailing of financial and planning support. But it does not always happen, and there is a need to consider how issues around place play out in explaining where governments and industry may be able to 'hold the line' of decision-making procedures, delimiting destabilising dissent, and where they cannot.

This review has suggested how place concerns can help us to better understand energy transitions. 'Place' is not just a potential location for innovation, but the evolution and prospective future reproduction of dominant socio-technical systems of energy provision may also be associated with systems of places, which shape the emergence and efficacy of critique. The power of planning and consenting procedures are key elements in the social construction of place and space. However, to grasp how societies come to view 'matter' as 'in' or 'out of place', it is necessary to give some attention to the 'matter' in hand. Here, this is technologies that burn gas to generate electricity.

2.3 Materialities of gas-powered electricity

The exploitation of natural gas creates a series of risks that might prompt social concern. It requires specialized technologies and infrastructures for extraction, transportation and to transform it into products suitable for use. Like gas manufactured from coal before it, natural gas is a hazardous material, being both toxic and highly combustible, and so its handling creates risks of leakages and explosions. Consequently, the siting of gas facilities can and has occasionally attracted controversy, especially centred on processing and storage facilities, and pipelines (e.g. Van der Vleuten E and Högselius 2012; Lindseth 2006; Marsden and Markusson 2011; Groves et al 2013; Sovacool and Cooper 2013), and the opening up of new gas sources, notably unconventional hydrocarbons.

As a fossil fuel deployed in electricity generation, natural gas has come to occupy a contested position between different decarbonisation pathways, with proponents placing great emphasis on its *relative* merits. Natural gas has lower carbon intensity than other fossil fuels, embodying only 56% and 71% of the carbon of coal and oil respectively. In addition, gas combustion generates negligible acidifying sulphur emissions, and lower levels of nitrogen oxides than coal and oil. Thus, proponents might say that gas has greater 'eco-efficiency' (Jacobs 1991) than other fossil fuels, in that for each unit of energy delivered it creates less impact. The relative eco-efficiency of gas is further enhanced by Combined-Cycle Gas Turbine (CCGT) technologies. The 'combined cycle' is the use of gas turbines to generate electricity but then the re-use of the hot exhaust gases to drive an additional, electricity-generating steam turbine, thus raising energy conversion efficiencies above the 35% typical of coal-fired power stations to 50% and even 60%. The logics of eco-efficiency can also be extended to the direct use of land. Because gas is piped straight to the generator, needing few on-site handling facilities, with no ash to dispose of, CCGT power stations demand less land than equivalent thermal power sources (Watson 1997; Patterson and Grubb 1996). These factors all give CCGT facilities the potential to be highly compact, compared to a coal-fired station of equivalent output, or to equivalent renewable energy capacity (Mackay 2009; Huber and McCarthy).

It is these elements of fuel and conversion technology that have allowed gas to be presented as a 'bridging fuel' in addressing climate change, replacing more polluting coal-fired electricity while giving time for renewables and other lower-carbon alternatives to be developed (Lindseth 2006). However, given the depth and speed of decarbonisation necessary to avoid dangerous climate change (IPCC 2014), a critical question is whether continually 'bridging' to a low carbon future via gas is actually maintaining a dangerous level of 'lock-in' to fossil-fuels (Chignell and Gross 2013). As the analysis below will show, the conjunction of technology and place is crucial to explaining why the traction of such critiques has been limited.

3.0 Methodology

The research presented here has distinctive features. First, as noted above, it is one of few studies focusing on gas-fired power stations. Second, in contrast to much research on energy infrastructure siting and social acceptance, it draws on a longitudinal, whole sector analysis, looking at the consenting decisions of all 111 major gas-fired power station applications made in England and Wales between 1988 and the end of 2019. Similar research remains rare in a field dominated by individual case studies (for exceptions see Owens 1985, Firestone et al 2018, Harper et al 2019, Roddis et al 2018), and avoids the pitfalls of constructing generalisations from single case studies.

The data set consists of 'major' applications, which means schemes of 50MW declared net capacity and over, which is the size threshold at which electricity generation projects are consented by central government rather than local planning authorities. Most are CCGTs, though some also have CHP (combined heat and power) provision. It includes 103 applications which have received consent and two that were passing through the latter stages of the consenting process at the end of 2019. The 103 excludes a small number of applications deemed likely to be repeat applications for a similar project on the same site, and excludes applications to vary an existing consent. The data set includes six 'failed applications' – i.e. projects where applications were made but which were withdrawn during (if not necessarily caused by) the consenting process. Capturing unsuccessful applications is difficult (Firestone et al 2018), with governments under no obligation to provide an accessible archive, but several strategies were used here to identify them. For applications post-2008 that followed the Planning Act 2008 consenting procedure, the website of the Planning Inspectorate records initial meetings with applicants. For the earlier period, applications were identified using the NexusUK database of the mass media and professional press, especially the ‘Power Station Monitor’ service of Power in Europe.

The core goal of the analysis was to examine siting decision outcomes, how decisions were rationalised, and how the various factors in play – place, site, concerns expressed by various actorss – were addressed. The analysis relies on documentary data. For each application, the consent letter and associated documentation was obtained and analysed. These letters do more than issue a decision: they deal with the merits of the application, review its compliance with key policies and also comment on objections, thus giving a justification as to why certain concerns may or may not prevail on decisions. This is supplemented by two sets of more detailed documentary analysis. For the 40 applications made prior to the end of 1994, the whole of the applications file, including all correspondence between parties and intermediate reports were examined. This includes five of the six failed applications. For most post-2008 decisions, the analysis was also able to utilise the full, detailed report on the application produced to inform the decision.

4.0 Findings and analysis

4.1 Key consenting outcomes

Figure 1 shows the significant capacity of gas-fired power that has been consented in the UK by the end of 2019: approximately 67,000MW. Not all consented projects were built (for various reasons, discussed below) but, by the end of 2014 – a period when installed capacity was peaking – some 34,000MW of gas-powered electricity generation was supplying the British national grid (DECC 2015).

<Insert Figure 1 somewhere near here>

The data also strongly suggests that few gas-fired power station applications encountered disruptive siting conflicts. 95% of applications gained consent, without any recourse to an appeal, an acceptance rate that greatly exceeds all the main renewable energy technologies (Harper et al 2019). This outcome might be summarised simplistically as a story of ‘siting success’. Research also shows an average time from application to consent for gas-fired power stations of about two years (see figure 2, below), with no tendency for decision times to increase over time (Marshall and Cowell 2016). This contrasts sharply with the 1980s experience of coal and new nuclear capacity, which appeared mired in inexorably extending decision making processes (Owens 1985). Under consenting legislation that prevailed until

2008[1], insurmountable objections from local councils would trigger a public inquiry, yet only three gas plants went through this process and all three were subsequently permitted. Post-2008 consenting legislation instituted fixed time frames for decisions, which was complied with in all cases.[2]

<Insert Figure 2 somewhere near here>

Table 1 shows important features of the patterns of public opposition. Many applications were consented very swiftly with minimal overt public opposition, as measured by written consultation responses. 80 applications, constituting 75.8% of consented capacity received no more than ten objections, and many received zero – including some very large schemes at Drakelow (1220MW) and South Humber Bank (770MW). In addition to the six withdrawn applications, only a further ten faced high levels of public opposition (26 or more written responses), with no evidence of controversy mounting over time. Applications attracting over 100 responses occurred in 1990 (two), 1996, 1998 and 2017.

<Insert Table 1 somewhere near here>

Of course, utilising written objections as data means focusing on the ‘invited spaces’ of formal consultation arrangements rather than spaces of popular, community expression (Cornwall 2004), and leaves open the question of what public non-responses might mean in terms of social marginalisation, stigma or the diverse modes of acceptance (as discussed in, Parkhill et al 2014). Nevertheless, formal responses are highly salient to understanding the broad extent of controversy but also the efficacy of oppositional arguments. The ten applications experiencing high levels of formal public opposition all received consent.

How might we explain these outcomes and what does it tell us about the salience of place?

4.2 Technologies meet sites

To understand the relative absence of disruptive opposition to gas power projects, many would point to particular technological form adopted by most schemes - the CCGT (Watson 1997; Patterson and Grubb 1996). As discussed above, the use of gas plus CCGT conversion technology delivers projects amenable to numerous relative environmental advantages compared to coal- or oil-fired equivalents, in terms of pollution, waste arising and land take. However, a key question is how and how far these generic claims about the relative eco-efficiency of CCGTs would actually enable developers to navigate the complex, site-specific and wider concerns that could arise as actual projects come forward. As the evidence shows, this is much shaped by the benchmarks against which applications should be judged, which brings the discussion to place.

[1] Since the Planning Act 2008 all major power station applications undergo an examination (six months max), which may involve an element of public hearings.
[2] The Planning Act 2008 also institutes requirements for pre-application consultation, for which time frames are not fixed.

On a *prima facie* basis, a key advantage for gas-powered generation has been the sites available to be exploited for new facilities. The data shows a very strong association between gas-power projects and the locations of former energy generation facilities and previous or existing heavy industry (see Table 2). Over 50% of capacity has been consented on sites either previously occupied by coal- or oil-fired power stations, or which had previously received planning consent for such projects. The relative spatial compactness of gas turbine technologies compared to their forebears enabled projects to fit easily within such spaces. The connections to the carbon economy increase further if one considers projects developed on former coal gas works, or on former or current oil refineries.

<Insert Table 2 somewhere near here>

The wide availability of places affected by previous layers of the fossil fuel economy assisted the siting process in a number of ways. In institutional terms, power generation or similar industrial activities were often recognised as 'an established use' of these sites in local land use plans. For the first Coryton application, it was land allocated for 'refinery uses'; with Medway CCGT, the land fell into a 'special industrial uses'[3] classification. Developers could also claim that they were re-using brownfield land rather than consuming greenfield sites: a durable interpretation of sustainability in the planning sphere in the UK (DoE 1997), which serves to reinforce distinctions between 'unspoilt' rural and developed land. Many such sites conferred the cost and technical advantages of proximity to existing grid connections (Garrone and Groppi 2012), gas pipelines too. This is important because new high voltage grid connections can be as much if not more controversial than the power plant itself.

Even where proposals encompassed areas of undeveloped, greenfield land, previous patterns of use meant that this land often had limited public access, reducing the basis on which place attachments might form (Van der Horst and Vermeylen 2011). Such spaces often fell within the boundaries of existing facilities, and were owned by the company developing the project. Such places may not be without affective attachment, but the formalised parameters of land use plans and property ownership readily institutionalised their prime value as sites for particular economic uses.

Linked to these practical-material and institutional advantages, the scope to re-exploit previous fossil energy sites also conferred symbolic and representational advantages. In their environmental statements, it was almost standard for developers to extol the relative eco-efficiency of CCGTs compared to oil or coal plant. From the Seabank Power Environmental Statement in 1991, we read that 'CCGT technology results in lower emissions of carbon dioxide, sulphur dioxide and nitrogen dioxide than conventional power stations' (Section 2.1). The terms changed little over time, for example, with the developers of Eggborough, 26 years later (Eggborough Power Limited 2017, para 18.3.1), claiming to demonstrate that the 'Proposed Development compares favourably with the existing coal-fired power station, and

[3] Rochester upon Medway City Council, Planning Committee report, 25.09.1991.

with current UK gas-fired power stations' by dint of lower emissions. Emergent concerns like climate change were layered on to these arguments, as another dimension of gas power's eco-efficiency, but did not change the relative, comparative nature of the argument.

These arguments could achieve particular resonance where more-polluting oil or coal plant had in fact been the previous or intended site use. Planners considering the 350MW CCGT at Great Yarmouth in 1989 concluded 'there would be a planning gain through the use of the old coal yard site and the redevelopment of the old (coal) station'[4]; as did Inspectors in 2019 determining the 3600MW CCGT at Drax, noting: 'that the development would reuse an existing site for energy generation leading to a positive effect in the planning balance'[5]. Dust and ash associated with previous coal burning had sometimes invaded the purity of nearby residents' domestic space (Parkhill et al 2014); gas-fired power stations would not create such 'matter out of place'.

Another major category of site selected was within or adjacent to existing major industrial complexes: steelworks, paper mills, chemical plants (see Table 2). Gas power offered these facilities a way of meeting their electricity requirements, often also replacing older, more polluting on-site power plant and providing a surplus for export to the grid, as well as supplying steam for industrial processes. The fact that new gas generation capacity has been developed *within* existing, 'private' industrialised places, where the surrounding industrial operations framed expectations, is a highly plausible factor in explaining low numbers of objections. For example, the Coryton 750MW CCGT, which attracted no formal public responses, was located within land used for Mobil's oil refinery.

The salience of place, but also the way places are shaped by institutionalised judgements, is readily apparent from the treatment of landscape. Research has shown that perceived effects on landscapes and their meanings are integral to the experience of place and can exert powerful effects on public opinion towards energy facilities (Firestone et al 2018; Wolsink 2018). For gas-fired power stations, however, landscape concerns rarely detained the consenting process. Decision files provide copious evidence of how the past and its visible landscape legacies conditioned the legitimacy of new facilities. Thus, of the 299MW Wrexham CCGT:

> 'it will be visible in distant views from the higher ground of the (Area of Outstanding Beauty) to the West. However, it will be seen in the context of the larger existing developed area of Wrexham Industrial Estate, including the nearby Kelloggs plant which will in part obscure views of the proposed power station, and will appear as a small component of a much wider scene'.[6]

This quotation exemplifies the recurring, authoritative landscape narratives for gas-fired power stations:

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[4] Great Yarmouth Borough Council, Planning Committee Report, 06.11.1989.
[5] Recommendation report, 2019, paragraph 4.77.
[6] Submission from Joint Committee for the Clwydian Range and Dee Valley AONB.

- the sites occupied by the project have no intrinsic landscape value;
- the chosen sites tend to be distant from landscapes designated for their scenic qualities;
- where the proposed facilities will be visible, they are viewed within the context of industrial facilities; consequently, the net additional impacts are small;
- ergo, the impact is acceptable.

Where it was felt that a new power station could be visually intrusive, with stacks sometimes over 50m high, this was mostly dealt with managerially by requiring developers to provide on-site and/or off-site screening, using tree planting. Addressing such issues was a condition of consent, not a bar to consent. With early projects, some actors were able to embrace the visibility of CCGTs as a positive symbol for the area – 'a new landmark'[7] - tapping into claims of relative cleanness. At the 1500MW Staythorpe C CCGT inquiry, inspectors dismissed landscape objections thus: 'the Trent Valley has a history of power generation and the current landscape character reflects that' (Durrant 2002, para 114).

So, in Mary Douglas's terms, one might argue that gas-fired power stations have rarely transgressed beyond the system of places closely associated with carbon energy and energy-intensive business, which sequesters them from symbolically clean places elsewhere. Whereas wind energy has been widely observed as attracting opposition for 'defiling' symbolically 'pure', natural rural locations (Woods 2003), with gas we see a concentrated re-inhabiting or 'recycling' of old energy landscapes, presenting limited challenges to place qualities and their wider societal associations. This matters because gas power creates all sorts of impacts but the material history of the sites chosen helped comparative claims about relative environmental improvement to 'stick' (Nadaï and van der Horst 2010) i.e. to go relatively unchallenged.

The explanatory importance of place is underlined by the counterfactuals. CCGTs proposed for greenfield sites did attract high levels of local opposition (two of the five projects attracting 100+ objections, in Figure 3), and place meanings were a major factor in the projects scuppered by planning objections. Projects at Rugby (for a site allocated in the local plan for light industry), Ardleigh (a greenfield site, not far from landscapes painted by John Constable), and Blythe Bridge (an industrial estate close to rural villages), were all withdrawn after significant local objections. Abstract, generic claims about the relative eco-efficiency of gas-power, compared to hypothetical coal-fired equivalents, failed to persuade in places with no history of pollution-intensive industry; improving eco-efficiency at the level of the energy system was seen instead as local environmental deterioration. Moreover, rural places, once defiled, were recognised as likely to allow further 'pollution':

> 'Chimneys are visible over a wide area ... emphasised by power lines radiating from the power station, indicate an area of industrial development. The whole effect will be to act as a magnet for further industrial development, with the destruction of the rural nature of the whole area' (Rural Power Station Action Group 1991).

[7] Peterborough City Council, Planning Committee Report, April 1990.

Such fears are well founded. The research shows the powerful tendency of certain categories of land use to reproduce over time, with an industrialised past helping to legitimise an industrialised future, hemmed in very often by societal desires to protect ‘pure’, rural spaces from such fates. Indeed, objectors at Rugby, Blythe Bridge and Trafford did advocate that former power station sites nearby be used instead.

Projects also failed where environmental expectations around power station sites shifted upwards. This occurred in Greenwich, London, where a proposal to replace existing electricity generators with (higher capacity) CCGTs was withdrawn, as claims about relative greenness could not dispel local concerns about net increases in pollution in an area earmarked for environmental improvement. Indeed, objectors actively resisted the place representations being promulgated: ‘The assertion by the developers that the power station “will benefit what has become a decaying and relatively deprived inner-city area” is demonstrably incorrect’[8].

4.3 Delimiting debate?

Achieving ‘successful fit’ between new infrastructures and the places in which they were located was not simply a functionalist exercise in matching past and future land uses, or successfully navigating notional place attachments. As Table 1 shows, publics and pressure groups were not wholly acquiescent in the face of gas power projects. However, such critique was rarely effective. To explain this, the attributes of place need linking to wider relationships, especially the institutional arrangements that govern consenting processes.

Assessment of the objections shows that the direct land-use change caused by gas-fired power stations was rarely the basis of opposition, but such projects have effects that spill beyond site boundaries and it is these that attracted most concerns. Visual impact was often raised, though – as discussed above – site choice and context enabled developers to deflect most criticisms. Construction traffic raised concerns in numerous sites (e.g. Keadby); so did noise (e.g. Roosecote), and – at a number of sites - the handling of cooling water. Many projects pursued coastal locations (see Figure 3), where constructing cooling water pipes and the abstraction and discharge of water within what were often highly protected wetland habitats required careful attention. For example, protracted disputes about the ecological consequences of discharging warm water from a 2000MW CCGT at Pembroke into the sensitive waters of Milford Haven explain why that project took more than four years to receive consent, despite re-using an oil-fired power station site.

<Insert Figure 3 somewhere near here>

Risks to air quality were expressed with many projects (gas combustion still emits considerable volumes of NOx), with respondents in many regions expressing concerns about

[8] Greenwich Action to Stop Pollution 1992.

cumulative effects. Figure 4 shows how gas-fired power stations have concentrated in particular areas, often adding their potential pollution to other combustion projects such as waste incinerators: notably estuaries of the Humber and Thames (Street 1997).

All these environmental impacts could delay decision-making while impacts were assessed and mitigation measures were negotiated, but rarely proved an existential threat to projects or to the expansion of gas-fired power plants generally. Almost invariably, acceptable technical fixes were negotiated between developers, statutory environmental bodies and local planning authorities, while views about these same issues expressed by local publics were badged as 'other concerns' and set aside (as others have noted for major energy projects, see Lee 2017). Indeed, a consistent feature of consent decisions is the remorseless deference by decision-makers to the opinion of statutory, expert bodies and the technical procedures that they operated. For example, in the Sutton Bridge decision letter (1992, para 3.4):

> 'With regard to the other concerns, abstraction and discharges are the responsibility of Her Majesty's Inspectorate of Pollution. HMIP have advised that atmospheric emissions will be limited to a level so as not to be detrimental to health'

Over time the name of the agencies deferred to changed, but the line remains the same. The fact that consents are issued centrally, also renders decision-makers less susceptible to 'local concerns' than is the case with local planning authorities.

The fragmented nature of consenting processes also served to delimit developer responsibilities and curtail effective challenge. Although gas-fired power stations may be spatially compact, they could generate requirements for new or enhanced grid or gas pipe connections with wider effects, yet these projects were typically the subject of separate applications, making 'comprehensive assessment' difficult.[9] A classic example is the 1700MW Wilton CCGT on Teesside: consented in just four months in 1990, exploiting a site within a larger chemicals complex, but boosting the need for 50 miles of new high voltage grid line that encroached on a National Park and took seven years to approve (Glasson et al 1998).

The rapid expansion of gas-fired power stations was the subject of more fundamental criticisms that sought to re-scale concerns from individual project impacts to the wider social, economic and environmental implications of this development pathway (Lindseth 2006). However, for most of the period under analysis, such generic challenges to the need for gas power had little impact. This ineffectiveness can in large part be explained by the small number of voices raising such challenges in the majority of cases (see Table 1), allowing them to be represented as marginal, but Governments have been able to hold the line around what they regarded as legitimate concerns even for applications that attracted more concerted opposition.

[9] The 2008 Planning Act allows for proposals for generating stations to be considered in conjunction with new grid connections, but does not mandate it.

Concerns at the effects of the ‘dash for gas’ on the UK’s domestic coal industry was one concern of the Coalfield Communities Campaign, which submitted objections to a number of CCGT applications in the 1990s. CCC concerns formed a major element of oppositional discourse at Langage and Spalding. On the environmental front, Friends of the Earth ran national campaigns through the 1990s that gas-fired power stations should not be developed without more assiduous efforts to re-use the waste heat, to further improve eco-efficiencies. Evidence suggests it was the only organisation to challenge the environmental merits of burning gas, though individual objectors to specific power station applications sometimes articulated heat wastage concerns.

However, Government decision letters invariably rebuffed generic objections with words to the effect that ‘as a general rule, the need for a generating station remains a commercial matter for the applicant’[10]. This position persisted and, if anything, tightened over the period. Steps taken in the Planning Act 2008 included the issuing of National Policy Statements, designed to provide authoritative, governmental statements on the need for various categories of energy infrastructure, and thereby prevent such ‘generic’ or ‘policy issues’ being contested with individual project applications (DECC 2011)

Remarkably, objections to gas power applications based on their CO_2 emissions and contribution to climate change barely feature until 2010[11]. This illustrates the widely noted dislocation between ‘global’ but ‘abstract’ environmental problems and place-based public concerns (Burningham and Thrush 2001), which finds some echo in patterns of opposition. CCGTs were targeted for direct action protests, as physical emblems of unsustainable energy pathways, with the No Dash for Gas group occupying the West Burton B CCGT construction site in 2012. However, this group did not submit a formal response to the application; indeed, West Burton received only one individual response.

4.4 Space to negotiate climate constraints?

Since the start of the 21st century, UK energy policy has reflected tightening targets on greenhouse gas emissions but this has scarcely impinged on consenting for gas-fired power stations. This is partly due to the deliberate compartmentalising of decision-making arrangements, with the relevant National Policy Statement stating that it is for developers of electricity generation projects to determine how best to respond to the Government’s strategic and incentive-based policies like the emissions trading systems (DECC 2011, para 5.2.2), and warning that decision-makers ought not assess individual applications against carbon budgets[12]. However, the sites exploited by gas power projects have also enabled proponents to navigate tightening limits on carbon emissions. In effect, systems of places have helped vitiate non place-based challenges.

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[10] Decision letter for Killingholme, issued 31st October 1996.
[11] Decision letter, Abernedd, 23.02.2011, referring to application made in September 2008.
[12] Drax decision letter, para 4.15, 4th October 2019.

In 2009, the government introduced a policy that all new thermal power plants should either include CHP, or – if not – provide evidence that 'the possibilities for CHP have been fully explored' (DECC 2011, para 4.6). However, gas-fired power station projects have tended to gravitate towards former power station sites (as per Table 2), which tend to be remote from major heat loads like large residential areas. Such siting norms may have helped to prevent matter getting 'out of place', by contaminating domestic spaces, but the resulting spatial distanciation reduces the prospects of waste heat energy being reused. Moreover, if a 'full exploration' by developers reveals little realistic demand for heat users in the vicinity, this is no bar to the electricity generating station being consented. Significant levels of gas power have been consented since 2009 with no realistic prospects of heat use: for example, the 2500MW CCGT at Eggborough and 1500MW CCGT at Knottingley.

From 2011, the Government has required that all commercial scale combustion power stations (defined as 300MW capacity or over) would need to demonstrate that they are 'carbon capture ready' to obtain consent (DECC 2011, para 4.7.10). Dimensions of 'readiness' include that the developer has secured sufficient space for Carbon Capture and Storage (CCS) equipment, and can access suitable geological storage. One effect of this requirement has been to encourage developers to scale their project below the threshold (more than ten have been consented with a 299MW capacity). With larger projects, the re-use of former coal-fired power stations makes the space requirements easier to meet, given the land released by redundant requirements for rail supply of coal, coal storage and ash disposal. While CCS remains under development, then the investment requirements of 'readiness' are largely notional.

Although gas power has dominated UK electricity markets since the 1990s, the period since 2010 has seen this dominance eroded. Falling electricity demand (Vaughan 2019), increasing output from renewables, faltering wholesale prices (Bridge 2018; Vaughan 2019) have threatened project financing (explaining why a number of consented projects have failed to proceed) and undermined the viability of existing plant (Harding 2017). As a result, a number of 1990s gas-fired power stations have been mothballed and demolished: some, in a perpetuation of energy uses, becoming the sites for more efficient, more competitive new CCGTs (e.g. Keadby II, Tees), or battery storage (e.g. Roosecote).

But the squeeze is also environmental, with tightening regulatory links being asserted between climate change impacts (i.e. emissions) and individual project consenting. In a 'planning first' (Early 2018), the UK government refused consent for an opencast coal mine partly on carbon emission grounds. In the gas power field, the 3600MW CCGT at Drax has become a key site of contestation. Objectors challenged the application on climate change grounds (Simkins 2018); had their arguments accepted by the inspectors, only for the Minister to accept the proposal, reinforcing the line that both the need for gas power and its compatibility with climate change goals have been established by policy and should not legitimately be reopened.[13] The fight is not yet over. Campaigners are seeking legal challenge that the project is incompatible with the UK's 2019 legislative commitment to 'net zero' (reducing greenhouse gas emissions by 100% by 2050). What is significant for the argument here is that questions of place compatibility are becoming irrelevant. The justificatory power of relative eco-efficiency arguments, co-produced by systems of places, is being exhausted as 'net zero' legislation and declarations of 'climate emergencies' threaten to shift the benchmarks against which decisions are made, towards policies linked to planetary ecological boundaries.

5.0 Conclusions

This paper has sought to demonstrate the insights that siting research on energy infrastructure can add to our understanding of energy transition. It provides a strong argument for seeing systems of places as integral to energy transitions; not just as locations for innovation, but because of the contextual support places provide for incumbent energy regimes. This is evident from the research findings presented here. A large volume of gas-fired electricity generation has been consented, and a major factor facilitating this expansion is that developers have rarely encountered insuperable planning problems. This is because developers have been able to insert relatively compact gas-power technologies into the large supply of sites associated with fossil energy and heavy industry. The chosen sites meant project proponents could readily anchor claims about the *relative* greenness of gas power technologies against the existing context: place was the 'glue' that enabled contestable arguments to stick.

From this analysis we can observe how systems of places prove functional for the reproduction of particular socio-technical regimes, facilitating 'lock-in' to unsustainable systems of provision. To return to reflections on pollution as 'matter out of place', a further and under-used part of Mary Douglas's argument was that confronting the prospects of transgression is a vital societal requirement in order that change can be addressed (Douglas 1966). One might say that the expansion of gas power in the UK has been accompanied by too little such confrontation: as Cresswell (1996) argues, transgressive acts must be visible to spark questions of the established order. With gas power, however, the surfeit of amenable locations linked to carbon-intensive industrialism meant very few projects transgressed into places of symbolic environmental purity. Systems of places matter then not just for helping us to understand the spatial uneveness of energy transitions, but because of the ways they can distance and sequester large sections of societies from the consequences of their actions, influencing what gets politicised and what does not.

Politics is important because negotiating the acceptability of new fossil energy projects is not simply a local, reductionist exercise of establishing a fit between technology and site. As was noted above, places are constituted by multi-scalar process and the construction of places can

[13] Drax decision letter, 4th October 2019.

entail boundary-making activities that regulate the decision-making salience of processes that flow to and from facilities across wider spatial scales. For the gas power sector, this means institutional arrangements governing *inter alia* emissions, grid connections and need, which served to render many objections *ultra vires* or capable of technocratic resolution. Thus, although fossil energy systems make notionally concentrated demands on land (after Huber and McCarthy 2015), it can still require considerable institutional work to contain challenges based on supra-local concerns. But systems of places still matter here. The locations chosen for many gas-fired power stations, with their minimal disturbance of landscape meanings, did not generate place-protective public action of sufficient scale or efficacy to pressurise the 'rules of the game' of the consenting process. Thus, with gas power in the UK, there has been relatively little of the kind of mutual reinforcement of project-related and generic policy critique, linking place-specific groups and broader NGOs, that has destabilised wider policy for road building, minerals extraction (Cowell and Owens 2006) or on-shore wind. While climate change concerns may now impinge on the acceptability of further gas-fired power stations, this squeeze is being driven by national law, mobilised by non-local NGOs, with local dissent largely absent.

The research presented here shows the multi-arena, spatially uneven processes by which fossil fuel sectors can negotiate environmental limits, but it also points to other themes for further study. It has shown the powerful tendency for 'industrialised' land uses to reproduce over time. What has been observed with gas is echoed in the frequent repowering, life extension and expansion of existing windfarms (Windemer 2019), and the attachments of new battery storage to various existing generation facilities. For low carbon energy, too, we should expect the emergence of 'systems of places' that configure the dynamics of future change. This being so, it is vital to recognise how any 'siting success' realised by re-exploiting industrial spaces can be bought at the expense of spatially concentrating locally-unwanted land uses near particular communities. The environmental justice of these outcomes, and prospective remedies, requires ongoing attention.

In relation to the burgeoning literature on 'social acceptance', the case of gas power in England and Wales shows the frailty of over-emphasising community acceptance – the responses of people living in proximity to prospective facilities - in explaining the dynamics of transition (Wolsink 2018). What is required is further research into the (dis)connections between grassroots and broader environmental activism around high carbon energy. We need to better understand the circumstances in which articulations of wider planetary threats can be brought effectively to bear on decisions, especially so where there is a lack of obvious, visible triggers that might generate a politics of place.

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Figure 1: Gas-fired power stations, capacity consented per annum, 1989-2019

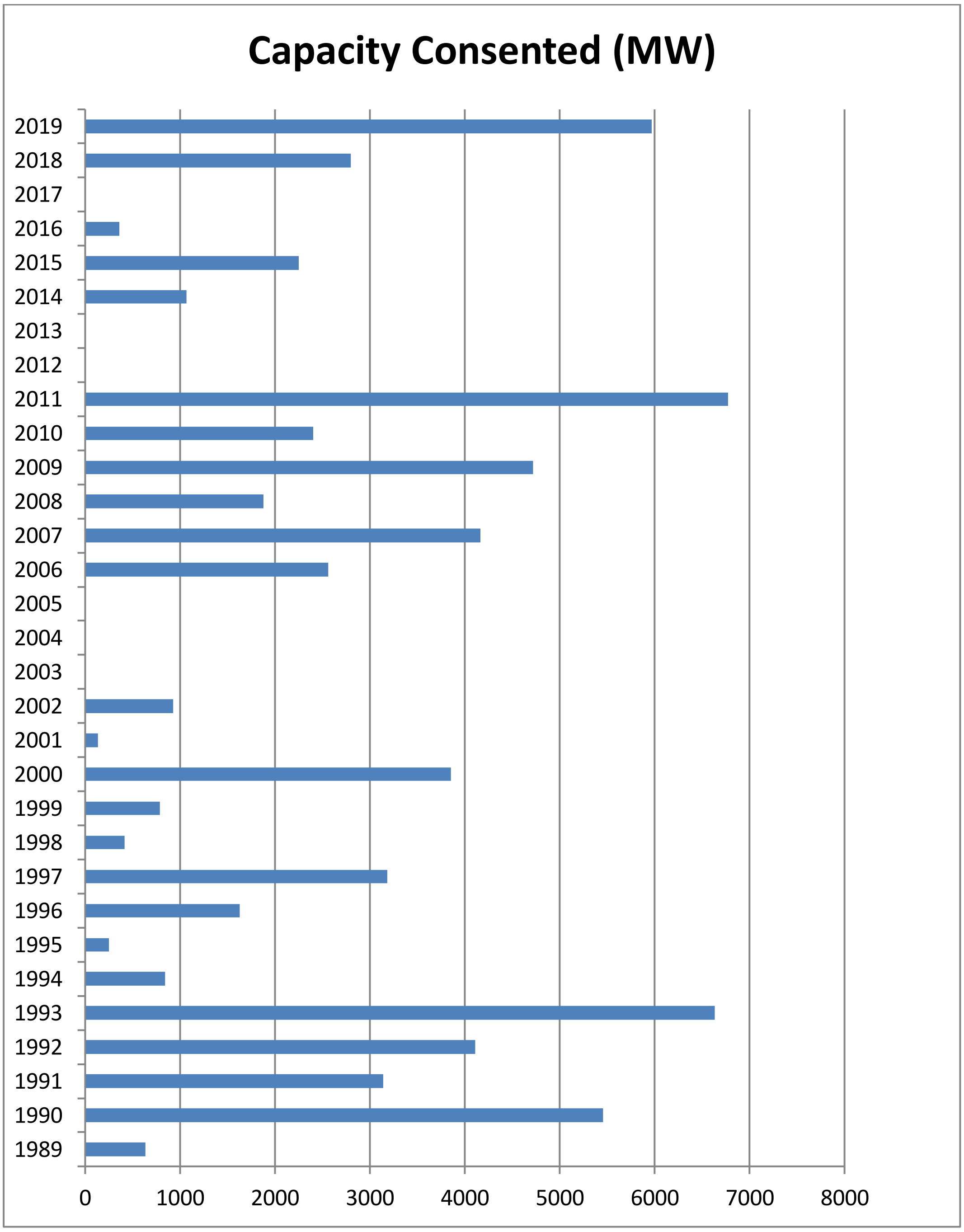

Figure 2: Decision times for Combined-Cycle Gas Turbines (CCGTs) 1988-2019

Notes: Data gives time from project application to consent, excluding those projects that were withdrawn before consent was issued. It does not include applications to vary a consent made after initial project was consented. Early applications were consented by the local planning authority under the Town and Country Planning Acts (1971 then 1990), indicated as 'TCPA'; most were consented under Section 36 of the Electricity Act 1989, and the Planning Act 2008 (as amended).

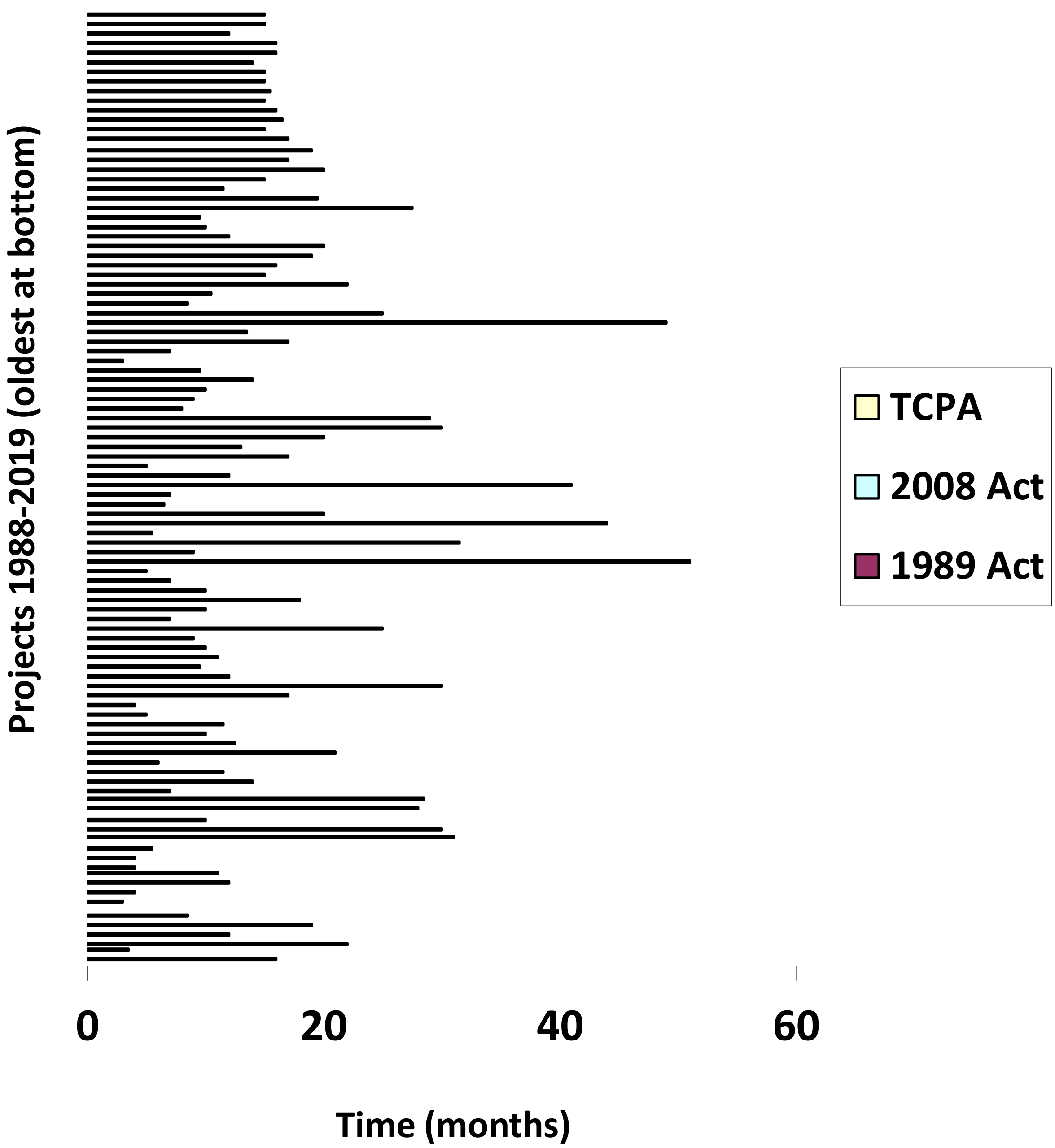

Figure 3: Gas Fired Power Stations in England and Wales

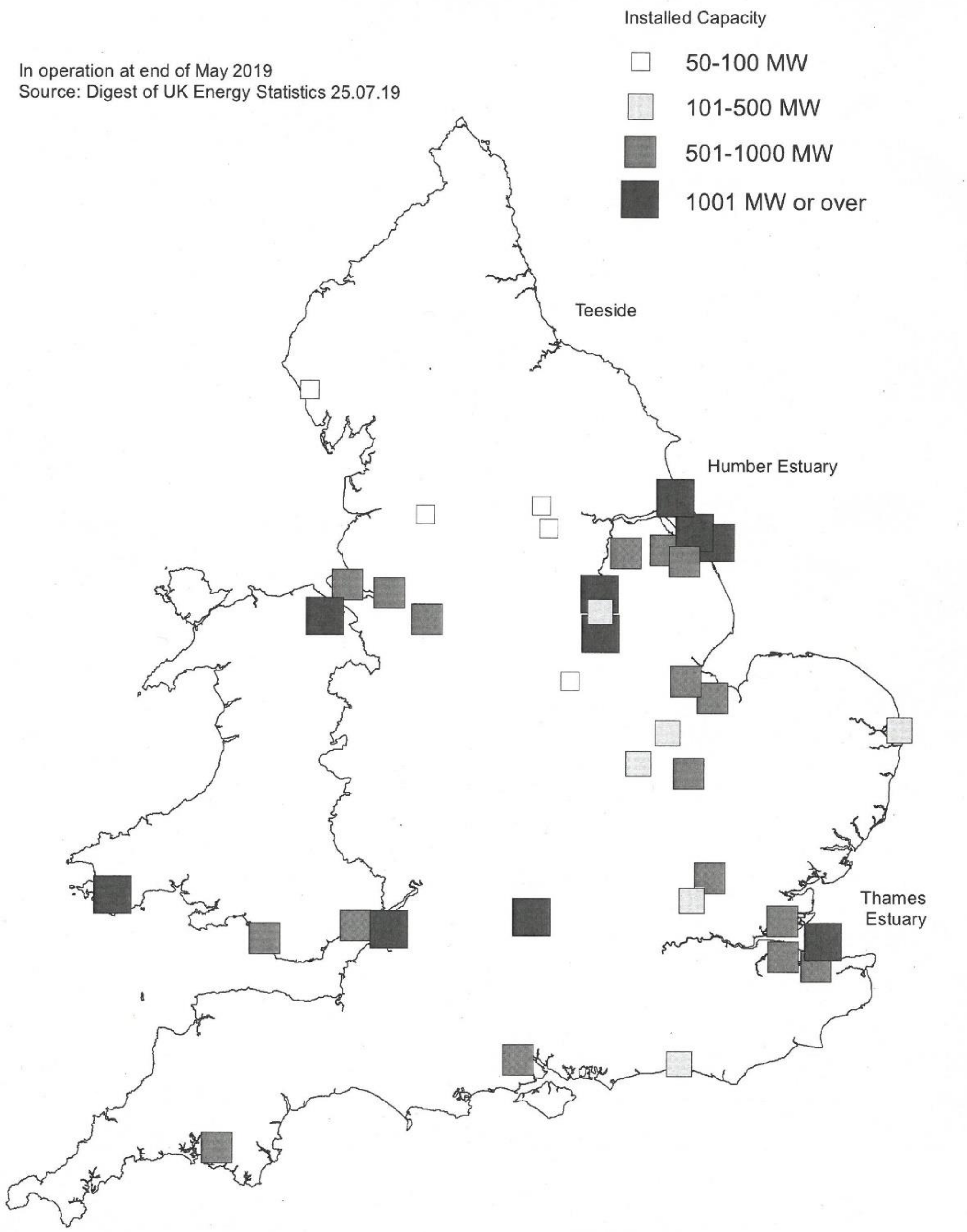

Table 1: Frequencies of written public responses to gas-fired power station applications

No. of responses	No. of applications with this frequency	Volume of capacity for these applications	% of total capacity
0	22	11,619 MW	17.6%
1-4	47	29,603 MW	44.9%
6-10	11	8753 MW	13.3%
11-25	6	5469 MW	8.3%
26-99	5	3423 MW	5.2%
100+	5	7020 MW	10.6%

Note: covers only consented applications, 1988 to 2019

Table 2: Sites of gas-fired electricity generation, UK, 1988-2019

Site category	No. of projects	Total capacity consented, MW	% of total capacity
Electricity generation (former coal/oil power station site; consented for such a use; or associated use e.g. ash disposal area)	34	36,567	53.8%
Former industrial use (ex iron production, chemical plant, gas works, sugar processing, etc)	18	13,975	20.5%
Adjacent, within and/or connected to existing industrial complex (chemical plant, sugar processing, oil refinery, paper mill)	40	13,864	20.4%
Greenfield site (no previous industrial use of site)	3	1159	1.7%
Greenfield site (allocated for/adjacent to industrial uses)	5	2402	3.5%
Within existing urban building	1	90	<0.1%

Source: Author. Note, includes only consented capacity.