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Coal and Climate Change

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Abstract

This overview adopts a critical social science perspective to examine the state of play and potential futures for coal in the context of climate change. It introduces key trends in coal consumption, production and trade, before appraising the relevant literature. Finding surprisingly little literature directly focussed on coal and climate change compared with related fields, it appraises existing work and highlights key areas for future work. In addition to established bodies of work on the situated politics of coal and the political economy of coal, new work calling for demand side policies to be supplemented with supply side policies highlights the increasing importance of how normative contestations drive debates over coal, suggesting that future work needs to engage not only much more directly with climate change as an issue, but particularly with the place of coal in a just transition. Because of coal's mammoth contribution to climate change and the complex political economy which drives its production and consumption, it is likely that coal will remain at the centre of difficult questions about the relationship between climate action and development for some time.

Keywords

coal, climate change, future of global energy, climate justice, just transition

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Introduction

In 2015, at the same time as countries around the world were hammering out their positions in preparation for COP21 in Paris, global coal production declined by 2.8%. This was the largest fall since the International Energy Agency (IEA) began keeping records in 1971 and the second successive year of declining production since 13 years of constant growth had delivered the

highest ever coal production in 2013 (IEA, 2016a). It was immediately followed up with a 6.3% fall in production in 2016, confirming the trend away from coal. But despite these drops, coal still provides around 40% of the world's heat and power, a proportion largely unchanged in the 48 years of IEA records (IEA, 2018b). At COP21, the member states of the United Nations Framework Convention on Climate Change (UNFCCC) overwhelmingly endorsed the key recommendations contained in the Paris Climate Agreement, the headline target of which was to limit global warming well below 2ºC above pre-industrial levels.[1] Because coal is such a significant energy source and the most carbon intensive and dirtiest of the fossil fuels (Gohlke *et al.*, 2011), movement towards this <2ºC target will require significant reductions in coal production and consumption in absolute terms (Fankhauser and Jotzo, 2018; Spencer *et al.*, 2018). Remarkably in this context, the Paris Agreement contains no mentions of either coal or 'fossil fuels' (Healy and Barry, 2017). McGlade and Ekins (2015: 187) calculate that even with widespread deployment of Carbon Capture and Storage (CCS) technology, "over 80 per cent of current coal reserves should remain unused from 2010 to 2050 in order to meet the target" (compared with just a third of oil reserves and half of gas reserves) and Johnson *et al.* (2015: 100) argue that it would require "the complete phase-out of coal-based electricity generation without CCS by 2050". This means that shifts in the coal trade or in public opinion over coal have amplified significance, since the future of the global climate is inextricably linked with the future of coal.

This overview is guided by the overarching question 'What is the future of coal in the context of climate change?' Of course, to understand the future of coal requires understanding the history of coal. Barbara Freese's magisterial *Coal: A Human History* (2005) opens with the summer of 1306, when the English nobility descending on London for Parliament found the air so toxic as a result of the burning of coal that they sought to ban the practice. The world would have been a very different place had their attempts been successful, but they were not, and her investigations led her to the conclusion that "a deep, rich vein of coal runs through human history and underlies many of the hardest decisions our world now faces" (Freese, 2005: 9). These decisions—Freese observed—concerned the climate, and particularly how it was changing in the face of massive consumption of coal and other fossil fuels. Modernity itself is coal-powered. William Cavert's environmental history of early modern London focusses on how "burning coal became an essential aspect of London life, a vital component, so it seemed to contemporaries, of social stability, commercial progress, and state power" (Cavert, 2016: 16). John Urry (2014) argues it was the emergence of coal-fired power that sent the non-fossil fuelled Chinese and Indian economies into decline in from the 18th century. Coal, in other words, was deeply embedded in social, political and economic life long before industrialisation began to demand ever-increasing supplies of coal in ever-more concentrated channels of energy flow.

With industrialisation, though, the quantities of coal required were so large that transporting and burning it required large numbers of workers concentrated in particular places. This, combined with the significance of the product, gave these workers new political power which shaped the emergence of a new mass politics (Mitchell, 2009, 2013; see also Urry, 2014). So

[1] As of November 2017, all UNFCCC member states had signed the agreement, though the USA has given notification that it intends to withdraw.

coal emerges as a particular paradox, because it "both enables contemporary patterns of development and yet, by producing climate change, threatens that development" (Goodman *et al.*, 2016: 180). This means that positioning oneself against coal—particularly from the rich countries—"can easily be portrayed as to be pro-poverty or even racist, the obsession of the Western environmentalist happy to kick away the ladder to levels of economic prosperity that they themselves enjoy" (Tyfield, 2014: 69; see also Kartha *et al.*, 2018). It is no surprise that this 'equity' rationale has consistently underpinned both domestic climate politics in coal-dependent developing countries such as India (Dubash, 2013, 2017), and been explicitly deployed in international fora, such as by Prime Minister Narendra Modi in his remarks at the opening of COP21 in Paris in November 2015.[2]

To understand the future of coal requires an understanding of the trends in consumption, production and trade. The paper starts with these, drawing centrally on new analysis of IEA statistics, in the context of the broader literature. This reveals that Asia will determine the future of coal, and that despite the fact that China's actions outweigh any others, that India is emerging as a pivotal player. In particular, the dynamic between Indian demand and Australian supply could determine whether the Paris Agreement target of well below 2°C is achievable. The balance of the paper turns to the scholarly literature, drawing out key themes of work focussing specifically on coal and drawing connections with related literatures. The astute reader will notice that many (though by no means all) of the examples focus on either India or Australia. This is deliberate, since these countries will play a decisive role in the future of coal, and the relationship between them illuminates some of the key areas where research is required, including the role of coal in the global energy mix, the links between coal use and development, and the particularly pressing question of what implications the changing geographies of coal trade and the transition away from coal have for socio-environmental and climate justice.

Producing, consuming and trading coal in a climate-changed world

The IEA's annual *Coal Information* report remains the most authoritative source of information about the state of the global coal industry, combining both key statistics and important time-series data on coal and coal-derivative products (IEA, 2018b). For readers interested in the drivers of change in the coal market, including emerging trends and subnational shifts in production, consumption or trade, the IEA also publishes an annual *Market Report Series: Coal* (most recently, IEA, 2018a),[3] which contains much more detailed analysis of both recent trends and forecasts over a 5-year timeframe. As a balance to the coal industry-dominated projections from the IEA, the CoalSwarm 'Global Coal Plant Tracker' seeks to identify, map and describe every known coal plant larger than 30MW in capacity (Nace, 2018).[4]

Before we can examine the coal trade, though, it is important to understand the types and uses of coal. Coal and coal-products are used for a variety of purposes, but the two key uses of coal are (a) the generation of electricity and heat; and (b) as an input to the production of iron, mainly for steel production. In the first case, energy is extracted from the expanding gases (mostly steam) produced by burning the coal and transformed into electricity and heat. There are myriad

[2] https://www.mea.gov.in/Speeches-Statements.htm?dtl/26071/
[3] Between 2011 and 2016 this series was published as the *Medium Term Coal Market Report* series.
[4] https://endcoal.org/global-coal-plant-tracker/

different grades of coal used for this application, but broadly speaking they are broken down into two categories: 'black' or 'hard' coal (with a higher energy content of >5732kcal/kg) and 'brown' coal' (with a lower energy content of <5732kcal/kg). 'Lignite' is a form of brown coal with a particularly low energy content of <4777kcal/kg (IEA, 2018b). In the first case, coal is generally pulverised then burned. The heat generated turns water in tubes lining the boiler to steam, the pressure of which turns turbines. These turbines generate electricity by the magnetic coupling created by the rotation of these wire-coils.[5] In the second case, raw coal is first baked at high temperatures to remove impurities and create a fuel with a high carbon content known as 'coke', which is then burned in a blast furnace along with iron ore to produce iron. Because coal is frequently used to power the initial coke-making process, it therefore provides both the chemical agent (carbon monoxide) and the heat required to convert iron ore to iron.[6] Coke is also used as the primary fuel in the kilns used to produce cement. Like with coal for electricity and heat, different grades of coal are used, but because coal for coke production must be low in ash, sulphur and phosphorus, as well as strong enough to produce a coke that can hold the weight of the iron ore in the blast furnace, it is more uniform in quality than steam coal. This coal is referred to as 'coking' coal in IEA publications, and often referred to as 'metallurgical' coal elsewhere. When combined, 'steam coal', 'coking coal' and 'lignite' are often referred to as 'primary coal'.

Coal consumption

Understanding the purposes for which coal is used, the first consideration is where coal consumption takes place. The IEA tends to report coal consumption in energy-equivalent terms,[7] and in such terms China has been the world's largest consumer of coal for three decades, having surpassed the consumption of the USA in 1987. To put China's consumption in perspective, growth in Chinese consumption from 29.2% of global consumption in 2000 to 52.2% in 2013 almost singlehandedly drove global coal consumption to its highest ever levels in 2013, and China has accounted for ~50% of the world's coal consumption ever since. In 2016, China's consumption was still over five times that of India, the second largest consumer.[8] Coal consumption is also highly concentrated amongst a small group of countries. In 2016, the Top 10 coal consuming nations accounted for 86% of global consumption, and Figure 1 highlights them along with historical data that helps contextualise their consumption relative to important UNFCCC dates including the 1990 'baseline' against which emissions reductions are gauged.

[5] https://www.worldcoal.org/coal/uses-coal/coal-electricity
[6] https://www.worldcoal.org/coal/uses-coal/how-steel-produced
[7] The IEA expresses coal consumption statistics both in volumetric terms (Million tonnes or Mt) and in terms of an energy unit (Million tonnes of coal equivalent or Mtce) derived from calorific values supplied by the producing nations to facilitate comparisons between different energy sources because the energy content of coal varies according to its type and source. 1Tce = 7,000,000 kcal. Because higher quality coal produces more energy per kilogram, a higher Mtce:Mt ratio indicates a higher proportion of higher quality coal in the mix. Some typical conversion factors to kgce can be found at https://www.euronuclear.org/info/encyclopedia/coalequivalent.htm.
[8] India became the world's second largest coal consumer in energy terms in 2015, having overtaken the USA in volumetric terms a year earlier in 2014.

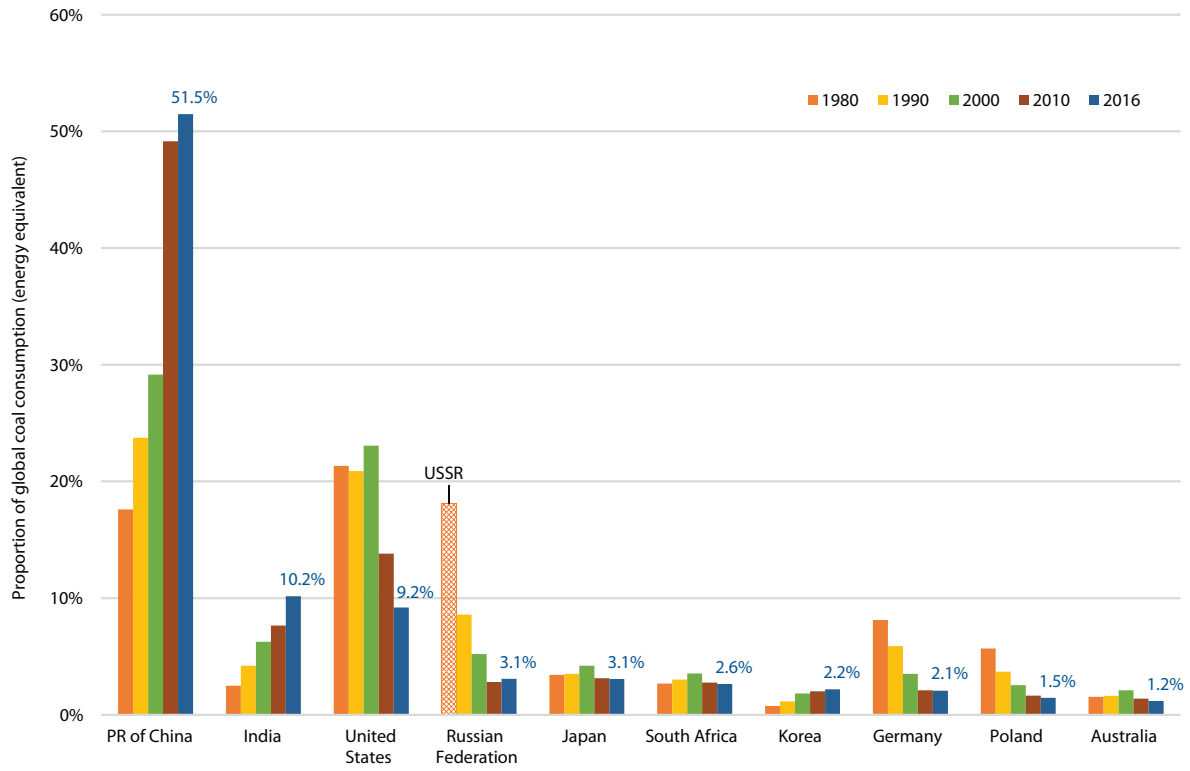

Figure 1: Historical consumption of the top 10 coal consuming countries in 2016. Based on IEA data from Coal Information © OECD/IEA 2018, www.iea.org/statistics. Licence: www.iea.org/t&c; as modified by G.A.S. Edwards.

If the overall proportion of the world's heat and power derived from coal has remained rather constant since the IEA started keeping records, over the same period the geography of coal consumption has been consistently shifting towards Asia, particularly non-OECD Asia. In part, this is merely a function of population and economic growth (Steckel *et al.*, 2015), exacerbated by globalization and the global division of labour which further shifts energy consumption into the developing world (Clark *et al.*, 2012). This shift has been led by China and India, which in 2016 together consumed over 60% of the world's primary coal.[9] Despite the historical significance of consumption in the USA, in reality its consumption has been in almost constant decline since the turn of the 21st century, and it is China and India that will determine the future of coal (Thurber and Morse, 2015; Tyfield, 2014). China and India also have the most significant 'infrastructural inertia'— already committed emissions—because the coal power plants in both countries are considerably 'younger' than those in the developed world, and thus have more of their useable life remaining (Davis *et al.*, 2010; Edenhofer *et al.*, 2018).

Despite China's overwhelming influence, the pivot has begun to swing towards India (Sahu *et al.*, 2017; Meng *et al.*, 2018). China recorded its third successive year of falling consumption in 2016 and has explicitly set targets to cap coal consumption by 2020 (Spencer *et al.*, 2018). By contrast, in 2016 India recorded its 18th successive year of successive growth in coal consumption, around 60% of which is used to generate electricity. The IEA forecasts Indian consumption to continue growing by 3.3%pa between 2017-2022, underpinning the global coal

[9] 62.2% in energy terms (Mtce) and 60.7% in volumetric terms (Mt)

market for the next 5 years at least, and for non-OECD Asia to be the key growth region over the next two decades as rising living standards, industrialization and economic development programmes drive growth in energy consumption (IEA, 2017: 84; see also Froggatt, 2013; Morse, 2012; Sahu *et al.*, 2017; Thurber, 2019). Some commentators consider the IEA projections to be overstated (e.g. Sartor, 2018), but the growing influence of India is not in dispute, nor is the fact that "the success of the Paris Agreement and international climate mitigation efforts may therefore depend on curtailing growth of coal-based energy and emissions in now-industrializing and urbanizing countries" (Meng *et al.*, 2018: 5).

Coal production

A similar pattern of coal concentration emerges in the production sphere. The three largest coal consumers—China, India, and the USA—are also the three largest coal producers, and the Top 10 coal producers account for 91% of the worlds production (Figure 2). As with consumption, it was the influence of China which drove global coal production to its peak in 2013 and global production has been declining since then, with the 460Mt decline recorded in 2016 the largest absolute fall (IEA, 2017). Some countries notably buck the general trend towards reduced production since 2013. India and Russia have registered increases in production every year, and Australia increased production every year except 2016 (Figure 2). Overall, the most recent figures show that coal production remains over 60% higher than it was in 2000 (IEA, 2018b).

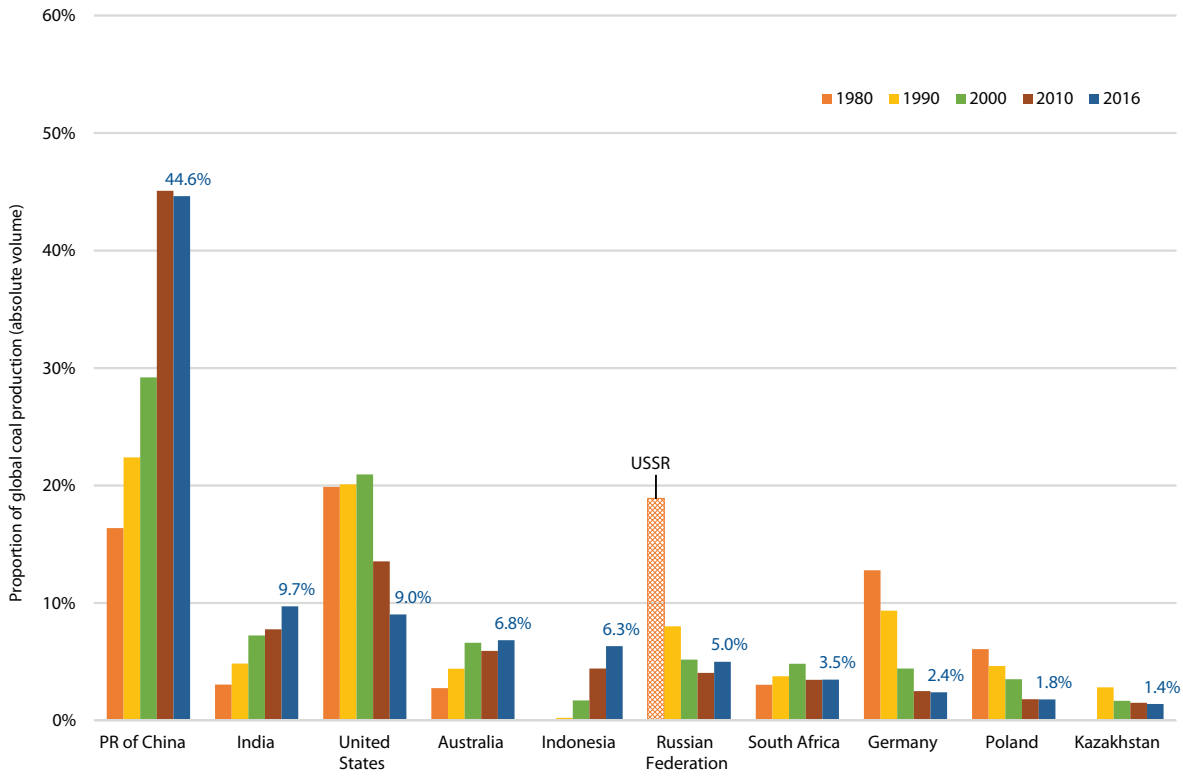

Figure 2: Historical production of the top 10 coal consuming countries in 2016. Based on IEA data from Coal Information © OECD/IEA 2018, www.iea.org/statistics. Licence: www.iea.org/t&c; as modified by G.A.S. Edwards.

The coal trade

The consumption and production data just presented show a pattern of 'coal countries': the top 10 coal producing countries produce 91% of the world's coal and also consume 81% in volumetric terms. Only Japan and Korea are in the top 10 coal consumers without being significant producers too. But in a climate change context there are two important trends to note. Firstly, the coal trade is dominated by demand for power and heat rather than steel production or industrial processes. Steam coal and lignite consistently accounting for more than three-quarters of the coal trade. Secondly, Australia and Indonesia dominate the international coal trade. Together they were the source of 57.4% of coal exports in 2016 (29.3% from Australia and 28.1% from Indonesia), and both export more than twice as much coal as Russia, consistently the third largest exporter (IEA, 2018b). In 2015 Australia also once again overtook Indonesia to become the world's largest coal exporter, regaining a position it had previously held from 1984 to 2010 (IEA, 2016a). Australia and Indonesia are also the most export-oriented coal producers in the world by a considerable margin, with 77.8% of Australian and 80.4% of Indonesian coal exported in 2016, and both are favourably located for export into the same Asian export market which is the destination for 70.8% of global imports (Figure 3) (Oei and Mendelevitch, 2019). Import forecasts are highly volatile. In 2016, the IEA's 5-year forecast was for Indian imports to grow at 3% per year (IEA, 2016b: 93); a year later the forecast had been revised to a decline of 3.6% per year (IEA, 2017: 104). But, as discussed above, this does not dampen the consensus that non-OECD Asia in general and India in particular are key to the future fortunes of coal.

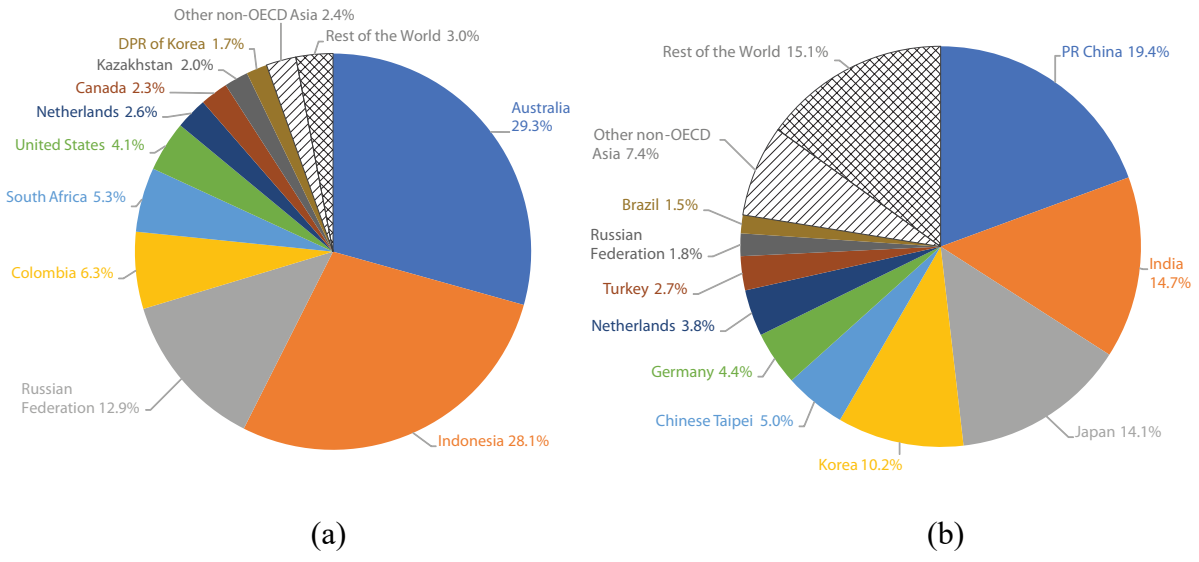

Figure 3: Major coal (a) exporters and (b) importers in 2016. Based on IEA data from Coal Information © OECD/IEA 2018, www.iea.org/statistics. Licence: www.iea.org/t&c; as modified by G.A.S. Edwards. Useful visualisations of the global coal trade both by weight and value based on UN Commodity Trade Statistics can be found at resourcetrade.earth (Chatham House, 2017)

Key trends in coal consumption, production and trade

In overall terms, the global story of coal as an energy source is one of stasis. Coal remains the most abundant, most widespread and most easily extracted fossil fuel around the world, and has been the source of ~40% of the world's heat and power for over 40 years (IEA, 2018b). Coal is also supported by a powerful and well-resourced political-economic complex (Bell and York, 2012; see also Huber, 2009; Tyfield, 2014; Urry, 2014). But just beneath the surface, it is clear that the international political economy of coal is undergoing significant change in the context of climate change. Many advanced industrial countries have shifted towards deliberate phase-outs of coal as an energy source and at the same time years of technological development and greatly enhanced investment in the renewable energy sector is beginning to deliver the reduced costs and increased reliability of supply which has so far helped ensure coal, gas or nuclear energy generation remained the go-to options for baseload power generation.

However, coal remains on the ascendency amidst a group of developing and extraction-oriented countries, particularly in the 'Pacific Basin' coal market focussed on Asia and Oceania (Thurber and Morse, 2015). China will dominate coal production and consumption in absolute terms for the foreseeable future, and as such its policies will be significant drivers of the fortunes of coal. But indications are that despite China's mammoth coal production and consumption figures, a gradual decline in coal is much more likely there than any growth (Spencer *et al.*, 2018). By contrast, coal consumption is rapidly growing in Asia generally and the Indian subcontinent particularly. India is emerging as a key driver of coal demand, and coal in India is not just a means to an end; it is also associated with the very *idea* of India as a modernising, industrialising country (Lahiri-Dutt, 2014). India's absolute demand for coal and its policies for sourcing it will be a major factor driving production decisions in Australia and Indonesia, the world's two biggest coal exporters (Rosewarne, 2016), with potentially catastrophic consequences for the global climate system (McGlade and Ekins, 2015; Meng *et al.*, 2018; IPCC, 2018).

A recent report argued that it was realistic to envisage a global transition away from coal by 2050 (Sartor, 2018). But this will require significant political will and rapid action, neither of which history gives reason to be confident about. Concluding a historical appraisal of coal in Australia, Duus argues that "Considering the largely aligned objectives of the state and mining interests, deep change is unlikely to be initiated by governments or industry at the current time" (Duus, 2013: 106), and the same can be said for India (Lahiri-Dutt, 2016). The discursive representation of coal in India today is strongly reminiscent of coal's central role in the emergence of industrial modernity, with its associated political and social structures (Freese, 2005; Tyfield, 2014), mirroring the experience in other 'coal countries' such as Poland (Kuchler and Bridge, 2018). In arguing that modern democracy was built on coal until the mid 20th century, and thereafter on oil, Mitchell (2013) captured something essential about the symbiotic relationship between fossil fuel exploitation and modern democratic capitalism. But perhaps he overstated the demise of coal, which some scholars have argued is currently experiencing a remarkable renaissance (Edenhofer *et al.*, 2018; Steckel *et al.*, 2015). The relationship between India and Australia is notable for capturing open questions surrounding the role of coal in the global energy mix, the links between coal use and development, and the under-researched question of what implications the changing geographies of coal trade and the transition away from coal have for socio-environmental and climate justice.

Appraising the literature

What then, should research on coal in the context of climate change focus on? In this section, I consider the existing literature and seek to sketch out some productive avenues for future research. To get a sense of the literature on coal and climate change, a series of searches were conducted in both Google Scholar and the Web of Science (WOS) Core Collection (Table 1), following Haddaway *et al.*'s (2015) methodology which supplemented existing techniques for systematic reviews with a Google Scholar title search to increase the grey literature coverage. The most narrow search—for sources with both "coal" and "climate change" in the title (Search 1 in Table 1)—yielded only 221 sources on Google Scholar and 28 sources on WOS. By contrast, "fossil fuel" (Search 5) generated 7030 and 1445 results respectively, and "climate change" (Search 6) generated ~242,000 and 41,067 results respectively.

Table 1: Results of a search on Google Scholar and Web of Science for key words in the title and [full text] of published literature, conducted 13 December 2018.

Search Term[10]	Google Scholar sources	Web of Science sources
1. coal AND "climate change"	221 [~581,000]	28 [2,341]
2. coal AND climate	602 [~1,930,000]	105 [4,411]
3. low AND carbon AND transition	1050 [~4,150,000]	343 [21,856]
4. climate AND justice	2350 [~2,210,000]	426 [3,117]
5. "fossil fuel"	7030 [~1,010,000]	1445 [15,831]
6. "climate change"	~242,000 [~2,440,000]	41,067 [224,456]

Though this is a rather crude measure, it was notable just how little literature there is which explicitly focusses on coal and climate change, particularly given the significance of coal in driving climate change historically and constraining climate change responses in the present. Most of the social science literature engages with coal only indirectly, inasmuch as coal is relevant to other economic, environmental and political questions such as resource extraction, energy policy or climate policy. Indeed, this journal has never previously published a paper with "coal" in its title or keywords, and has published only two articles where coal was mentioned in the abstract; the national reviews on Poland and Australia (Kundzewicz and Matczak, 2012; Head *et al.*, 2014).

Because the relevant literature is so diverse, parsing and organising it is challenging. I have therefore arranged this section to highlight five areas for research which I think should be prominent in considering the future of coal in the context of climate change. I start by considering existing work on (1) the locally situated politics of coal and (2) the political economy of coal. Taken together, these bodies of work establish why coal politics are so central to climate policy, and how coal fits into political and economic structures. I then turn to two literatures which envision very different futures for coal: (3) the emergent literature on supply-side climate policy, which is concerned with stimulating a rapid and transformative shift away from coal, and (4) more briefly the literature on Carbon Capture and Storage (CCS), which sees

[10] Google Scholar searches used the form [allintitle:*Search Term*] while WOS searches used the form [TI=(*Search Term*)].

a substantial future for coal. In both of these literatures—the areas where coal and climate change are most frequently articulated together—it becomes clear that normative questions are always either latent or patent on work on coal and climate change. So finally, (5) I turn to the place of coal in a 'just transition', what climate justice means for coal, and what coal means for climate justice. The future of coal is central to any proposal for a just transition and any attempt to achieve climate justice, because of the historical significance of coal in driving climate change, the shifting geographies of coal production and consumption, and the issue of carbon entanglement. But though justice crops up everywhere in debates about coal, the connections between the issues raised in the other bodies of literature require an explicit justice lens. I conclude with some areas for future research.

1. The locally situated politics of coal: from livelihoods and health to divestment

There is a fairly long-standing body of work from disciplines including sociology, anthropology, geography and social movement studies which focusses on largely local-scale contests over the extraction and use of coal. In Australia, for example, scholars have focussed on environmental conflicts over coal infrastructure, notably in the Hunter Valley of NSW (see Connor *et al.*, 2009; Higginbotham *et al.*, 2010), or on associated negative health impacts of coal mines or combustion (Morrice and Colagiuri, 2013). Climate change is not particularly prominent in this work, perhaps partly because conflicts emerged before climate change rose to prominence. In Australia, for instance, conflicts developed in the 1980s between coal mining and agriculture (Duus, 2013), and McManus and Connor (2013) noted that in this context, rural residents were much more likely to focus on the local environmental damage caused by coal mines than on larger tropes such as climate change or climate justice. This finding is corroborated in coal-using regions such as in Alberta, Canada, where 'health' was the primary mobilizing frame used to promote a phase-out of coal-fired electricity (Lysack, 2015) and in other cases where delicate constituencies needed to be constructed between interest groups who have historically been in conflict themselves, such as environmental groups, agricultural landholders, and indigenous groups (see Piggot, 2018 for one example). Methodologically, discourse analysis—frequently of media coverage—has proven a popular tool for this work, which often focusses on how coal is represented by its proponents and opponents, (McManus, 2000; Bacon and Nash, 2012; Ayling, 2017). Findings often point to political economic explanations for local conflicts or highlight normative discourses about justice and morality structuring the debate. For instance, Connor *et al.* (2009) understand contests over the Anvil Hill coal mine in NSW's Hunter Valley in terms of Bourdieu's concept of 'social fields', to "analyse the ways in which local conflicts over coal mine developments have become incorporated into the climate change agenda of transnational environmental organisations" (Connor *et al.*, 2009: 492). They find in their case that moral framings have favoured the opponents of mining—particularly as the science of climate change was increasingly accepted—leading the proponents to deploy tactics including the use of "industry-sponsored science to discredit opponents' views about climate change" (Connor *et al.*, 2009: 506). Some of the more explicitly climate-change focused work in this vein has analysing the effectiveness of climate advocacy amongst the third sector and social movements, using coal conflicts as the empirical foil for the analysis (e.g. Hall and Taplin, 2008; McAllister, 2009; Evans and Phelan, 2016). Sometimes, the studies adopt an overt normative position against coal. For instance, in

introducing their special issue of *Organization & Environment* (2012), Bell and York build on Daniel Faber's (2008) notion of a 'polluter-industrial complex' to observe that "the biggest corporate polluters have a stranglehold on democracy in the United States and abroad" (Bell and York, 2012: 364) and suggest that "Working with local environmental justice groups to create activist research projects for our students is one way to fight the Polluter-Industrial Complex" (Bell and York, 2012: 365).

Work on the fossil fuel divestment movement (FFDM) has more consistently framed contests over coal as normative conflicts, perhaps because as Seidman argues, "In most divestment campaigns, institutional divestment is not the ultimate goal; activists' broader aim is to spark a sense of moral urgency and support for strong intervention" (Seidman, 2015: 1029). Though its genesis lies in a campaign by North American students for their colleges to divest from coal stocks in 2011 (Ayling and Gunningham, 2017), the FFDM literature has tended to focus more on oil than coal. In one coal-focussed study, though, Ayling analyses media releases from the Australian Coal Association and Minerals Council of Australia and 350.org Australia between 2013 and 2016, arguing that they reveal a contest of legitimacy between the coal lobby and climate movement, in which "each party attempts to represent itself as deserving the grant of cognitive, moral, pragmatic, and legal legitimacy" (Ayling, 2017: 362). Indeed, Healy and Barry (2017) argue that FFDM is an issue which brings together work from diverse literatures on supply side climate policy, the just transition, and climate and energy justice. Taken together, this literature provides a rich basis for further studies which more explicitly frame coal conflicts in terms of climate change, either adopting a social movement focus.

2. The political economy of coal

Whereas work discussed in the previous section focusses on mainly specific cases and contests, contextualising it either theoretically or empirically with broader political economic structures, work on the political economy of coal has sought to understand how coal fits into political and economic structures in the context of globalisation. IEA reports aside, Thurber and Morse's (2015) edited collection *The Global Coal Market: Supplying the Major Fuel for Emerging Economies* remains the most comprehensive treatment of the global coal trade, and even it (understandably) limits itself primarily to the 'Pacific Basin' trade. Thurber's very recently published monograph *Coal* aims for a more expansive treatment (Thurber, 2019). There is a growing body of literature which seeks to situate coal production and consumption within broader political economic contexts. For instance, Burton *et al.* (2018) and Strambo *et al.* (2018) connect the politics of coal subsidies with the broader political context for coal extraction in South Africa and Colombia respectively, and Baer (2016) shows how longstanding and bipartisan political support for the Australian coal industry is. Finally, Lahiri-Dutt shows that in India, coal is both deeply linked to the nation's sense of itself and caught up in the capitalist state agenda (Lahiri-Dutt, 2014), but also underpins at least four different economies and myriad livelihoods, each of which "is governed by different sets of norms and values" (Lahiri-Dutt, 2016: 210).

But explicitly cross-national political economy analyses are less common, and every few explicitly situate their analysis in the context of climate change. In many ways, Stuart Rosewarne's contribution to a broader project investigating coal transitions in India, Australia

and Germany (Goodman *et al.*, 2016) is the most salient. Linking India's economic development agenda to Australia's extractivist one, he proposes that proposed coal export projects from Australia to India represent a fusion of regimes of accumulation, and starts to unpack the discourses supporting this political-economic pivot (Rosewarne, 2016). Two other examples of this kind of analysis are Cardoso and Turhan's (2018) study of the South-South coal trade between Colombia and Turkey and Healy *et al.*'s (2019) work examining the connection between coal extraction in Colombia and production in Pennsylvania. The former makes a strong argument that the 'energyscapes' created by the trade between Colombia and Turkey "are anchored in socio-ecological injustices associated with mining and coal consumption, as well as in the profound tensions between public health, economic gain, and political power in these two increasingly linked countries" (Cardoso and Turhan, 2018: 406). The latter highlights the "accountability deficit" that transboundary fossil fuel supply chains frequently exhibit, arguing that this necessitates a greater focus on 'embodied energy injustice' (Healy *et al.*, 2019: 231).

More of these kinds of analysis are urgently needed, as is work which links political economic connections over coal to climate change action or inaction. Here a natural initial focus would be on the countries which dominate the global coal trade: China, India, Australia, Indonesia, Russia, and to a smaller extent Colombia and South Africa. Connections could also be developed to the literature on the changing geographies of resource extraction in the context of economic liberalisation (e.g. Bridge, 2004), which has more recently analysed the emergence of 'resource nationalism' and 'neo-extractivism,' both of which see control over resources and the proceeds of export-oriented extractivism as intrinsic to economic development and—in the latter case—wealth redistribution (Rosales, 2013; Burchardt and Dietz, 2014; Childs, 2016; Childs and Hearn, 2016). To date little of this broader 'resource geographies' literature has focussed on coal, and Bridge observed that "there have been very few efforts by geographers to think about the logics of care and responsibility associated with fossil fuels" (Bridge, 2011: 828), despite the fact that climate change can be understood "as fundamentally a problem of carbon mobilization" (Bridge, 2011: 829–830).

3. Shifting the focus from demand to supply: motivating coal transitions

This geographical literature on resource politics shares with the climate policy literature a focus on the consumption of resources rather than their production. In the climate policy literature this manifests itself in a near universal focus on the question of how to curtail demand for fossil fuels (and a strong implicit bias towards the use of cap and trade mechanisms). However, in the absence of a worldwide, legally enforced, emissions trading regime, demand-side policies on their own actually incentivise behaviours which hamper transitions, which Sinn (2008) terms the 'green paradox'. The first is the non-participation in cap and trade mechanisms of fossil fuel producers and exporters, on the grounds that such actors are at an inherent disadvantage (Richter *et al.*, 2018; e.g. Siegmeier *et al.*, 2018). The second is increased production and over-extraction of fossil fuels even in relation to the pareto optimality principle, on the grounds that the effective life of their assets is being shortened, and therefore their profits stand to decline successively over time (Sinn, 2008). Sinn proposed "time-invariant unit taxes on carbon extraction and source taxes on capital income" as "feasible policy options" to flatten the carbon supply curve (Sinn, 2008: 388). In other words, he said climate policy should focus on the

supply side as well as the demand side. The paradox is particularly acute in the case of coal, because many of the environmental and social costs of coal are externalised, so its effective 'price' is in the order of one third its true cost (Epstein *et al.*, 2011). So it is unsurprising that the economist Bård Harstad's (2012) straightforward proposal that "purchasing fossil-fuel deposits, with the intention of preserving them, may be the best possible climate policy" (p. 79) came in a paper entitled 'Buy Coal!'.

Since Harstad's proposal, a small but growing body of literature has sought to develop the case for 'supply side' climate policies, based on the emerging consensus that any hope of limiting global warming to 'well below' 2°C—let alone more recent calls for 1.5°C (IPCC, 2018)—will require leaving significant known fossil fuel reserves unburned (Davis *et al.*, 2010; Collier and Venables, 2014; McGlade and Ekins, 2015; Johnson *et al.*, 2015; Spencer *et al.*, 2018). Perhaps because such a significant coal transition is required so fast (McGlade and Ekins, 2015; Johnson *et al.*, 2015), a significant proportion of this literature focusses explicitly on coal, including the vast majority of recent special issue on 'Fossil fuel supply and climate policy' in *Climatic Change*, where all but two of the eight papers either focussed exclusively on coal or drew heavily on examples related to coal, and the case was made for a range of supply side options, from export and production taxes to subsidy removal and moratoria on new coal developments (Lazarus and van Asselt, 2018; Mendelevitch, 2018; Richter *et al.*, 2018; Green and Denniss, 2018; Blondeel and Van de Graaf, 2018; Spencer *et al.*, 2018).

Importantly, though such proponents of supply-side climate policies think they offer several key advantages over 'demand side' policies such as carbon taxes and emissions pricing and trading schemes generally, they generally do not think economic pressure alone will be sufficient to generate the emissions reductions required for 2°C. Collier and Venables make this point explicit when they argued that economic pressure would need to be supplemented with *moral pressure*, since "The closure of the global coal industry requires a series of decisions by politicians and coal-mining companies which are not currently in their interest" (Collier and Venables, 2014: 494). They propose a sequenced approach to closing the coal industry as a way to generate the required economic and moral pressures, starting with the USA, Australia and Germany, followed by Russia and Poland, then China and South Africa, and finally Indonesia and India (Collier and Venables, 2014: 506). A complementary policy option—a coal export safeguard regime, in which exporters leverage their positions to regulate global usage of coal—has been proposed by Martin. However, like Collier and Venables' sequenced closure proposal such a policy would need a "broad coalition" of the major exporters, listed as "Indonesia, Australia, Russia, Colombia, South Africa, the United States, and Kazakhstan" (Martin, 2014: 598), and he concludes that the most that can be hoped for is that these exporters to begin to regulate exports based on the anticipated end-uses of that coal, and that even this "compromise position" would require "sustained national and international pressure to halt all coal exports" (Martin, 2014: 605). Without significant enough buy in from major coal producers, even the proponents observe that they fall foul of Sinn's 'green paradox' (Collier and Venables, 2014). For a very recent contribution which explicitly examines the justice implications of supply-side mechanisms, see Le Billion and Kristofferson (2019).

Given that a number of the key participants in any such 'coalition of the willing' have consistently ignored and even obstructed multilateral climate negotiations, these proposals

appear susceptible to criticisms that they are simply politically infeasible. One major barrier to action is what the OECD's Secretary-General in 2013 called the problem of 'carbon entanglement';[11] the deep ties between the state and fossil fuel industry due to the organised, capital and asset intensive nature of production (Piggot, 2018; Lahiri-Dutt, 2014; Baer, 2016; Thomson, 2017; Green and Denniss, 2018; Lazarus and van Asselt, 2018; Blondeel and Van de Graaf, 2018; Kuchler and Bridge, 2018). When it mobilises politically, the coal industry is a force to be reckoned with, (for an example drawn from Germany, see Leipprand and Flachsland, 2018; for one from Australia, see Muenstermann, 2012). However, despite questions about its feasibility, the proposal to use supply side mechanisms to rapidly transition away from coal is an important topic for further research, for at least two reasons. Firstly, because it raises important questions about coal finance and the economic, political and social networks which influence it. To date, there is very little academic literature that closely examines this question. But secondly, the invocation of the *normative* benefits of supply side policy options—something not comprehensively covered by the existing climate ethics literature (Kartha *et al.*, 2018)—is reminiscent of the prominence of normative discourses observed in the literature on the locally situated politics of coal, both in an analytical sense and as a normative commitment.

4. 'Clean' coal is a distraction, but studying it is revealing

Before moving on to discuss coal's place in a 'just transition' what climate justice means for coal, we should briefly pause to consider the question of CCS and 'clean coal' (Tyfield, 2014). A special issue in *Global Environmental Change* provides a good entry point into the debate about CCS (Bäckstrand *et al.*, 2011), which is frequently mooted by proponents of coal as a technological solution that provides 'pollution free' coal-fired energy to either avert the need for a transition or at the very least facilitate a more just transition (Knights and Hood, 2009; Morse, 2012), CCS has foundered in practice, with just one plant in operation (Markusson *et al.*, 2017). Moreover, technical modelling of the potential of CCS consistently concludes that its ability to significantly reduce radiative forcing is heavily dependent on it being rapidly implemented at scale (Davis *et al.*, 2010; Sathre and Masanet, 2012; Myhrvold and Caldeira, 2012; Haftendorn *et al.*, 2012; Sathre *et al.*, 2017), and even if this implementation at scale were achieved, CO_2 is just one of the pollutants produced by coal combustion which contribute to radiative forcing (Shindell and Faluvegi, 2010). This suggests that Markusson *et al.* (2012) were correct to argue that carbon pricing alone would never generate sufficient incentive for CCS. Indeed, recent research argues that solar photovoltaic (PV) installations would be preferable to carbon-neutral coal-fired electricity on a suite of criteria including energy generation, GHG emissions, and even land use (Groesbeck and Pearce, 2018). So far from a 'transition' technology, CCS can be seen as "a spatio-temporal fix. It would offer opportunities for investment, and so potentially be a response to not only the ongoing climate crisis, but also the financial one" (Markusson *et al.*, 2017: 4). Further research on CCS would be beneficial, particularly from a discursive perspective, such as recent work which has examined CCS technologies and discourses from an ethical perspective (Kuch, 2017). As Tyfield (2014: 68) argues, "Coal will be a, or even *the*, key energy resource as low-carbon transition slowly

[11] http://www.oecd.org/about/secretary-general/the-climate-challenge-achieving-zero-emissions.htm

unfolds. 'Clean coal' thus provides a particularly insightful window on the interdependent near-future emergence of energy and power regimes."

5. Coal's place in a 'just transition,' what climate justice means for coal, and what coal means for climate justice

Justice has emerged as a major theme and point of contention in work on coal in the context of climate change. Like in other literatures, justice emerges both as an object of analysis and something of a normative commitment on the part of scholars; a means to an end and an end in itself (Edwards, 2015). Lazarus and van Asselt (2018: 4) see "moral pressure" and "public support for climate action" as inextricably interlinked outcomes generated by implementation of supply-side policies; Pearse argued a decade ago that to most Australian voters "the quality and morality of Australia's emission cuts does matter a great deal" (Pearse, 2009: 58), and Green argued that bans on fossil fuel exploitation "send a clear signal that practices of large-scale fossil fuel exploitation are categorically wrong, and implicitly cast aspersions on the moral character of actors who engage in such practices" (Green, 2018b: 449). On the other side of the ledger, as social movements, civil society groups and scholars have increased moral pressure on the coal industry, it has increasingly started to formulate normative counter-arguments (Ayling, 2017; Jamieson, 2017; Green, 2018a; see e.g. Knights and Hood, 2009). Writing in the American context, Seidman recounts how the coal magnate Charles Koch framed the issue:

> Koch warned conservative audiences that if they want to shape national policy, they need to put forward their own moral claims to counter those being put forward by environmentalists. "History demonstrates that when the American people get motivated by an issue of justice that they believe is just, extraordinary things can be accomplished," Koch told conservative backers. (Seidman, 2015: 1033)

Scholars interested in coal in the context of climate change will therefore need to engage with the growing literature on the 'just transition', which blends insights from political economy, environmental justice, climate ethics and social movements studies. The literature has also notably broadened in recent years from one focussed on the implications of transitions for workers to one much more engaged with larger political economic and ethical questions concerning the links between climate change policy and sustainable development (Goodman, 2009; Newell and Mulvaney, 2013; Routledge *et al.*, 2018). But they will also need to engage much more directly and substantively with the literature on climate justice (a good entry point here is Heyward and Roser, 2016), because questions of *how much* coal can be used, *where* it can be used and *when* it can be used will always be posed in the context of broader debates about who has responsibility for climate change action, and what this responsibility means in practice.

It is well understood that the UNFCCC principle of 'common but differentiated responsibility and respective capabilities'—though admirable in intent—is in many senses a veneer of agreement hiding from view the intractable question of how to gain political will to limit climate change whilst also responding to pressing issues of poverty and underdevelopment (du Pont and Meinshausen, 2018; Dubash, 2017; Kartha *et al.*, 2018). But as one of the most significant sources of both historical and current greenhouse gas emissions, abstract questions about responsibility for climate action and climate rights are given very material substance when

viewed empirically with reference to coal (Bulkeley *et al.*, 2014). The solution in principle might be to more deeply embed the notion of *common* responsibility, as Chakrabarty (2014) advocates, but in practice this appears to be a somewhat utopian view of the possibilities of climate politics. For instance, Moss (2016) argues that accounting for Scope 3 (extra-territorial) emissions as well as its Scope 1 and 2 (intra-territorial) emissions from coal and gas would nearly triple Australia's per capita emissions, making it the world's top polluter on a per capita basis. This implies a very different level of responsibility than that based on notions of historical responsibility, though the situation is complicated by the fact that most of Australia's coal projects are majority foreign-owned (Pearse, 2009) – raising questions about the ultimate as well as proximate beneficiaries of continued coal exploitation there.

The academic literature has tended to agree with the IEA's prognosis that the future of coal will be decided in the developing world as the developed world continues to transition away from coal, a point reinforced by the emergence at COP23 of the *Powering Past Coal Alliance* (Cardoso and Turhan, 2018; Green, 2018a).[12] But it is reasonable to expect that justice will remain a powerful action frame for both proponents and opponents of coal going forward, wherever in the world they happen to be. Debates about coal in the context of climate change are therefore frequently (perhaps always) proxy debates about development, about justice, and about sustainability which are coloured by the interests of actors with overlapping and often contradictory interests. This both supports and raises questions about Kyllönnen's radical argument that Rawlsian fairness demands civil disobedience in the context of fossil fuel infrastructure, drawing on protests in the UK to argue for "climate stability as an indispensable global public good, whose provision over time requires not only global but intergenerational cooperation" and that "plans to build a new coal-fired power station in a developed country may justifiably be held as a clear violation of these fair terms [of atmospheric cooperation]" (Kyllönen, 2014: 605, 610). For Pearse, the choice was a stark one a decade ago: with such a high proportion of Australian coal exported, the moral and environmental necessity is that the industry must close: "The choice facing Australia is what type of sunset that will be: a long one that fuels catastrophic climate change, or a short one that fights it. It is undoubtedly one of the biggest decisions this country will face." (Pearse, 2009: 66). Pearse's conclusion points to the centrality of justice as both a motivator of action and an outcome of appropriate action: "Ultimately, however, the decision to withdraw from the coal trade is a moral one. It recognises that not everything that is profitable is desirable, and sees dealing with our greatest carbon liability as being in the long-term interests of the nation and the world" (Pearse, 2009: 68).

Conclusion: The future of coal?

Starting with the question 'What is the future of coal in the context of climate change?', this paper has focussed on the changing dynamics of coal exploitation in the context of climate change. It has surveyed the political economy and politics of coal extraction, use and trade in the context of consensus about climate change. There is a clear need for focussed research in this area, particularly given the role of coal in shaping the future of global energy and questions the ongoing utilization and extraction of coal, which is still expanding in some regions. It has

[12] https://www.gov.uk/government/publications/powering-past-coal-alliance-declaration

called for continued work on the locally situated politics of coal and the political economy of coal, suggesting that more explicit climate change framings would strengthen these bodies of work. The possibilities for the future of coal are radically divergent, as illustrated by work on supply-side climate policy and CCS; the former calls for a rapid and complete transition away from coal, the latter very little change in production or consumption. But underlying all of them is the clear sense that coal sits at the centre of questions not only about how to respond to climate change justly, but how to promote development which is both sustainable and just.

All the bodies of work reviewed, on the locally situated politics of coal, the political economy of coal, and the potentials and pitfalls of supply side interventions to reduce coal extraction and even the technological solutions proposed with CCS raise questions either implicitly or explicitly about justice. There is a critical need for normatively-engaged and reflexive work on coal in the context of climate change, because in the final analysis, the politics of coal is the politics of climate justice.

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