A climate for change? The impacts of climate change on energy politics

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Abstract

The geophysical phenomena of climate change impact on the existing organization of energy economies and their attendant politics in multiple ways—at times magnifying and at other times dampening pressures on contemporary energy systems. Climate change has been increasingly viewed as a 'threat multiplier'. However, the geophysical phenomena of climate change are socially and politically mediated by actors with uneven power, capacity and divergent interests in order to support either incumbent or alternative energy pathways. While climate change intensifies and magnifies existing tensions and contradictions in global energy politics around the simultaneous pursuit of growth, security and sustainability, it does not do so in any straightforward or unmediated way. Instead, it gives rise to new concerns in relation to the imperatives of de-carbonization and increasing the resilience of energy systems. Understanding the impact of climate change on energy systems requires taking seriously the necessary role of energy within the global political economy and the relationship between fossil fuels and capitalism. It must be analysed both directly through climate change's impacts, and indirectly through the uses of political narratives about climate change to sometimes unsettle, and sometimes reinforce, particular energy pathways.

1. Introduction

The geophysical phenomena of climate change impact on the existing organization of energy economies and their attendant politics in multiple ways—at times magnifying and at other times dampening pressures on contemporary energy systems. What is clear, however, is that energy is central to debates about climate change. Energy production and use account for two-thirds of the world's green- house-gas emissions (International Energy Agency 2015) and climate change is one element of what has been referred to as the 'world energy trilemma'[1]. This trilemma highlights the problem of simultaneously pursuing goals of improved energy access and accelerated growth, enhanced energy security and decarbonized energy systems in order to tackle climate change (World Energy Council 2012).

In March 2017, United Nations (UN) Secretary General Antonio Guterres referred to climate change as a 'threat multiplier' at a high-level event on cli- mate change and the Sustainable Development Agenda (Guterres 2017). A 2007 report by 11 high-ranking retired United States (US) admirals and generals first mooted this understanding of climate change (Center for Naval Analyses Corporation 2007). The ex-military men argued that climate change will exacerbate and further complicate existing concerns over environmentally sensitive issues, multiplying threats from food insecurity, water scarcity and energy access (Brown et al 2007). That same year, the UN Security Council (UNSC) held a landmark debate on climate change, energy supply and security (UNSC 2007), and since then the concept has been deployed in a variety of settings as a means of both analysing and managing the relationship between the geophysical phenomena of climate change and the global energy sector.

We argue in this article that viewing climate change as a 'threat multiplier' does not adequately

[1] The 'world energy trilemma' is one of four strategic studies carried out by World Energy Council. The trilemma finds its origin in the Council's definition of energy sustainability. This definition is based on three core dimensions—energy security, energy equity and environmental sustainability. These three goals constitute a 'trilemma', entailing complex interwoven links between public and private actors, governments and regulators, economic and social factors, national resources, environmental concerns and individual behaviour.

capture the relationship of climate change to energy systems and the international social and political formations that are intimately bound up with specific energy pathways. Rather than position climate change as external to human and social systems in ways that abstract from climate change's anthropogenic roots, we suggest climate change is internal to economic and social systems. Climate change derives from these systems and this fact helps to explain the ways in which actors and institutions in the dominant energy regime seek to accommodate and manage the threat that climate change poses. That is, while capturing the multimodal impacts of climate change, the concept of climate change as a 'threat multiplier' fundamentally misconstrues the drivers of energy system change. Instead, we maintain that the geophysical phenomena of climate change are socially and politically mediated by actors with uneven power, capacity and divergent interests in order to support either incumbent or alternative energy pathways. For example, the threat of climate change has been invoked to justify the accelerated decline of widely opposed energy sources such as coal, while at the same time it has been used to promote the expansion of controversial technologies such as nuclear energy in some parts of the world (IEA 2016). While climate change intensifies and magnifies existing tensions and contradictions in the global politics of energy around the simultaneous pursuit of the objectives of growth, security and sustainability, it does not do so in a straightforward or unmediated way.

Given the nature of these tightly interlinked issues, we seek to locate cli- mate change as part of a specific socio-natural relationship that has evolved over time and must be located historically, rather than presented as a trans-historical and objective phenomenon (Bonneuil and Fressoz 2016). Rather than isolating and seeking to quantify climate change's importance as an independent 'threat multiplier' to energy systems, we highlight the composition of energy systems as complex, historically bound assemblages. These assemblages are comprised of natural material resource flows extracted or harnessed from certain environments and spaces, leaving certain waste products and environ- mental impacts in return, and they rely on specific hardware, human labour, material and calculative technologies, institutions, infrastructures and financial flows.

The arrival of climate change as an issue of international political importance in the late 1980s did not bring about a rupture in global energy politics. Growing recognition of its seriousness, despite the efforts of major fossil fuel interests to discredit the scientific and economic case for action (Newell and Paterson 1998), instead triggered a series of political accommodations and realignments in the energy sector. These shifts were undertaken both by actors threatened by the challenge that climate change poses to the sustainability of the fossil fuel economy, and by those seeking to capitalize on the opportunities associated with an anticipated transition to a low-carbon economy. In other words, the natural and social phenomena of climate change and its governance are both produced by and change the ways in which energy systems and (predominantly) capitalist political economies are organized. This unsettles the notion of climate change working as a 'threat multiplier' external to political systems. Understanding the impact of climate change on energy systems requires that we take seriously the necessary role of energy within the global political economy and the relationship between fossil fuels and capitalism. It must be analysed both directly through climate change's impacts, and indirectly through the uses of political narratives of climate change to sometimes unsettle and sometimes reinforce particular energy pathways.

In this article we explore how climate change affects the viability of particular energy systems and the circuits of production, exchange and consumption that they (em)power. In Section 2, we look at the centrality of the energy sector and particularly fossil fuel use to both the contemporary global political econ- omy and the global climate system, situating this discussion within existing lit- eratures in international relations (IR). In Section 3, we highlight the differential impacts of climate change on energy systems via infrastructural disruption and the reduced viability of certain forms of energy production. In Section 4, we focus on the invocation of climate change as a political narrative and how this has been used to both accelerate and resist energy sys- tem transition.

2. Energy and fossil capital

Energy is the lifeblood of modern society and is central to the contemporary global political economy through its relationship to growth, statehood, militar- ism and geopolitics (Huber 2013; Bromley 1991; Yergin 2008; Malm 2015; Mitchell 2011; Vitalis 2009; Parra 2004; Painter 1986; Labban 2008; Wrigley 2010). In spite of this fact, energy has often been neglected within the discip- line of IR. Traditionally its role in international affairs has been reified and simultaneously naturalized—reduced to the status of material resource external to the state and state formation. In Realist literature energy is often simply the object of state competition (Ikenberry 1986; Deni 2015; Colgan 2013), while more Marxist-inspired renditions (Bromley 1991; Rees 2001) emphasize energy resources (particularly oil) as the focus of imperialism and exploitation. Bromley suggests, for example, 'Control of oil may be seen as the centre of gravity of US economic hegemony' (Bromley 2005, 227). By way of indictment of the debate about energy in the discipline, Van de Graaf et al (2016, 4) maintain that Ernest Wilson's claim in 1987 that work on the international dimensions of energy is 'largely descriptive, atheoretical and noncumulative' remains valid today. Against this background, how global environmental change and climate change in particular might alter and be changed by global energy politics has received even less attention (Falkner 2014).

Strange's (1988) invitation to take energy seriously, in her seminal book on States and Markets, suggests that as a discipline international political economy (IPE) should be better placed than IR to address the interrelation of energy and social and political formations. Indeed, IPE arose as discipline distinct from IR in the shadow of the 1970s oil-price shocks. However, besides a very recent spike in interest (Di Muzio 2012; 2015; Di Muzio and Ovadia 2016; Van de Graaf et al 2016; Kern and Markard 2016), a mutual neglect by IPE scholars of questions of energy, and conversely by energy policy scholars of IPE, has frustrated a productive cross-pollination of insights. Given the centrality of energy to state power, geopolitics and the balance of power in the inter- national system, international economic relations and the global politics of sus- tainability, this neglect is particularly surprising and problematic (Newell 2018).

We suggest here that any conception of the impact of climate change on energy systems must proceed from an anthropocene or 'capitalocene' perspec- tive (Moore 2015; 2016; Malm and Hornborg 2014). Anthropogenic climate change is (by definition) a human condition, but not one produced by the homogeneous mass of humanity. Some humans, in some places, at some times, under some socio-natural relations bear a greater responsibility for climate change, and other humans, in different places, times and conditions, will bear the brunt of it. The anthropocene's dialectical energy–society relation can be situated historically in a number of ways. For Wrigley (2010), Mitchell (2011) and Malm (2015), the development of the industrial revolution (the initially purported location of the origins of the anthropocene age) and its relation to fossil fuels represents a qualitative turning point. While Wrigley argued that the development of industrial capitalism must be understood as enabled primarily by the exploitation of energy-dense coal, Malm (2015) argues the con- verse relation—that a transition from water power to coal power during the industrial revolution in Britain occurred, not because of the realization of coal as a superior source of energy, but rather due to the opportunity it afforded textile mill owners to further discipline and exploit labour. This transition enabled the development of urban, steam-powered factories—workshops that regulated work rhythms, squeezed higher productivity from workers and allowed the exploitation of women's and children's labour (Malm 2015, 76).

As Mitchell shows, however, the exploitation of labour through the exploitation of coal did not ossify socio-natural relations. From the beginning of the twentieth century the very material specificity of coal and its production enabled labour to exploit certain choke points in its production and distribution to fight for greater social protections and democratic freedoms through the use of the political technology of 'sabotage' (Mitchell 2011). Strikes at the coal face, railways and docks could exploit the requirement for concentrated energy and steam-powered machinery to dig coal from the earth and then transport it to its ultimate destination.

The shift from coal to oil as predominant fuel source in the post-war years similarly represents a further qualitative shift. Again, this shift disciplined labour through its removal from a transportation process now undertaken overland by pipeline (Mitchell 2011), and ushered in the 'great acceleration' in economic and population growth, food and materials production, consumption and the associated environmental damage (McNeill and Engelke 2016). The exploitation of oil and the simultaneous institutionalization of energy[2], understood as a system of

[2] This institutionalization lagged behind the material abstraction of energy in the form of widespread electrification, divorcing final energy use from its specific source (Mitchell 2008). This was preceded by

interchangeable power sources, were key to the development of the 'growth paradigm' (Dale 2011; Schmelzer 2016). Energy, largely in the form of oil, provided the material, conceptual and discursive fuel for the newly predominant post-war focus on the growth of national economies measured, defined and made comparable through the newly emergent systems of national accounts and gross national product (GNP) (Schmelzer 2016; Lane 2014; 2015; Mitchell 2011; Illich 2010).

As Kuzemko et al (forthcoming) note, 'The reproduction of world economy relations is now routinely confronted by the often fractious politics of securing access to energy; the drive towards constituting a distinctively low-carbon economy; the recent rise in perceptions of a generic energy crisis; and the ongoing institutional reconfiguration of both demand and supply of inter- national energy markets.' Climate change is simultaneously invoked as a signifier of the unsustainability of 'fossil capital' specifically, of capitalism in general and industrialism and growth fetishism more broadly still (see, for example, Bonneuil and Fressoz 2016; Dale 2011; 2017; Di Muzio 2012; Klein 2014; Malm 2015; Moore 2015; 2016). Energy is important materially, institutionally, technically and symbolically, given its ties to economic growth, development and political legitimacy, providing energy security and status in international society (Kuzemko et al 2016). In this sense, it is not hard to understand why the growing recognition of the need to tackle climate change is an unwelcome development for most states, industrial actors and the net- works of power that characterize energy regimes organized around and beyond the state. It is similarly unsurprising that there are many interests aligned against the notion that climate change should be allowed to disrupt what Di Muzio calls 'petro-market civilization', extending Gill's (1995) notion of 'market civilization'. This highlights the way in which the current pattern of energy-intensive social

an even earlier conceptual abstraction through the development and application of the new physics of the nineteenth century (Mirowski 1989; Illich 1974; 2010).

reproduction is produced by the oil and gas sector (Di Muzio 2012).

Yet, as we show in this article, both the requirement for climate change mitigation and the reality of adaptation are increasing and amplifying the challenges and crises currently facing global energy systems and the broader global political economy they engender. This suggests a need to understand how the geophysical, social and political dimensions of climate change interact with incumbent political and economic systems as they relate to energy. At times climate change disrupts them and creates crises for the organization and legitimacy of existing ways of ordering the world, revealing systemic vulnerabilities (for example, the dependence on finite resources for the current production of food and energy or for trade and transportation). At other times opportunities are projected onto it to 'creatively destruct', in Schumpeterian terms—to make money from crisis or to organize new rounds of accumulation around 'climate-compatible growth' (Organization for Economic Cooperation and Development [OECD] 2011). This latter situation involves the reworking and remaking of energy assemblages in ways that ostensibly address climate change without unsettling deeper structures of political and economic power.

Climate change can also further 'lock in' (Unruh 2000) incumbent energy systems. Seto et al (2016) show how the large capital costs, long infrastructure lifetimes and complex interrelationships between socioeconomic and technical systems mean that fossil-fuel-based energy infrastructures are particularly prone to lock-in. They identify three major types of such lock-in. The first is associated with the technologies and infrastructure that shape energy supply and indirectly or directly emit greenhouse gases. The second is institutional lock-in due to governance and decision-making impacting on energy produc- tion and consumption. The third refers to behavioural lock-in and relates to the habits and norms associated with the demand for energy-related goods and services. They argue that lock-in risks are exacerbated by the urgency of efforts to mitigate climate change.

This is a reading of incumbency not as a rigid and static set of structures for which climate change simply presents an external 'threat multiplier', but as an assemblage of components that are held together in the face of the contra- dictions and vulnerabilities that climate change produces and exacerbates. This assemblage includes securing finance for 'unburnable carbon'[3], protecting and expanding infrastructure in the face of resistance and civil disobedience and finding alternative technological options and fixes. Alongside these, institutional backing for business-as-usual trajectories is provided by states and regional and global institutions even in the face of multiplying evidence of the non-sustainability of these trajectories. This in turn requires the construction and repetition of discourses that deny, ignore or obfuscate the contradictions of containing climate change while expanding a resource-hungry global capitalist political economy.

3. The differential impacts of climate change on energy systems

In this section, we briefly explore the multiple direct impacts of climate change on the energy sector. Despite the challenges associated with modelling the precise effects of changes to a complex climate system upon numerous aspects of the energy system, several general outcomes can be identified.

[3] This refers to reserves of fossil fuels whose extraction and release into the atmosphere are incompatible with the goals of keeping global warming at least <2 C (McGlade and Ekins 2015).

First, climate change is likely to have a variety of impacts upon the supply of energy. This may constrain and close certain pathways while opening others. Substantial variations across regions and even within countries may emerge (Intergovernmental Panel on Climate Change [IPCC] 2014), in addition to the potential for stranded infrastructure (infrastructural assets that suffer from unanticipated or premature write-downs, devaluation or conversion to liabilities). One example of this is the declining long-term viability of hydro- power in some African countries, such as Kenya, due to reduced rainfall (Newell et al 2014).

The IPCC's Fifth Assessment Report also highlighted the potential impact of climate change on a variety of other renewable energy sources (IPCC 2014; Scharlemann et al 2016). There are potentially large variations in these impacts across and within regions. Altered soil conditions, precipitation changes and impacts on crop productivity in response to climate change could negatively impact on the potential for bioenergy generation. In the case of the direct con- version of sunlight into electricity through solar photovoltaic (PV) systems, solar resources may no longer be stable and could undergo decadal changes due to the distribution and variability of cloud cover. For example, scenario analysis undertaken by Wild et al (2015) using the IPCC's Representative Concentration Pathway (RCP) 8.4[4] indicated that statistically significant decreases in solar PV outputs would be observed in large parts of the world, alongside notable increases in large parts of Europe, the southeast US and southeast China. Climate change is not expected to significantly impact on the global potential for wind energy production; however, changes in the regional distribution of wind energy resources may occur. Experts also do not expect that climate change

[4] RCP 8.5 assumes high population growth, relatively slow income growth, modest rates of technological change and energy intensity improvements as well as the absence of effective climate change policies. RCP 8.5 has the highest long-term greenhouse gas emissions of all of the RCPs produced by the IPCC.

will significantly impact on the size or geographic distribution of geothermal or ocean energy resources (Scharlemann et al 2016). Conversely, climate change has the ironic effect of enabling further exploitation of fossil energy sources though the melting of Arctic ice sheets, allowing access to new oil frontiers for drilling and extraction. The consumption of these resources would further accelerate climate change. As Walsh (2012) notes, 'here's the real irony: the most immediate impact of climate change-related Arctic ice melting will likely be the opening of vast new drilling territory for a thirsty oil industry'.

Second, climate change is likely to add to energy demand through changes in heating and cooling requirements. Peak electricity demand could increase, resulting in increasing demands on energy infrastructure and potentially increased energy use for climate-sensitive processes (for example, pumping water for agricultural and municipal use or desalination). In their review of the literature Ciscar and Dowling (2014) argue that no conclusive predictions can be made about the expected net impact of climate change on the energy sector, though the general pattern seems to be that heating demand will decrease and cooling demand will rise.

Third, climate change increases the risks from 'natural' disasters to energy infrastructure (Field et al 2012; Van Aalst 2006). Both generation and delivery infrastructures can be impacted by sea-level rise and extreme weather events (IPCC 2014), affecting biofuel production, for example. A striking example of how a natural disaster could play out is the impact of the tsunami on the nuclear facility at Fukushima and the effect this disaster had on the fate of the nuclear industry both in Japan and in Germany. Beyond nuclear, offshore infrastructures for oil, gas and wind are also susceptible to extreme weather events.

Production losses from thermal power plants are also anticipated, as well as efficiency losses from delivery infrastructures when temperatures exceed design criteria (IPCC 2014). Alongside these losses, changes in access to cooling water (IPCC 2014) will impact on some power generation facilities. Overall, then, the impacts of climate change on energy systems are expected to be diverse, impacting on both supply and demand, depending upon the mode and means of power generation and transmission, as well as their susceptibility to extreme weather events.

4. The impact of climate change as a political narrative

The potential threat and impact of climate change on energy systems and the broader global political economy do not reside solely in the material impacts of climate change on energy supply, demand and transportation. As part of the dialectical and historically determined relationship between energy and capitalism, some actors have deployed a narrative of climate change as catastrophic and irrevocable to both accelerate and resist energy system transition in multiple ways.

First, the current and projected effects of climate change can give rise to neo-Malthusian narratives of conflicts over diminishing resources in ‘climate war’ scenarios (Welzer 2012). Research positing these connections has been critiqued on multiple grounds, including: that the correlations it identifies are spurious, since they always rest upon coding and causal assumptions that range from arbitrary to untenable; that even if the correlations identified were significant and meaningful, they would still not constitute a sound basis for making predictions about the conflict impacts of climate change; and that such models reflect and reproduce a problematic ensemble of Northern stereotypes, ideologies and policy agendas (Bonds 2016; Selby 2014; Theisen 2017). Nevertheless, such narratives are potentially attractive to military actors as part of a securitizing discourse on climate change. Militaries have also been keen to secure new financial resources by developing new roles for themselves as the protectors of global supplies of water and land for energy production (CNA Corporation 2007; Duffield 2014; Hayes and Knox-Hayes 2014). Likewise, as Corry (2012, 235) notes, risks can be repositioned as threats and 'exceptional measures [can be] made permanent and introduced to deal with merely potential, hypothetical and less-than-existential dangers'. This is the danger that others have noted of framing climate change as a 'threat multi- plier'—this framing implies and validates a need for military responses to contain threats to security which bypasses public political discussion and potential contestation in favour of a 'high politics' of threat reduction and resolution.

Many scholars have also observed the growing securitization of energy whereby threats to the energy sector from other states are presented as national security threats. This presentation intensifies strategic and economic competition between states over energy supplies by tying energy to a national security 'us versus them' scenario (Kuzemko et al 2016; Natorski and Herranz- Surrall es 2008). This extends to corporations and the branding of competitive economic threats as issues of national security. For example, when the China National Offshore Oil Corporation (CNOOC) made a 2005 bid for US energy company UNOCAL, elite actors in the US responded by calling for presidential action to prevent the sale on the grounds of 'national security' (Nyman 2014).

Similar concerns have been articulated about the ways in which climate change serves to reconfigure geopolitical calculations in a rush for energy resources (Klare 2008). A reluctance on the part of powerful states to restructure energy systems and unsettle incumbent interests implies scenarios in which military interventions and commercial and coercive diplomacy are used to secure future supplies of energy overseas. This occurs through land grabs to secure bioenergy supplies[5] or wars over oil (Kaldor et al 2007). In addition to the overt impacts of land grabs and the 'accumulation by dispossession' that results (Harvey 2004), more indirect effects of the desire to avoid domestic action by sourcing 'solutions' in the Global South include the exacerbation of existing inequalities. For example, there are direct trade-offs between land used for fuel as opposed to food, and competition for land needed for biofuel production can increase food poverty (Smith 2010). Temporary climate 'solutions' such as these mean crises can be moved around through spatial and temporal fixes over time and across the globe (Harvey 1981).

Second, as well as representing a threat to the current fossil-fuel-powered global geopolitical configuration, significant efforts have been made to recast the threat posed by climate change as an opportunity. These include attempts to reconcile climate change with capitalism through ecological modernization narratives around green growth (Bailey et al 2011; Wanner 2015), as well as advocating a fundamental diversion of technology, finance and production towards low-carbon goals (Newell and Paterson 2010). Whereas 'niche' actors have long made this argument, incumbent actors, including the fossil fuel majors (the world's eight largest oil companies), are clearly also accepting the need for change. Still, the degree of change required to take advantage of this apparent opportunity is not at all clear. From the OECD to the World Bank, prominent global governance institutions have been at pains to show that continued economic growth—and the energy required to power this growth—is not only compatible with tackling climate change, but is actually a prerequisite to tackling the issue, given requirements of finance, technology and

[5] For a review of European corporate and financial entities involved in land-grabbing outside the EU see, for example, Borras Jr et al. (2016) and Bracco (2016). On land-grabbing and food security in Africa, see, for example, Mutopo et al (2011).

new forms of production (OECD 2011; World Bank 2012). This focus on the expansion of supply, rather than reduction in demand, upon changing patterns of production and consumption but not levels, even among governments that accept the ‘planetary boundaries’ framing (the European Union [EU], for example), goes to the heart of some of the contradictions facing states in a growth-oriented capitalist global political economy.

These arguments are reliant upon an absolute decoupling of economic growth from energy and material throughput that, while previously asserted (for example, Handrich et al 2015; UNEP 2015), are now widely considered impossible (Giljum et al 2014; Knight and Schor 2014; von Weizsäcker et al 2014; Mir and Storm 2016; Ward et al 2016; Schandl et al 2018). Moreover, in the case of oil companies, apart from investing some capital in renewable energies, this impossibility has resulted in attempts to control the pace of low- carbon developments by continuing to argue for a major role for fossil fuels and the use of ‘transition’ technologies and fuels such as fracked gas.

The need to address climate change has also been invoked to drive more disruptive Schumpetarian ‘waves of creative destruction’ as restless finance seeks to unsettle incumbent power (Perez 2002; Newell 2015). As discussed further below, a mix of financial and civil society actors are driving this move towards ‘divestment’ from fossil fuels and reallocation of capital towards low- carbon energy. Perez’s (2013, 10) work points to the key role of finance in sup- porting previous historical transitions—the ‘grand experiments’ she refers to ‘when unrestrained finance can override the power of the old production giants and fund the new entrepreneurs in testing the vast new potential’. Though current debates about transitions and transformations include technology centrally in visions of how to move towards a lower-carbon model of development, Perez shows that finance capital has previously been crucial to challenging and dislodging the power of incumbents. Examples include the technological revolutions produced in the industrial revolution, what she refers to as the 'age of steam and railways', and innovations around 'oil, automobile and mass production' in the Fordist era (Perez 2002). Indeed, as Arrighi (2010, xi–xii) notes, 'Throughout the capitalist era financial expansions have signaled the transition from one regime of accumulation on a world scale to another. They are integral aspects of the recurrent destruction of "old" regimes and the simultaneous creation of new ones.'

In addition to climate change's mobilization to disrupt existing regimes, it also magnifies, consolidates and extends particular types of global energy politics as invocations of it lend further weight to neoliberal policy reforms. It is drawn upon by donors and multilateral development banks (MDBs) as a rationale for market-led private transitions—opening up markets to 'clean energy' investment when state utilities are presented as lacking the finance and experience to undertake them efficiently and effectively. The case of Kenya is indicative in this regard. The need for private sector investment and technology to achieve low-carbon development goals validates power sector reforms and the unbundling of 'inefficient' state service providers as part of 'neoliberal energy transitions' (Newell and Phillips 2016). Likewise, the World Bank and OECD have called for an 'energy' trade round and a reduction of subsidies for fossil fuels under the banner of addressing climate change (Newell 2009).

Techno-fixes and 'end of pipe' solutions also feature highly in contemporary policy debates about the implications of climate change for energy systems. Examples include carbon capture and storage, a technology used to justify continued and expanded use of coal, even if its assumed adoption and roll-out are not justified by its development and availability to date. Many of the ambitions of the 2015 United Nations Framework Convention on Climate Change Paris agreement about net-zero emissions also imply the widespread use of NETs (negative emission technologies), the most commonly proposed form of which is BECCS (biomass energy with carbon capture and storage). BECCS is utilized in more than 80 per cent of IPCC pathway projections and involves the mass plantation of trees to absorb carbon dioxide from the atmosphere. Even in spite of the technological issues involved, for these to work at the scale necessary to combat climate change they would need to include plantations up to three times the size of India, consuming one-third of the planet's arable land (Anderson 2015; Anderson and Peters 2016). This could potentially drive further land grabs.

Similarly extreme are the forms of geoengineering being proposed and built into projections to reduce the need for structural change (Parliamentary Office of Science and Technology 2009). In some instances, the imperative of tackling climate change is invoked to re-legitimize a role for controversial technologies. Examples include the nuclear renaissance in Asia (led by China, India and Korea)[6] and the branding of fracked gas as a 'transition fuel' between coal or oil and renewables. In this sense, climate change is invoked as catastrophic master discourse for 'post-political reasons' (Swyngedouw 2010) to bypass conflict and opposition to controversial planning decisions and technology such as fracking, nuclear and geo-engineering. The urgency of addressing climate change is also mobilized to sideline more radical and disruptive calls for reform

[6] The International Atomic Energy Agency (IAEA) predicts that nuclear power will continue to expand globally in the coming years, even as the pace of economic growth slows amid competition from low fossil fuel prices and renewable energy sources. According to IAEA projections, the world's nuclear power generating capacity could expand to 390.2–598.2 GW(e) by 2030 (IAEA 2016).

of existing systems of energy production and consumption. The democratization of energy systems (Fairchild and Weinrub 2017), reductions in energy demand through conservation and the need for transitions to address issues of social justice (Swilling and Annecke 2012) have been contested on the grounds that the urgency of climate change necessitates working within existing structures and institutions.

The relationship between climate change and energy is also intertwined with dependencies on other natural resources, including water, forests and land. All of these resources are, in turn, affected by climate change (through shifting rainfall, changes to soil quality and productivity etc) throughout water and carbon cycles. Thus, to take climate change ‘out of ecology’ is not feasible. This is captured in the idea of the ‘nexus’ of energy–water–food and how interventions in one domain impact on all others (Wichelns 2017). We noted above how hydropower futures are increasingly compromised by shifting rain- fall patterns, while biofuels are presented as a solution to climate change, despite the energy and water inputs they require (Scharlemann et al 2016). This indicates how boundaries are drawn around certain technologies and energy pathways in order to position them as ‘low carbon’.

Third, the need to mitigate climate change potentially changes the political, economic and environmental viability of resource trajectories, magnifying and intensifying existing struggles over energy futures. This could shift the balance of power among actors in the energy domain in ways that represent potential embryonic shifts away from fossil-fuelled capitalism. For example, in many countries the need to de-carbonize the energy system has rebalanced the conflict over state support to energy sectors between fossil fuel incumbents and niches promoting renewable energy. Perhaps most prominent is Germany's transition to a low-carbon economy (Energiewende), but across the world this dynamic plays out to varying degrees in debates about feed-in tariffs and the balance of subsidies committed to fossil fuels compared with renewable energy (Lockwood 2015).

We can also observe this potential to bring about shifts in power in relation to the phenomenon of fossil fuel reserve assets being 'stranded' (McGlade and Ekins 2015). This generates pressures from activist shareholders upon firms to disclose and divest these assets. Even recalcitrant actors such as Exxon are forced to demonstrate to shareholders why their assets are not stranded amid shifting perceptions among some investors about the long-term future of fossil fuels (Newell 2008). Tracker (2013) suggests that as much as 80 per cent of coal, oil and gas reserves are now unburnable if climate targets are to be met. A write-off of assets of this magnitude presents the possibility of global financial destabilization and unknown impacts on a carbon-fuelled global political economy. Alongside this threat, the falling costs of solar energy production also make renewables cost competitive with fossil fuels in many markets.

Since climate change is invoked as a campaign motif and meta-narrative regarding the unsustainability of the current global political economy (Klein 2014), climate change also gives rise to new mobilizations and new forms of resistance politics that shape, both directly and indirectly, the energy pathways of countries. These movements have and will put some projects and investments off- limits. The divestment movement, noted immediately above, has done this, as well as movements to leave fossil fuels in the ground. Concretely, this finds expression in resistance to infrastructural projects from indigenous and environ- mental movements, such as the extension of the Canada–US Keystone pipeline distributing oil from Canada to refineries in the US, as well as in Europe in mobilizations against gas in Italy and anti-fracking movements in the UK.

The extent to which states are able to resist the role of climate change as a driver of structural change in the energy sector depends upon many things, most obviously the degree of policy autonomy and developmental space they are able to exercise to determine their own energy policies (Wade 2003; Gallagher 2005). This space is a function of aid dependency, trade ties and relations with large investors. For example, a key driver of initiatives towards 'climate-compatible development' (Mitchell and Maxwell 2010) in the energy sector is bilateral and multilateral donor climate funds. This is actively reshaping energy pathways, even if the heightened interest and investment power of so-called rising powers provides continued channels of finance for fossil fuel trajectories with fewer, if any, conditions (Power et al 2016).

5. Conclusions

This article has explored how climate change affects in multidimensional ways the viability of particular energy systems and the circuits of production, exchange and consumption that they fuel. First, we established the centrality of the energy sector and particularly fossil fuel use to both the global political economy and the global climate system. Second, we reviewed evidence of the differential, direct impacts of climate change on energy systems via infrastructural disruption and the reduced viability of certain forms of energy. Third, we analysed the ways in which climate change is invoked as a political narrative to both accelerate and resist energy system transition.

The analysis has revealed the multitude of ways (geophysical, material, financial and symbolic) in which climate change impacts upon global energy politics—exacerbating and intensifying some challenges and forms of energy politics and creating new ones. It is not so much that climate change multiplies external threats to energy systems as that it forcefully reasserts the internal, ecological relationship of energy policy to broader natural and social systems. Decision-making on energy policy increasingly must take into account the need for development to be both low carbon and climate change resilient, in addition to pursuing traditional goals of tackling energy poverty and security. This realization does not diminish the ways in which the geophysical impacts of climate change may further undermine the energy security of some of the world's poorest groups, through impacts on energy infrastructure such as dams in areas of reduced rainfall and electricity grid outages. Nor is it to dis- regard the notion that climate change adds to the issues that states, corporations and civil society actors must address.

However, climate change does not act as an external, unidirectional (albeit multidimensional) 'threat multiplier' to energy systems and politics. Instead, it heightens trade-offs and contradictions around growth, the limits of technology and the current organization of the global economy internal to contemporary capitalism. Simultaneously, it is also invoked to advance and reify the preferred visions and strategies of elite managers of the global economy. The trade-offs over limits to resources, capital, labour and land which lie at the heart of our climate-changed energy politics are hardly new. The ways in which states and corporations use their power to overcome these, often at the expense of the poorest countries and social groups within them, provide a shorthand for trends in energy politics since at least the industrial revolution, if not before.

The questions of whether climate change is identified as a threat, by whom and to what, and the types of responses and interventions these narratives then justify, are ultimately a function of social and political processes as well as geophysical and material ones. Climate change must be understood as a product of, and in relation to, the political and economic institutions that simultaneously create and seek to contain this threat. Rather than passively accepting the 'natural' reorderings that climate change imposes, or the construction of the threats it inevitably implies for 'us' as a homogeneous mass of humanity, this article demonstrates that it has become both possible and necessary to approach energy politics in new ways. It is critical that issues of responsibility and justice within and between nations, international institutions and global corporate actors are front and centre in any discussion of the threats posed by climate change.

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