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Down the black hole: Sustaining national socio-technical imaginaries of coal in Poland

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ABSTRACT

This paper explores the socio-technical imaginaries surrounding infrastructures of coal mining and coal combustion in Poland. Contemporary policy makers in Poland mobilise a national imaginary inherited from communist times – encapsulated in the slogan ‘Poland stands on coal’ – that fuses infrastructures of coal extraction and combustion with the fate of the nation. This socio-technical imaginary provides support for coal futures, even in the face of contradictory evidence for domestic resource depletion, poor regional air quality, and global climate change. To examine this process, the paper brings research on socio-technical imaginaries into conversation with work on resource materialities. It highlights how certain materialities of coal (abundance, accessibility, energy density, location) were integral to the emergence of a national socio-technical imaginary of modernisation via coal; and how other materialities (declining resource quality, effects of emissions on respiratory health, coal as CO₂-in-waiting) now collide with the political strategies of a government determined to reassert ‘black gold’ as a bedrock of national development for years to come. The paper considers how contemporary political efforts to rehabilitate coal and secure its future in Poland draw selectively upon a socio-technical imaginary of coal-fuelled national modernisation.

1. Introduction

In a public speech celebrating the traditional “Barbórka” Miners’ Day in December 2016, Poland’s former Prime Minister, Beata Szydło, called for Polish coal “to be a synonym of development and modernity” arguing that “there will be no strong Polish economy without a strong mining industry” [1]. The Prime Minister was speaking in the town of Jaworzno in Silesia (southern Poland), a location loaded with social meaning as the cradle of Poland’s hard coal mining industry [2]. On the same day of Barbórka celebrations, the former Polish Minister of Defence, Antoni Macierewicz, also gave a speech at the country’s largest lignite mine in Bełchatów (central Poland). “Poland stands on coal” (*Polska węglem stoi*) he proclaimed, praising the hard work of Polish coal miners whose labours gave the country economic development and national security, adding “and this will not change” [3]. Not to be outdone, the Polish Minister of Energy, Krzysztof Tchórzewski, expanded on this theme of coal-as-continuity in his own Miners’ Day speech: he championed a vision of Poland as “the leader in modern coal-fired power generation” and “the first in Europe in terms of clean coal technologies” [1].

The vision expressed by the Polish political elite of the relationship

between past and future was striking in at least two ways. First, it fused nothing less than the fate of the nation with a continuation and modernisation of the country’s extensive (and ultimately banal) infrastructure for digging, transporting and burning coal which, in Poland, is commonly referred to as “black gold” (*Czarne złoto*). A combustible rock embodied both the nation’s past achievements and its future hopes for prosperity, security and a place in the world: by continuing to mobilise the country’s coal resources, Poland would secure its destiny. Second, the Barbórka speeches made scant reference to growing concerns that existing mines will shortly become exhausted, or to Poland’s status as a major emitter of greenhouse gases (Poland is Europe’s second highest emitter, after Germany, of CO₂ from fuel combustion in the energy sector). While many countries are moving away from coal in the power sector, Poland’s ambition to maintain coal as a dominant source of energy until at least 2050 [4] places it at odds with direction of European and global climate and energy policy. But unless new mines are opened, the country faces resource depletion, deteriorating coal mining infrastructure and rising costs, or the necessity of importing coal (from Russia, for example).

Historically Poland has had abundant resources of both hard coal and lignite, and their extraction and combustion have played an

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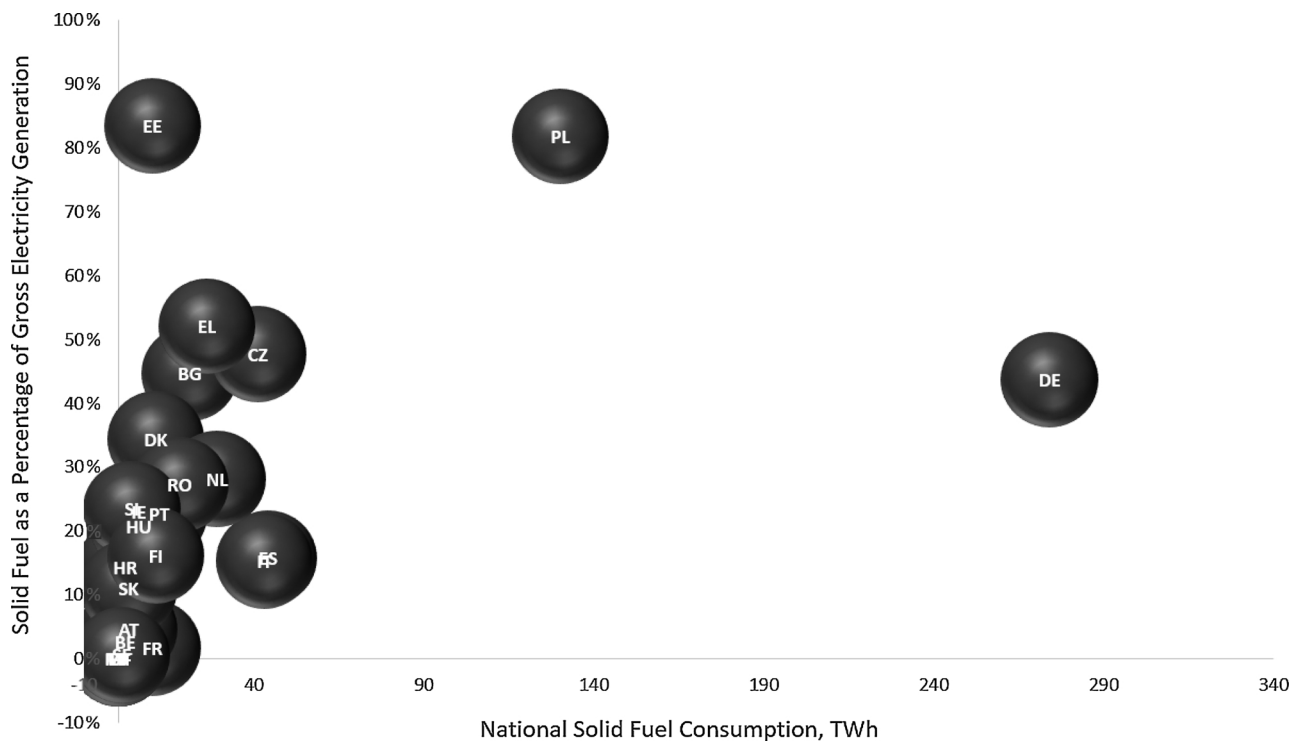


Fig. 1. Solid Fuel Consumption, EU 28 (2014).

Source: Drawn by authors from data in EU Energy in Figures – Statistical Pocketbook [5].

important role in building modern Poland. Today hard coal and lignite retain a dominant position in the country's power sector: over 80% of electricity is generated by burning coal (for Europe as a whole the figure is around 25%), and Poland burns more coal than any other European country apart from Germany (see Fig. 1). In this paper, we explore coal's material grip on the political imagination in Poland and its consequences for energy and climate policy. Our objective is to bring research on sociotechnical imaginaries into conversation with literature on resource materialities, with two goals in mind. First, we show in historical outline how the potency of a contemporary national sociotechnical imaginary of a country that "stands on coal" has been enabled and fuelled by specific materialities of black gold and its related infrastructure. Second, we examine how contemporary energy and development policies in Poland maintain this coal-based sociotechnical imaginary as part of the country's energy future, despite being on a collision course with the material constraints of resource depletion, and poor air quality and greenhouse gas emissions associated with coal combustion. Rather than attempting to gradually move away from coal in the future, policy-makers are seeking strategies to rebrand black gold as a "clean" and "modern" source of energy by improving, cleaning or concealing material properties of coal and its associated infrastructures. These strategies are problematic, we suggest, because the deeper the country travels down the black hole, the harder it will be for Poland to attain low-carbon energy transition in the future. The paper's wider provocation is that the significance of coal extends beyond its extraction and material use in electricity generation to include the shared understandings of national progress and promises of modernisation that coal infrastructures enable. The common national saying "Poland stands on coal", repeated by the former Minister of Defence in his Barbórka speech, reflects the particular way in which coal has become important to economic and political life in Poland during the 20th century. It also tightly fuses subterranean geology, national territory and the 'body politic' in ways that naturalise, and make seemingly inevitable, these historically specific relations.

2. Sociotechnical imaginaries and materialities of energy infrastructure

In this section, we briefly introduce two bodies of social science literature on the relationship between natural resources, infrastructures and social order that frame our concern with the role of coal in the socio-political imagination in Poland and its implications for energy and climate policy. The first of these draws from science and technology studies and revolves around the concept of sociotechnical imaginaries; the second emerges from work in anthropology and human geography and concerns resource materialities. Both are rich bodies of work and we make no claim here to be comprehensive in our review: instead, we identify key strands of thought within each of these literatures that are relevant to our examination of Poland's (coal-based) energy infrastructure, paying particular attention to the research space in which imaginaries and materialities come together. We then briefly consider a few pieces of work that have mobilised these (and related) ideas in relation to coal, before summarising the key points from this review for the analysis that follows in Sections 3 and 4.

2.1. Sociotechnical imaginaries

The term 'imaginary,' as used in contemporary social science, refers to shared conceptions of the world and the social meanings that attach to it [6]. It also points to the cultural and political work of these meanings, and how "the capacity to imagine futures is a crucial constitutive element in social and political life" [7: 122]. Jasanoff and Kim [7] coined the term 'national socio-technical imaginary' to refer to the "collectively imagined forms of social life and social order reflected in the design and fulfilment of nation-specific scientific and/or technological projects" [7: 121]. In their comparison of nuclear power in the United States and South Korea, they show how imaginaries about nuclear power "articulate feasible futures...and activ(ate) collective consciousness...(helping) create the political will or public resolve to attain them." (p. 123). As this quotation suggests, Jasanoff and Kim's research highlights the capacity of socio-technical systems for imagining

collective futures within particular national contexts. They show how “hopes and desires for the future...get bound up with the hard stuff of past achievements, whether the material infrastructures of roads, power plants, and the security state, or the normative infrastructures of constitutional principles, juridical practices, and public reason” (2015: 22). Their accounts reveal how the “power to imagine futures” [8: 33] is closely associated with the role of a nation state in stabilising energy visions, and governing the resources necessary to attain them. A growing number of scholars have employed the concept of socio-technical imaginaries to interrogate distinct national visions of future energy systems and energy transitions. Ballo [9], for example, examines collective techno-scientific visions for a Smart Grid in Norway and illustrates how this top-down imaginary frames the public as energy consumers. Levidow and Papaioannou [10], on the other hand, explore the role of UK governmental bodies and policy agendas in promoting a sustainable biomass-based energy future while rejecting alternative imaginaries.

Visions of future energy systems are, like utopias, “trapped within the imaginative potentials and resources available in the contemporary socioeconomic system” [11: 433]. As a consequence, the imaginary future is rarely a radical departure from the past: in casting itself forward onto the unknown terrain of the future, societies tend to populate that future with representations and materialities of the present and/or past [12,13]. Smith and Tidwell [14: 327] elaborate this point in their comparative study of contested sociotechnical imaginaries of the uranium-rich Western Slope in Colorado and the coal-rich Powder River Basin in Wyoming: they show how “material assemblages and sediments of the past place” impose constraints on the capacity to imagine futures. Energy infrastructures have a particular potency for constructing or reproducing socio-technical imaginaries. Power stations, like dams, mines and transmission grids for electricity and natural gas, are hybrid phenomena that combine human labour with territorially-embedded raw materials and readily feed narratives of national modernisation [15–18]. Those who labour on and in these energy landscapes – as scientists, technicians or manual workers – are engaged in building the future and, consequently, they and their work can acquire both symbolic and material power [19,20]. Indeed, the prevalence of sociotechnical imaginaries around natural resources and energy infrastructure projects means that “resource struggles are never only (or even primarily) about resources. Rather, conflicts over resources...become focal points for broader struggles involving the terms of citizenship, the nation, rights and identity” [21: 691]; see also [22].

2.2. Materialities

To reference ‘materialities’ within social science research is to draw attention to the difference that objects and other non-human phenomena play in social life and producing social order. The word signals a mode of explanation in which capacities traditionally reserved for human actors (agency, affect, enrolment) are distributed more widely and symmetrically across both human and non-human actors. Research on materiality draws on several different conceptual traditions; from work at the interface of political economy and ecological economics that stresses the temporality and variability of biophysical processes (e.g. [23–25]); to post-structural accounts such as assemblage theory [26] or vital materialism [27] which highlight the capacity of inanimate things to assert their presence and have effects in the world. More prosaically, although frequently in conversation with these broader conceptual concerns, research on energy infrastructures from a socio-technical perspective uses ‘materiality’ to reference the sundry, frequently mundane, devices (switches, pipes, display units etc.) of which energy systems are composed: the point of referencing materiality in this work is to highlight how such devices make possible, pre-empt or preclude various social practices.

Within this broad body of work, the disruptive capacity of materiality within social organisation is widely acknowledged, together with

its capacity to generate alternative or novel outcomes. Concepts such as ‘turbulence’ and ‘excess’, for example, speak to the ways non-human phenomena interrupt modes of social organisation and disrupt conventional social science analyses that assume objects and materials are passive participants in social life [28]. A number of researchers have extended this line of enquiry to think about the potential instability and ambiguity of materials and objects – that is, how their apparent properties and meaning are not necessarily fixed but, instead, are emergent and susceptible to change over space and time. Barry [29], example, shows how the scientific and legal practices of scrutiny associated with resource development drive a process of ‘informational enrichment’ around materials. Instability arises because objects and materials can become constituted in new ways, either via the application of new scientific or valuation techniques, or because the networks through which information circulates enrolls objects and materials in different knowledge constituencies. Recent work in anthropology on resource materialities develops further this relational and distributed perspective in which resources are “always in flux and open-ended” [30: 16]. The notion of ‘affordances’ in this work is particularly fruitful for thinking about materiality and imaginaries in combination, as it draws attention to the socio-political possibilities offered by different environments and materials. It opens up the possibility, for example, of “understanding what resources can be made to do, and how they are known, circulated, and engaged with” [30: 18–19].

2.3. Bringing imaginaries and materialities together in relation to coal

Imaginaries and materialities are “voyaging concepts” – to use Jasanoff’s [31: 321] useful phrase – because they seek to travel across the gaps and boundaries of conventional thought structures, such as those which divide nature from culture, or the mental from the material. Social scientists have found both of them useful for understanding the mixture of cultural, political and economic processes through which societies bring new worlds into being, although researchers have typically emphasised one or the other. Increasingly, however, work on national imaginaries has reached out to acknowledge the significance of materiality alongside the geographical imagination, as Bouzarovski and Bassin [32] do in their account of how oil and gas infrastructures are central to Putin’s effort to restore Russia as a ‘Great Power.’ Recent agenda pieces signal a move towards understanding how “imaginaries get built into the hard edifices of matter and praxis” [31: 323], and are “bound up with the hard stuff of past achievements, whether the material infrastructures of roads, power plants, and the security state, or the normative infrastructures of constitutional principles, juridical practices, and public reason” [33: 22]. We find useful, for example, the suggestion that to “gain assent...and become full-fledged imaginaries” ideas “must latch onto tangible things that circulate and generate economic and social value” [31: 326], with its implicit suggestion that some ‘things’ (materials, environments, landscapes) are more amenable to this process than others.

Coal’s political-economic and symbolic power have ensured an abundant literature on the social lives of this energy resource [34]. Given coal’s relative ubiquity as a fuel and substantial role in the energy systems of many countries, however, there are relatively few studies that try to read the potent social imaginaries associated with coal alongside the material conditions of coal extraction and consumption (see, however, Arifi and Späth [35]).¹ Perhaps the most thorough-going

¹ McDonald’s [107] analysis of South Africa’s coal-based energy system provides a rich account of the political economic relations under which it emerged (and continues to shape), although it does not explore coal’s role in sustaining the racialized imaginaries of modernisation associated with apartheid (compare, for example, with Edwards and Hecht [108] for nuclear). Peebles et al. [106] consider the promotion of an apocalyptic national imaginary by the US coal industry (i.e. an industry and way of life under threat) as a strategic response to environmental concerns, noting in passing its capacity to manage tensions between market logics and patriotism. Bell and York ([109], see also their special

treatment of the co-evolution of coal's materialities and imaginaries is Lahiri-Dutt's [36] work on coal in India, which considers the political, economic and cultural effects of coal on national life in a country where 'coal is regarded as equivalent to national wellbeing.' She shows how the modernisation of coal mining and coal-fired power have been constants across key historical transitions in India, from colonialism to independence in the middle of the 20th century and, more recently, from a state-led model of national development to economic liberalisation. Through coal, she argues, India "internalised many of the modernist values and ideas that colonialism introduced" such that coal became "elevated to the status of a national treasure" (p. 12/17). A similarly long-standing association between coal and progress also underpins Schneider et al. [37] analysis of the on-going rhetorical work of coal producers in the US to re-position their product in the context of urban and regional air pollution and global climate change. Deploying the tools of environmental communication research, Schneider et al. [37] highlight a range of rhetorical strategies that currently sustain coal: from the 'industrial apocalyptic' associated with the imagined consequences of abandoning coal; to the 'technological shell-game' associated with the socio-technical imaginary of 'clean coal.' Their analysis points to an evolving rhetoric of ecological modernisation around coal that is "not merely evasive: it also allows industry to justify accepting billions of dollars in government assistance in the form of research and development funding...to implement the kind of massive infrastructure improvements required to meet the techno-optimist rhetoric of 'clean coal'" [37: 99]. Others have commented on how various "fantasies of technology" that either do not yet exist or which are highly ambiguous – such as carbon capture and storage (CCS), geo-sequestration and "clean coal" itself – sustain a socio-technical imaginary of modernity via coal in ways that prolong coal usage [38–40]. Tyfield [41] takes this further argument further to suggest that "clean coal" is more than a legitimisation strategy by corporate capital: in his analysis it is, instead, an indispensable element of an emerging 'power regime' (in both energetic and political senses of the word) at the global scale, for which China's combination of coal-based electrification and state power are the exemplar.

In this paper we share Lahiri-Dutt's interest in the cultural and political work of coal as an instrument and medium of modernity; and we build on the small yet growing body of scholarship that offers a robust critique of coal's ecological modernisation. We are drawn to this work because of the way it considers the social imaginaries and materialities of coal side-by-side and, in our analysis of the evolution of the coal sector in Poland we extend this work in three ways. First, we pay close attention to the material affordances of coal and how these provide particular socio-technical opportunities for imagining modernity. Second, we consider how the material properties of coal that sustain this socio-technical imaginary are, in fact, neither fixed nor passive; and, drawing on an expanded notion of materiality outlined above, we explore the cultural and political consequences of this instability. Third, we reflect on contemporary efforts – in Poland and beyond – to shore up a coal-based socio-technical imaginary that re-materialises coal as 'clean' and sustainable. We show how these seek to re-position coal within a renewed programme of environmental modernisation that "build(s) on the world as it is, but... also project(s) futures as they ought to be" [31: 323]. It is to the evolution of these 'dreamscapes of modernity' [33] that we now turn.

3. 'Dreamscapes of modernity'²: forward through coal

In this section we provide a brief overview of how Poland's

(footnote continued)

issue on coal and the environment: [110]) provide a sociological take on evolving strategies of social power in the US coal industry, focussing on its cultivation of cultural and economic identities. A full review is beyond the scope of this paper.

² This phrase is borrowed from the title of Jasanoff and Kim's recent book [33].

sociotechnical imaginary of coal has evolved over time, focusing on the Communist period (1945–1989), and the period of post-Communism and EU accession (1990–today). As we describe below, the potency of a contemporary sociotechnical imaginary in which 'Poland stands on coal' derives its strength from the particular way in which coal became embedded politically and economically under Communist rule, post-WW2. The imaginary forged in this period took shape around several important materialities of coal: its tangible solidity and abundance, the latent capacity of its energy content to do the work of rapid economic transformation, and its amenability to technological interventions that scaled up infrastructures of production and consumption. An emergent imaginary of modernisation-through-coal also built around the 'vertical' emplacement of coal relative to human life on the surface, which enabled its association with a fundamental (i.e. underpinning) force shaping social development; and with the 'horizontal' emplacement of reserves inside the newly consolidated boundaries of post-war Poland. As we go on to show in Section 4, this imaginary has endured, despite the collapse of communism but now confronts a set of different materialities of coal which threaten its dominance.

3.1. Accelerating modernity through coal: post-war reconstruction and the communist period

The territory of modern-day Poland has a long history of coal mining. Primitive techniques for extracting hard coal are recorded for the Lower Silesian Basin in the second half of the 15th century. In the 18th century, resource exploitation slowly developed in the Upper Silesian Basin which subsequently became the centre of Poland's hard coal production [2]. The interwar period (1918–1939) saw hard coal production become increasingly centred on the Upper Silesia. Until 1939, coal extraction averaged 33 million tonnes per year (Fig. 2) and hard coal established itself as the main source of energy in the country, accounting for 80% share in the mix [42]. Heavy industry was the main domestic consumer but, because large parts of Poland's interwar territory were underdeveloped in regard to coal demand (e.g. infrastructures of electrification and transportation), up to 40% of production was exported, mainly to Germany and Austria [43].

The end of WW2 was significant for Poland's coal infrastructures for two reasons. First, the country's western and south-western borders were modified and the so-called recovered territories, that became part of sovereign Poland, included almost the entirety of coal-rich Upper and Lower Silesia. The newly independent country had now sovereign access to abundant reserves of hard coal and lignite within its reshaped territory. Second, Poland found itself under Soviet domination and, in 1946, the Communist government was established. The Polish economy was re-organised around socialist principles, with nationalisation and central planning applied to all industrial sectors and financial activities.

Poland's coal mining industry was one of the least destroyed sectors during the war and quickly resumed production. The material abundance and energy potency of coal became a major force in the country's post-war reconstruction efforts and economic development, fuelling political visions for an accelerated industrialisation of the entire country (Fig. 3). Centralized national development programmes focused on rapid electrification and the construction of large-scale heavy-industry complexes during the 1950s and 1960s drove formidable increases in coal demand, so that Communist elites referred to coal extraction in terms of war propaganda: slogans such as "fight for coal", "the great battle for coal", or "attack on coal" [48–51] were invoked to encourage miners to harder (patriotic) work and to attract a new workforce to the extraction sites (Fig. 4). Indeed, largely thanks to enthusiasm and dedication of many newcomer mining crews, hard coal production surged from 47 million tonnes in 1946 to 74 million tonnes in 1949 [46: 41]. This substantial rise in output was made possible, in part, by introducing competition among miners to exceed production levels, with many individual workers achieving between two and seven-times the official production targets [46: 85].

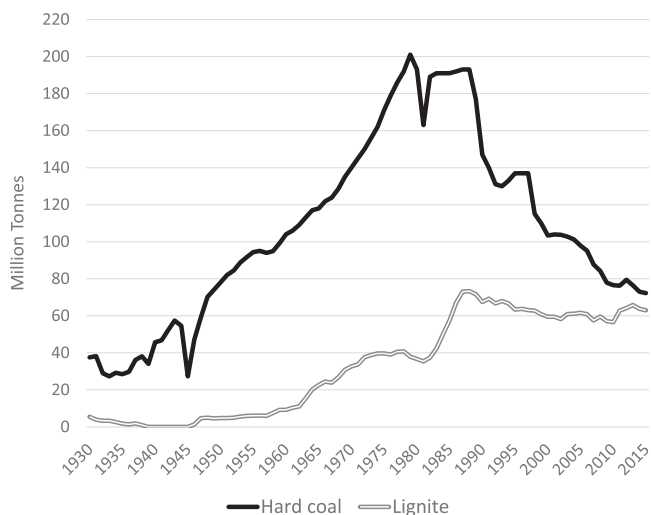


Fig. 2. Hard coal and lignite production in Poland, 1930–2015. Source: Drawn by authors from data in [44–47].



Fig. 4. “Forward! To Fight for the Six-Year Plan!” – A propaganda poster from 1950 by Włodzimierz Zakrzewski. The 6-year plan between 1950 and 1955 was a period of intensified industrialization that would not have been possible without coal as a key power source.

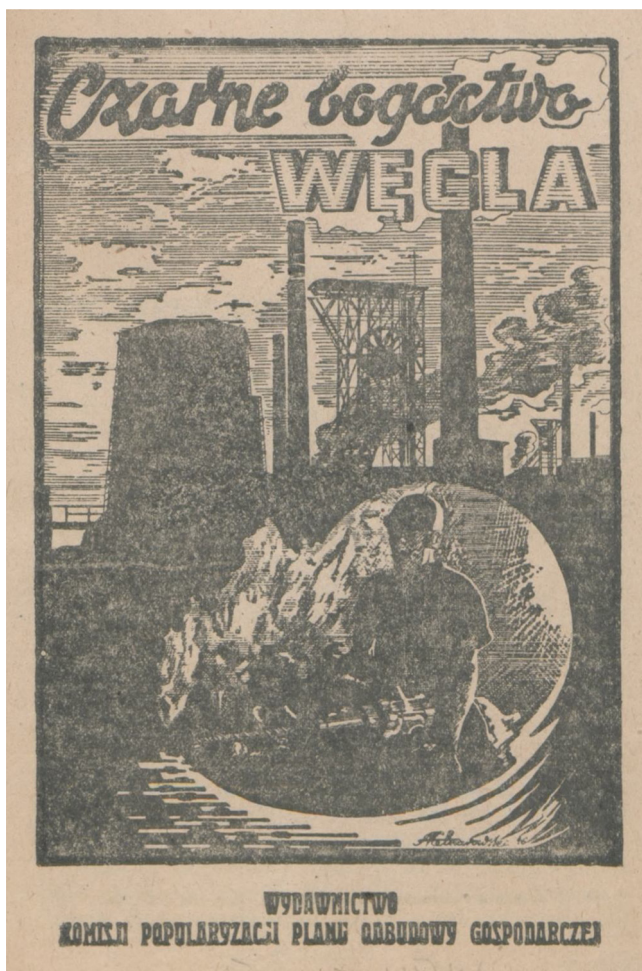


Fig. 3. *The Black Wealth of Coal* – cover of a pamphlet published in 1946 by the Commission for Popularizing the Economic Recovery Plan, 1947–1949.

To support large-scale extraction activities, distinctive spatial conditions were created. These included extensive coal infrastructures, e.g. mines, railroads, maintenance yards, power stations, and ash dumps [46]. The abundant and relatively accessible character of coal resources in Poland made it possible to apply economies of scale and significantly

expand the size of individual mines [52]. Consequently, hard coal production exceeded the symbolically significant threshold of 100 million tonnes for the first time in the country’s history in 1960 and, two decades later, it topped 200 million tonnes (Fig. 2). The large-scale extraction of lignite deposits began in the 1950s, and ramped up significantly from the 1960s onwards.³ Large-scale lignite power plants – constructed near mines in 1950s and 1960s – created significant domestic demand and triggered further increases in output. The largest Polish lignite-powered plant, and its dedicated opencast lignite mine nearby, started operating in Bełchatów (central Poland) in the 1980s.

Electricity output fuelled by hard coal and lignite grew ten-fold between 1950 and 1970, from 5.3 TWh to 54.2 TWh [53: 189]. The tight coupling of coal production to electricity generation in this period (Fig. 5) created a ‘coal complex’ that locked in demand for coal and made it synonymous with the expansion of modern energy services. At the same time, exports of hard coal became an increasingly significant source of national income. Around a third of hard coal production was exported in 1950, mainly to energy-thirsty economies of the communist bloc, and by the 1970s Poland was one of the world’s main exporters of hard coal [46,54]. The country’s mining sector delivered not only an

³ Although there is an earlier history of lignite use in Lower Silesia, individual mine output and cumulative contribution to demand were limited. The largest lignite mine in Polish territory in the 19th century, the “Joanna” mine in Turoszów basin, had a maximum capacity of 22,000 t and, in general, growing rail infrastructure allowed the wider distribution of hard coal at the expense of local lignite sources [43].

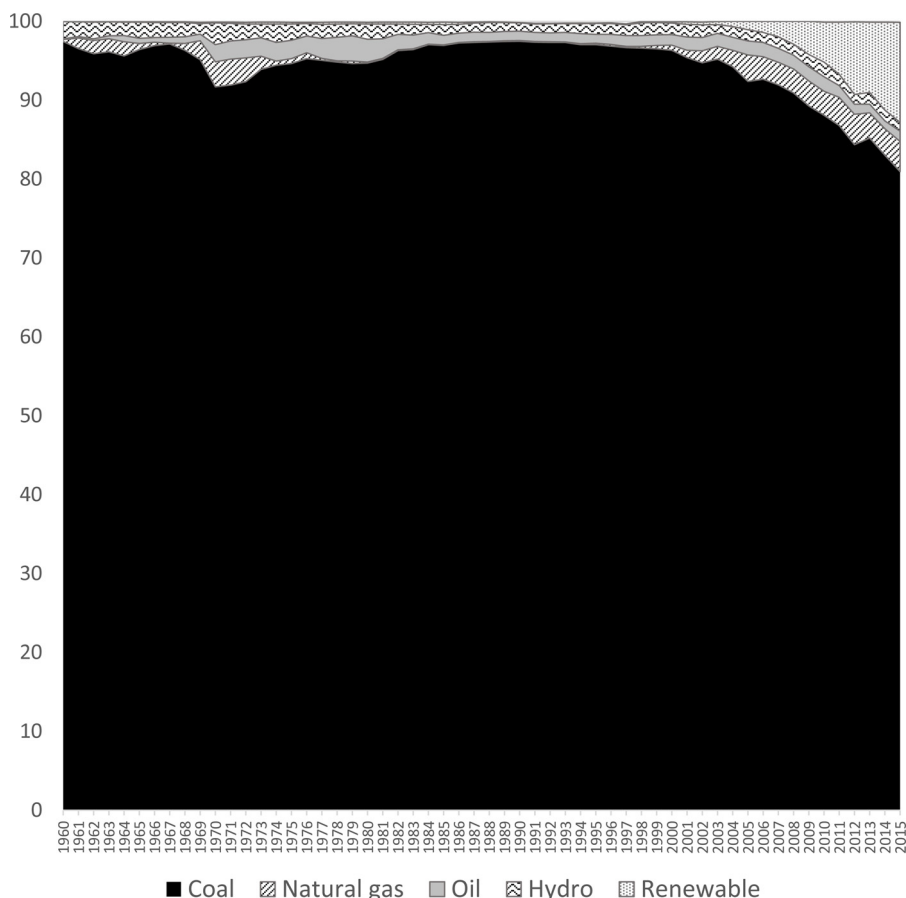


Fig. 5. Electricity production in Poland by fuel, 1960–2015 (% of total).
Source: Drawn by authors from the World Bank data series (data.worldbank.org).

essential energy resource and input to national industrial development: it also provided the state with a significant source of income for key investments in other industrial sectors and infrastructure.

For Poland's Communist elite, "black gold" played a crucial component in the vision of the country's rapid transformation and modernization. Various persuasive slogans – such as "Long Live the Mining State" (Fig. 6) [55–57] and "Poland Stands on Coal" [58,59] – were disseminated in public speeches by Communist leaders from the 1950s onwards to promote coal and affirm coal mining's national significance.⁴ Coal was framed not only as a source of national pride but also of survival. In his speech during the 1973 Barbórka celebrations, the First Secretary of the Polish United Workers' Party (1970–1980) Edward Gierek said: "Let us remember the role played by hard coal, our "black gold", in the reconstruction of the national economy after the war and the large-scale industrialization of the country (...) The raw material base, that Poland possesses, provides a good basis for uninterrupted, dynamic development of the economy and a strong and permanent position in the international system. Our homeland is equipped with rich – counted in tens of billions – coal resources, in the extraction of which we currently occupy the fourth place in the world (...) Coalmining (...) is and will remain our leading national industry." [60]. In another Barbórka speech a year later, Gierek – who grew up in a coal mining family and in his early life worked as a miner himself – reflected: "Coal is like bread – we [the nation] could live thanks to it

⁴ These included e.g. Władysław Gomułka, 1st Secretary of the Polish United Workers' Party (1956–1970); Edward Gierek, 1st Secretary of the Polish United Workers' Party (1970–1980); Piotr Jaroszewicz, Deputy Prime Minister (1952–1970) and Prime Minister of Poland (1970–1980); Jan Mitreğa, Minister of Mining and Energy (1959–1975) and Deputy Prime Minister of Poland (1970–1975).

(...)" [61].

With its material properties underpinning stability and abundance, coal played a critical role in reconstructing Poland at the end of the WW2. With sovereignty freshly regained following the occupation by Germany, a modified territory that incorporated significant Silesian coal reserves, and a transformed socioeconomic system, "black gold" enabled Poland to (re)build its economy, industry and infrastructure. As importantly, coal mining and coal-fired electrical power generation were tangible evidence of a country able to sustain its sovereignty through secure supplies of energy fuel. It was in this period that "imagination, objects, and social norms...(first) bec(a)me fused in practice" [31: 322]. The mines, power stations, export terminals, worker housing complexes and output competitions that developed in this period were not only material expressions of a national 'coal monoculture' in which output soared and coal came to account for over 90% of all electricity production (Fig. 5). They were also the material affordances around which a distinctive social imaginary could take root, against a backdrop of the WW2 and a divided Europe that tied coal to dreams of national modernisation, self-sufficiency and independence.

3.2. Acceleration interrupted: Polish coal after the collapse of communism

The collapse of the Soviet bloc in the early 1990s brought economic crisis and deteriorating conditions in Poland. The transition to capitalism exposed many serious structural problems in the mining sector. Especially hard coal production turned out to be highly inefficient, unprofitable and uncompetitive on international markets [62,63]. Since 1990, Poland's hard coal mining sector has gone through several stages of profound and complex restructuring, a process which continues until today [64,65]. Consequently, employment in hard coal production



Fig. 6. “Long Live the Mining State” – a propaganda poster from 1952 by Lucjan Jagodziński, portraying two generations of Polish miners dressed in traditional miner’s habits.

decreased between 1990 and 2014 from more than 400,000 to roughly 100,000 workers [65]. Output of hard coal shrank by more than 60% between 1988 and 2015 (Fig. 2), and the number of operating mines more than halved (from 70 to 30) [65]. The implementation of such dramatic changes by Polish decision makers has created social tensions and met with strong resistance from miner unions [66], while only partially achieving reform objectives [64]. Extraction of hard coal in the Lower Silesia Basin had been completely abandoned by 2000 so that the hard coal mining industry became concentrated in Upper Silesia (with only one mine in the Lublin Basin). Lignite production was less effected by comparison, and the country’s five mines continued to operate.

Nevertheless, since the 1990s Polish energy policy-makers have continuously emphasised the essential role of black gold in the country’s long-term energy mix and the necessity to sustain its dominance in electricity production [67,68], while acknowledging Poland’s coal monoculture is highly problematic. Plans to diversify the country’s energy mix in electricity generation – by boosting the role of natural gas, introducing renewables, and developing nuclear power in electricity generation – have never materialized. Both natural gas (70% of which must be imported, mostly from Russia), and renewables continue to play a marginal role in the power sector, and no nuclear power plant has been constructed. With access to potentially rich resource deposits within the country’s territory, successive Polish governments have rejected the possibility of substantially reducing national coal use, even in over the long-term [69–71]. As of 2015, the share of hard coal in Poland’s primary energy consumption was 39.5% and that of lignite 11.6% [72]. In 2015, Polish electricity output totalled 161 772 GWh, of which hard coal power plants produced nearly 81 883 GWh (51%) and lignite-based power stations delivered 53 564 GWh (33%) [73]. Together, hard coal and lignite dominate (84%) electricity production in the country (Fig. 5).

4. Coal interrupted? Managing coal’s material ambiguities

In this section, we bring together our conceptual interest in imaginaries and materialities to examine how the vision of coal as an agent

of modernisation and development is working in practice. We highlight the way in which this vision now confronts some of coal’s materialities, and how these now frustrate the political strategies of a national government determined to reassert ‘black gold’ as a bedrock of Poland’s sociotechnical imaginary. We show how a critical contradiction that policy makers have to navigate is to separate coal from the particular historical conditions of communism in which a national imaginary of Polish ‘black gold’ first took hold.

The most current official energy strategy document (*Energy Policy of Poland until 2030*, adopted by the Council of Ministers in 2009) identifies coal as “a major factor stabilising Poland’s energy security” for decades to come [69: 8]. Recent policy proposals extend coal’s role even further: for example, the proposed *Energy Policy of Poland until 2050*, prepared by the former ruling Civic Platform Party prior to the 2015 elections, would have extended coal’s dominant role until 2050 [70]. The Law and Justice Party, which came to power in 2015, has made even more assertive commitments to coal: under their plans, coal would still be providing up to 50% of electricity in the country as far out as 2050 which, given projected increases in electricity consumption in this period (e.g. the national Electromobility Development Plan, see Section 4.3 below), will maintain rather than reduce current quantities of coal in the energy mix. This vision of a Polish national economy rooted in coal is also reflected in the country’s most recent development strategy (*Strategy for Responsible Development*) adopted by the Council of Ministers in 2017 [71]. In early 2016 the Polish Minister of Energy, Krzysztof Tchórzewski, argued that it would not be possible to eliminate coal from Poland’s energy mix in the 2050 perspective due to the country’s fast economic growth and increasing energy consumption until 2030, and its share would remain unchanged in the next ten years [4]. These strategic documents and policy statements recycle the well-worn idea of coal as a source of national continuity: an abundant and dependable resource, part of the territorial body of the nation that can be mobilised to propel Poland into the future. However, several different materialities of coal have increasingly intruded on this established vision, in ways that problematize coal’s association with modern development. The challenge here comes from several different quarters, of which domestic resource depletion/decreasing resource quality

output, and the ‘dirty’ nature of coal combustion (greenhouse gas (GHG) emissions, regional air pollution and impacts on water supply) are the two most significant. Together these suggest the materialities of coal are more ambiguous than those informing an imaginary of the nation moving from the past to the future by ‘standing on coal.’

4.1. Mind the gap: resource depletion and decreasing resource quality

Poland’s coal output has been steadily declining (Fig. 2), from around 160 million tonnes in 1997 to around 130 million tonnes today. Production of lignite, which has traditionally been much lower than hard coal output (Fig. 2), has either expanded or remained steady during this time so that today the country produces broadly similar amounts of both coal types. In 2015 Polish mines produced 72 million tonnes of hard coal, and 63 million tonnes of lignite [44]. A series of energy experts have projected that total coal output will decrease further, and several current mines will have to be closed, unless new reserves of lignite and hard coal are opened up for commercial production [74–76]. A 2011 report published by Poland’s Supreme Audit Office indicated proved reserves of hard coal at operating mines could provide security of supply only until around 2035 [77]. However, resource quality at these mines is declining: miners must dig to increasingly deep levels which raises costs, increases work place risks, and exposes the limits and obsolescence of current plant and equipment. Additionally, a high coalbed methane concentration, associated with the growing depth of extraction, limits access to areas of good quality coal as it becomes too dangerous to extract [76]. A similar overall situation is found in lignite: current proved reserves at operating mines are estimated to last until around 2030–2035, with some mines likely to close before this [75].

At the same time as promoting coal in the national energy mix, the Polish government continues to pursue a strategy of closing the most unprofitable hard coal mines in an effort to reduce financial losses. Another six mines are set to be phased out by 2018, with production consolidated at remaining pits.⁵ The government’s most recent rescue project is the establishment of a new state-controlled mining company, Polish Mining Group (*Polska Grupa Górnicza*), in an effort to save the financially-struggling Coal Company (*Kompania Węglowa*) which owns around 20 of Poland’s hard coal mines and is currently the largest coal mining company in Europe [78]. This government-directed bail-out plan involves state-controlled utility companies taking equity stakes in the new mining company, further binding power generation to coal production organisationally. Moreover, the national government is determined to open new domestic coal mines to sustain supply levels in the period to 2050 and avoid coal imports. Plans for new mine development were written into the 2009 Energy Strategy and, in 2016, the Energy Minister announced tender offers would be invited for two new extraction sites in 2019 and 2022 [79]. The construction of new mines faces serious obstacles, however, related to high urban density (particularly in Upper Silesia), environmental concerns around air and water quality, and significant local opposition to new open-cast lignite mines. Without new extraction sites, Poland faces a substantial coal gap by 2030: without new mines, the share of coal from currently operating mines is expected to fall below 30% in the energy mix, with the balance made up from imports [74].

4.2. Greenhouse gas emissions and air pollution

A second material property of coal that increasingly troubles the idea of it as a solid and dependable national foundation concerns the emissions from its combustion. Widely recognised as the dirtiest fossil fuel, coal burning for heat and power is a significant contribution to

⁵ These closures are in accordance with the EU Council Decision 787 (2010) which phases out sector-specific state aid to the coal sector in Europe.

global warming, primarily through emissions of CO₂. In Poland, low resource quality (e.g. high sulphur content) and old energy infrastructure create additional atmospheric impacts, via toxic low-stack emissions and serious air pollution [74]. As a Kyoto Protocol signatory and an EU-member country, Poland is obliged to reduce its GHG emissions and increase renewable energy sources in the energy mix. Poland secured 1988 (rather than 1990) as a base year for measuring reductions under the UN Framework Convention on Climate Change (UNFCCC), enabling the bulk of emission reductions to have been achieved during the 1988–1992 economic crisis and subsequent transition period. National greenhouse gas emissions reached their lowest level in 2002 but have not subsequently fallen further [80]. Poland’s political elite have overtly harnessed the UNFCCC platform to promote their commitment to, and future vision of, (clean) coal. As host for the 19th session of the Conference of the Parties (COP19) in Warsaw in 2013, for example, Polish policy-makers organised a parallel event with support of the World Coal Association – the “International Coal and Climate Summit” – that focused predominantly on opportunities for innovation in clean coal technologies (CCT). Poland is also set to host the 24th session of global climate negotiations (COP24) in 2018, which will take place in the symbolically-significant city of Katowice, Poland’s ‘coal capital’, where CCT will be promoted as part of the regional development vision for Upper Silesia [81].

Although Poland’s Kyoto commitments are readily met, it is the set of more stringent EU policies and proposals that cause Polish policy-makers a serious headache. Four, in particular, now challenge the country’s current coal utilisation practices. First, EU 2030 climate targets proposed by the European Commission under the umbrella of “Transforming Europe’s Energy System” would require industrial and power sectors in the EU to collectively reduce emissions by 43% compared to the base year of 2005, with an annual rate of 2.2% [82]. Second, the Commission has proposed new rules on “Clean Energy for all Europeans”, according to which power generating units that emit more than 550 kg/MWh of CO₂ would no longer be able to access state aid [83]. The implication is that almost 28 Gigawatts of Poland’s existing electricity generation, unable to meet this emissions threshold, would lose access to subsidies [84]. Third, the recently adopted Best Available Technology (BAT) conclusions – the reference case for setting permit conditions at large industrial installations under the Industrial Emissions Directive (IED) – require a more stringent threshold for NO_x emissions from hard coal and lignite combustion (from 190 to 175 mg/Nm³) at existing power plants [85]. Fourth, recent reforms have cut out Poland’s coal power plants from the Modernization Fund under the EU Emissions Trading System (ETS) [86]. The country’s aging power infrastructure struggles to meet these (and other) environmental requirements consequent to EU membership. The average hard-coal power plant is roughly 40 years old, with some power station units commissioned in the 1960s [87: 9]. Large clusters of old and inefficient electricity generating facilities must be replaced or upgraded. Seventeen power plant units (2.4 GW of output) in Poland are currently operating with limited hours under the IED, and are set to close by 2023 [88]; and more than 30 units with a total capacity of almost 22 GW will be retired by 2050. Large scale investment is required in the power sector to replace old infrastructure with more efficient generating sources.

4.3. Rehabilitating coal: ‘black gold’ once more

The emergence of these alternative and more ambiguous materialities – coal as faltering and finite, as carbon dioxide-in-waiting, or as a cause of respiratory disease and increased morbidity – undermines the stability coal has acquired within the Polish national imaginary, creating doubt about its future role. In light of these challenges, there is currently a sustained political effort – headed by national government (as the Barbórka speeches attest) although drawing on a wide range of other actors – to reassert a national imaginary in which Poland

continues to ‘stand on coal’ into the future. As Jasanoff and Kim argue [7: 141], “we need to invoke not only the material and organizational resources that states deploy but also the imaginative resources with which they relate such policies to the public good.” In Poland, the state’s cultural and political “power to imagine futures” [8] draws on the same, familiar materialities of coal around which the imaginaries of the Communist period took hold: its solidity and abundance, capacity for economic transformation and sustaining development, and secure location within the body of the nation. Hence, the old and inefficient mining assemblage – even if Soviet-induced – cannot be rejected and disassembled: it is a core tradition through which Poland’s present has been secured, and that may yet be reassembled and transformed into something new and potent that can continue to sustain the nation.

Political efforts to uphold Poland’s ‘black gold’ as a foundation of the nation’s energy sovereignty and sustained economic growth involve rehabilitating coal by re-imagining it as a modern, innovative and clean source of energy. Coal is once more destined, as Poland’s former Prime Minister asserted in December 2016, to become “a synonym of development and modernity” [1]. Furthermore, ‘modern’ coal mining and coal infrastructures are repositioned as a trigger for national science and innovation, and the ambition to occupy an international technological niche around ‘clean coal technologies’ (CCT) that maintains coal as a flywheel for the country’s economic development. This approach – coal continuity via transformation – was signalled by the former Prime Minister in 2015, when she asserted that “without a doubt, there is no future for the Polish economy without Polish coal. There is also no future for Polish coal without modern and clean technologies” [89]. However, many of the CCTs on which dreams of the country’s coal-based future are borne along are costly to implement and/or as yet unavailable at commercial scale. These include: ultra-supercritical power plant units, direct carbon fuel cells, CCS, coal gasification, and integrated gasification combined cycle technology. The ambition is to create an innovation hub that concentrates expertise in coal mining and utilisation technologies, populated by a cluster of research institutions and companies who collectively will transform, modernise and ‘purify’ the place of coal in the national imaginary. The government has recently created several new R&D entities which seek to materialise this vision, including the Forum for Innovative Coal, Institute for Chemical Processing of Coal, and Clean Coal Technology Centre. Government has popularised the vision of transforming coal from the top, and a network of industry experts linked to state-controlled entities and pro-coal think-tanks have also played an important role [90,91]. As of 2017, the government’s active support for the development of CCTs is included in two strategic documents issued by the Ministry of Energy: the Programme for the Mining Sector in Poland [92]⁶ and Innovations for the Energy Sector [93]. As Jasanoff and Kim [7: 123] point out, “of the multiple contending sociotechnical imaginations at play in any society, some tend to be more durable at the national level because powerful instruments of meaning-making and goal-selecting often lie within the control of nation states”.

Clean coal projects in Poland are in an embryonic, early planning phase and far from becoming a national-scale reality. Nonetheless, a national imaginary based on clean coal is already doing important political-economic ‘work.’ For example, in 2017 a Polish energy company (TAURON) and chemical manufacturer (Grupa Azoty) signed a letter of intent to construct the country’s first commercial coal gasification unit, noting how the project “perfectly fits” with a national development trajectory based on harnessing “indigenous coal... to expand...into new business areas” [94]. Furthermore, coal is set to become the driving fuel behind the government’s ambitious

Electromobility Development Plan, adopted in 2017 [95]. The plan assumes one million electric vehicles will be driving on Polish roads by 2025. Aimed at reducing urban air pollution from the vehicle fleet, Polish policy-makers nonetheless admit that the Plan will have the added benefits of boosting demand for coal in electrical power generation and reducing imports of crude oil [96]. Here the rehabilitation of coal via the promise of technological innovation (i.e. CCT) has enabled its alignment with, and embedding within, other national projects of ecological modernisation. Through such means, the coal monoculture at the heart of national policy in Poland is set to dominate the country’s energy mix and power generation well beyond 2025.

Poland’s consistent efforts to defend the coal imaginary and rehabilitate or rebrand “black gold” as “clean” and “modern” are occurring in the context of EU climate and energy policy, and so have broader, supranational implications. In negotiations leading up to an EU-wide climate and energy package (establishing the 2020 targets) – and subsequently to the adoption of this legislation in 2008 – Polish policy-makers have sought to accommodate EU climate and energy policies to the country’s coal-based power industry [97]. Not only has Poland won national concessions as the main opponent of the EU’s ambitious climate leadership goals, but its defence of coal has also shaped EU-wide rules and procedures in line with Poland’s national preferences [98,99,97]. For example, the inclusion of CCS technology in the EU’s energy and climate package “was meant to provide an attractive solution for the coal industry, and consequently for Poland” [97: 503]. Similarly, the European Commission’s recently launched Platform for Coal Regions in Transition [100] is perceived by the Polish government as an opportunity to develop and apply CCT, and not only as a means for restructuring the post-coal economies of former mining regions [101]. In October 2017, Deputy Minister of Energy Michał Kurtyka remarked that the new initiative would provide “an opportunity to find a place for coal-based technologies in the power mix and economies of EU countries” [102]. In this way imaginaries of “clean coal,” propagated in Poland in the context of its energy history and the low-carbon objectives of EU energy and climate legislation, are set to be part of the EU’s energy mix for years to come.

5. Conclusions

In this paper we have considered the political mobilisation by Polish policy-makers of a powerful socio-technical imaginary that fuses the mining and burning of coal with national development. While the origins of this imaginary may be traced back to Polish independence, it was the communist period that forged the symbol of ‘black gold’ as a bedrock of the country’s place in the world. The rebuilding of Poland after WW2 drew heavily on the country’s rich deposits of coal and the mining industry became a source and emblem of technological progress, socioeconomic development and international prestige. During this time the slogan ‘Poland stands on coal’ derived its shared meaning and cultural power by mobilising several of coal’s distinctive material properties. Amongst these, coal’s solidity and indigenous abundance positioned it as a guarantor of Poland’s energy security, and the national sovereignty which had so often been abused in the past. However, the post-communist period of economic transition exposed serious structural problems in the coal mining sector. Output declined and inefficiencies, rising costs and enormous debts have meant the industry continues to undergo a complex restructuring process. Further closures and state-driven consolidation in the sector to reduce financial losses mean a domestic supply gap now looms, if coal is to maintain its dominant role in electricity generation. To plug this gap, national policy makers in two successive governments have bet on the efficacy of a national socio-technical imaginary that grounds the country’s future in the mobilisation of domestic coal resources: the government proposes Poland will ‘stand on coal’ until 2050 by expanding production via new mines, and by modernising coal production and use through technological innovation. These efforts to shore up an imaginary of

⁶ The Programme includes, among others, a pilot project “Clean coal, clean energy” with a goal to build a 500 MW power plant utilizing a combination of hard coal gasification technology from the Lublin Coal Basin and technologies for converting hydrogen into electricity and heat [92].

coal-fuelled national modernisation must contend, however, with the declining quality of domestic coal resources, and the environmental and health impacts of burning coal. The Barbórka speeches with which we opened show Polish policy-makers simultaneously appropriating and nourishing a national coal-based imaginary; and fuelling it with dreams of modernising traditional coal mining practices and infrastructures into innovative, internationally-competitive assemblages that will secure the country's sovereignty, development, and international prestige. The power to imagine Poland 'standing on "clean" coal' draws strength from a 'politics of potential' [103] and what Schneider et al. [37: 19] describe as clean coal's 'strategic ambiguity': the uncertain capacities of innovation to separate coal from its unwanted pasts (whether communism, environmental pollution, or inefficiency) and secure it against challenges to its future (such as pressure from EU environmental rules).

We have brought research on socio-technical imaginaries and materialities into conversation in the context of Poland's coal-based infrastructures for power generation. Our account suggests that the materialities of coal are not fixed essences stable over time and space; instead, they emerge from the way coal (and coal infrastructures, like mines and power stations) becomes embedded in different scientific and political networks (see also [36]). The ambiguous character of coal's materialities is evident in Poland: concerns about depletion and pollution reflect a re-imagining of coal's fixity in territorial space as imminent scarcity and vulnerability, rather than domestic abundance; and as a stewardship responsibility (and threat to legitimacy) rather than a resource to be harnessed, in the context of global efforts to mitigate anthropogenic climate change. Because coal's materialities are inherently ambiguous, what is important to understand is how they become stabilised in ways that do long-term cultural and political work: so that, for example, a lowly combustible rock is able to underwrite far-reaching socio-technical imaginaries, such as the idea of nationhood or national destiny. Contemporary Poland provides a window on these processes via the efforts of national policy makers to secure the dominant role of coal in the country's energy supply for years to come. Beyond the specific case of Poland, the paper highlights the value of examining how the current and future role of coal – and other fuels – in a national energy mix is shaped by widely held socio-technical imaginaries. It is through these imaginaries that desirable futures become bound to the material infrastructures of energy production and consumption (see also [104,105]). Our focus on coal in Poland, for example, suggests parallels with efforts in the United States under the Trump Administration to restore ('make great again') a particular form of nationally-defined, gendered and racialised social order that involves, in part, re-asserting the primacy of coal in electrical power generation. The promised future of 'clean coal' (which, as [37] point out, is a future with a century-long history) is part and parcel of this process, as it is in Poland. More broadly, the paper's approach to the co-evolution of socio-technical imaginaries and resource materialities can be applied to other nationally-embedded energy infrastructures, to understand both their (enduring) social power and opportunities for change (see also [14]). To return to Poland, there are enormous uncertainties associated with a renewed socio-technical imaginary of a nation 'standing on (clean) coal', not least among which are the continuing debt and restructuring of the Polish mining industry, significant social opposition to new mines, and the availability of large-scale, commercial 'clean coal' technologies. What is clear, however, is that Poland's future energy mix continues to be shaped by a national socio-technical imaginary that fuses the mobilisation of coal with the fate of the nation, and which now promises to modernise not only society but coal itself.

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References

- [1] ME, Minister Tchórzewski: potrafimy zamienić polskie czarne złoto w sukces, Ministry of Energy (Ministerstwo Energii), Warsaw, 2016 14 December 2016. Available at: <http://portal.mg.gov.pl/node/26739> . (Accessed 30 July 2017).
- [2] A. Rams (Ed.), *Najdawniejsze dzieje górnictwa węgla kamiennego w Polsce, Muzeum Miasta, Jaworzno, 2014.*
- [3] MON, Minister obrony narodowej na Barbórce, Ministry of National Defence (Ministerstwo Obrony Narodowej), Warsaw, 2016 Available at: <http://www.mon.gov.pl/aktualnosci/artykul/najnowsze/minister-obrony-narodowej-na-barborce-r2016-12-05/> . (Accessed 16 January 2018).
- [4] ME, Minister Tchórzewski o polityce energetycznej Polski w perspektywie 2050, Ministry of Energy (Ministerstwo Energii), Warsaw, 2016 27 January 2016. Available at: <http://www.me.gov.pl/node/25759> . (Accessed 22 January 2018).
- [5] EU, EU Energy in Figures: Statistical Pocketbook 2016, European Union, Brussels, 2016.
- [6] C. Castoriadis, *L'Institution imaginaire de la société*. Paris: Editions de Seuil/The Imaginary Institution of Society (trans. Kathleen Blamey), MIT Press, Cambridge, 1987.
- [7] S. Jasanoff, S.H. Kim, Containing the atom: sociotechnical imaginaries and nuclear power in the United States and South Korea, *Minerva* 47 (2) (2009) 119–146.
- [8] M. Kuchler, Post-conventional energy futures: rendering Europe's shale gas resources governable, *Energy Res. Soc. Sci.* 31 (2017) 32–40.
- [9] I.F. Ballo, Imagining energy futures: sociotechnical imaginaries of the future Smart Grid in Norway, *Energy Res. Soc. Sci.* 9 (2015) 9–20.
- [10] L. Levidow, T. Papaioannou, UK biofuel policy: envisaging sustainable biofuels: shaping institutions and futures, *Environ. Plan. A* 46 (2014) 280–298.
- [11] M. Kuchler, Sweet dreams (are made of cellulose): sociotechnical imaginaries of second-generation bioenergy in the global debate, *Ecol. Econ.* 107 (2014) 431–437.
- [12] F. Jameson, *Archaeologies of the Future: The Desire Called Utopia and Other Science Fictions*, Verso, London & New York, 2005.
- [13] R. Levitas, *Utopia as Method: The Imaginary Reconstitution of Society*, Palgrave Macmillan, New York, 2013.
- [14] J.M. Smith, A.S. Tidwell, The everyday lives of energy transitions: contested sociotechnical imaginaries in the American West, *Soc. Stud. Sci.* 46 (3) (2016) 327–350.
- [15] B. Black, Organic planning: the intersection of nature and economic planning in the early Tennessee Valley Authority, *J. Environ. Policy Plan.* 4 (2) (2002) 157–168.
- [16] C. Desbiens, *Power from the North: Territory, Identity, and the Culture of Hydroelectricity in Quebec*, UBC Press, 2013.
- [17] M. Evenden, *Allied Power: Mobilizing Hydro-Electricity During Canada's Second World War*, University of Toronto Press, Toronto, 2015.
- [18] M. Kaika, Dams as symbols of modernization: the urbanization of nature between geographical imagination and materiality, *Ann. Assoc. Am. Geogr.* 96 (2) (2006) 276–301.
- [19] G. Valdivia, Governing relations between people and things: citizenship, territory, and the political economy of petroleum in Ecuador, *Polit. Geogr.* 27 (4) (2008) 456–477.
- [20] S.T. Gillon, *Fields of Dreams: Agriculture, Economy and Nature in Midwest United States Biofuel Production*, University of California, Santa Cruz, 2011.
- [21] T. Perreault, G. Valdivia, Hydrocarbons, popular protest and national imaginaries: Ecuador and Bolivia in comparative context, *Geoforum* 41 (5) (2010) 689–699.
- [22] M. Watts, Petro-violence: community, extraction, and political ecology of a mythic commodity, in: L.N. Peluso, M. Watts (Eds.), *Violent Environments*, Cornell University Press, 2001, pp. 189–212.
- [23] S.G. Bunker, *Underdeveloping the Amazon: Extraction, Unequal Exchange, and the Failure of the Modern State*, University of Chicago Press, Chicago, 1985.
- [24] S. Prudham, *Knock on Wood: Nature as Commodity in Douglas-Fir Country*, Routledge, New York and London, 2005.
- [25] K. Bakker, G. Bridge, Material worlds? Resource geographies and the 'matter of nature', *Prog. Hum. Geogr.* 30 (1) (2006) 5–27.
- [26] B. Anderson, M. Kearnes, C. McFarlane, D. Swanton, Materialism and the politics of assemblage, *Dialogues Hum. Geogr.* 2 (2) (2012) 212–215.
- [27] J. Bennett, *Vibrant Matter: A Political Ecology of Things*, Duke University Press, Durham, NC, 2010.
- [28] B. Anderson, J. Wylie, On geography and materiality, *Environ. Plan. A* 41 (2) (2009) 318–335.
- [29] A. Barry, *Material Politics: Disputes Along the Pipeline*, John Wiley & Sons, 2013.
- [30] T. Richardson, G. Weszkalnys, Introduction: resource materialities, *Anthropol. Q.* 87 (1) (2014) 5–30.
- [31] S. Jasanoff, Imagined and invented worlds, in: S. Jasanoff, S.H. Kim (Eds.), *Dreamscapes of Modernity: Sociotechnical Imaginaries and the Fabrication of Power*, University of Chicago Press, 2015, pp. 321–342.
- [32] S. Bouzarovski, M. Bassin, Energy and identity: imagining Russia as a hydrocarbon superpower, *Ann. Assoc. Am. Geogr.* 101 (4) (2011) 783–794.
- [33] S. Jasanoff, S.H. Kim (Eds.), *Dreamscapes of Modernity: Sociotechnical Imaginaries and the Fabrication of Power*, University of Chicago Press, 2015.

- [34] B. Freese, *Coal: A Human History*, Basic Books, 2003.
- [35] B. Arifi, P. Späth, Sleeping on coal: trajectories of promoting and opposing a lignite-fired power plant in Kosovo, *Energy Res. Soc. Sci.* (2018) in this issue.
- [36] K. Lahiri-Dutt, *The Coal Nation: Histories, Ecologies and Politics of Coal in India*, Routledge, 2016.
- [37] J. Schneider, S. Schwarze, P. Bsumek, J. Peeples, *Under Pressure: Coal Industry Rhetoric and Neoliberalism*, Springer, 2016.
- [38] J. Marshall, Disordering fantasies of coal and technology: carbon capture and storage in Australia, *Energy Policy* 99 (2016) 288–298.
- [39] J. Fitzgerald, The messy politics of clean coal the shaping of a contested term in appalachia's energy debate, *Organ. Environ.* 25 (4) (2012) 437–451.
- [40] S. Tyree, M. Greenleaf, The environmental injustice of clean coal: expanding the national conversation on carbon capture and storage technology to include an analysis of potential environmental justice impacts, *Environ. Justice* 2 (4) (2009) 167–171.
- [41] D. Tyfield, 'King coal is dead! long live the king!': the paradoxes of coal's resurgence in the emergence of global low-carbon societies, *Theory Cult. Soc.* 31 (5) (2014) 59–81.
- [42] J. Jaros, *Historia górnictwa węglowego w Zagłębiu Górnśląskim (1914–1945)*, Śląski Instytut Naukowy w Katowicach, Katowice, 1969.
- [43] J. Jaros, *Zarys dziejów górnictwa węglowego*, Państwowe Wydawnictwo Naukowe, Warszawa-Kraków, 1975.
- [44] GUS, *International Statistics: Industry and Construction*, Central Statistical Office of Poland (Główny Urząd Statystyczny), Warszawa, 2017 27 March 2017. Available at: <http://stat.gov.pl/en/international-statistics/international-comparisons/tables-about-countries-by-subject/industry-and-construction/>. (Accessed 4 April 2017).
- [45] IEA, *Coal Information 2001*, OECD/IEA, Paris, 2001.
- [46] J. Jaros, *Historia górnictwa węglowego w Polsce Ludowej (1945–1970)*, Państwowe Wydawnictwo Naukowe, Warszawa-Kraków, 1973.
- [47] USGS, *Bureau of Mines Minerals Yearbook (1932–1993)*, The United States Geological Survey, Reston, VA, 1932–1993 Available at: <https://minerals.usgs.gov/minerals/pubs/usmmyb.html>. (Accessed 29 April 2017).
- [48] TR, *Worker's Tribune (Trybuna Robotnicza)* No. 227, (1954) 24 September 1954. Available at: <https://sbc.org.pl/dlibra/publication/89497/edition/84388>. (Accessed 22 January 2018).
- [49] TR, *Worker's Tribune (Trybuna Robotnicza)* No. 125, (1955) 31 May 1955. Available at: <https://sbc.org.pl/dlibra/publication/123270/edition/115819>. (Accessed 22 January 2018).
- [50] TR, *Worker's Tribune (Trybuna Robotnicza)* No. 131, (1955) 8 June 1955. Available at: <https://sbc.org.pl/dlibra/publication/123273/edition/115822>. (Accessed 22 January 2018).
- [51] TR, *Worker's Tribune (Trybuna Robotnicza)* No. 286, (1962) 1–2 December 1962. Available at: <https://sbc.org.pl/dlibra/publication/120767/edition/113569>. (Accessed 22 January 2018).
- [52] E. Bendyk, M. Popkiewicz, M. Sutowski, U. Papajak, *Polski Węgiel (Polish Coal)*, Wydawnicwo Krytyki Politycznej, Warszawa, 2015.
- [53] WEC, *Energy Sector of the World and Poland: Beginnings, Development, Present State*, World Energy Council, Warszawa, 2014.
- [54] *Węgielkoks, 1951–2014: Wczoraj i dziś*, Węgielkoks, Katowice, 2015.
- [55] TR, *Worker's Tribune (Trybuna Robotnicza)* No. 290, (1956) 5 December 1956. Available at: <https://www.sbc.org.pl/dlibra/publication/107969/edition/101590>. (Accessed 22 January 2018).
- [56] TR, *Worker's Tribune (Trybuna Robotnicza)* No. 288, (1962) 4 December 1962. Available at: <https://www.sbc.org.pl/dlibra/publication/120769/edition/113571>. (Accessed 22 January 2018).
- [57] TR, *Worker's Tribune (Trybuna Robotnicza)* No. 88, (1974) 13–15 June 1974. Available at: <https://www.sbc.org.pl/dlibra/publication/89692/edition/84570>. (Accessed 22 January 2018).
- [58] TR, *Worker's Tribune (Trybuna Robotnicza)* No. 289, (1956) 4 December 1956. Available at: <https://www.sbc.org.pl/dlibra/publication/107968/edition/101589>. (Accessed 22 January 2018).
- [59] TR, *Worker's Tribune (Trybuna Robotnicza)* No. 195, (1978) 26–27 August 1978. Available at: <https://www.sbc.org.pl/dlibra/publication/94569/edition/89251>. (Accessed 22 January 2018).
- [60] TR, *Worker's Tribune (Trybuna Robotnicza)* No. 287, (1973) 4 December 1973. Available at: <https://www.sbc.org.pl/dlibra/publication/90720/edition/85598>. (Accessed 22 January 2018).
- [61] TR, *Worker's Tribune (Trybuna Robotnicza)* No. 283, (1974) 4 December 1974. Available at: <https://www.sbc.org.pl/dlibra/publication/89885/edition/84763>. (Accessed 22 January 2018).
- [62] A. Karbownik, J. Bijańska, *Restrukturyzacja polskiego górnictwa węgla kamiennego w latach 1990–1999*, Wydawnictwo Politechniki Śląskiej, Gliwice, 2000.
- [63] A. Lisowski, *Górnictwo węgla kamiennego w Polsce: ku następnej generacji kopalń i sektora (1996–2005)*, Główny Instytut Górnictwa, Katowice, 2006.
- [64] I. Jonek Kowalska, Challenges for long-term industry restructuring in the upper silesian coal basin: what has polish coal mining achieved and failed from a twenty-year perspective, *Resour. Policy* 44 (2015) 135–149.
- [65] J. Korski, K. Tobór-Osadnik, M. Wyganowska, Reasons of problems of the Polish hard coal mining in connection with restructuring changes in the period 1988–2014, *Resour. Policy* 48 (2016) 25–31.
- [66] P. Zientara, Restructuring the coal mining industry: unionism, conflict, and cooperation: evidence from Poland, *East. Eur. Econ.* 47 (1) (2009) 41–59.
- [67] MG, *Assumptions for Energy Policy of Poland 1990–2010*, Ministry of Economy (Ministerstwo Gospodarki), Warsaw, 1990 Adopted by the Council of Ministers on 4 September 1990.
- [68] MG, *Assumptions for Energy Policy of Poland Until 2020*, Ministry of Economy (Ministerstwo Gospodarki), Warsaw, 2000 Adopted by the Council of Ministers on 22 February 2000.
- [69] MG, *Energy Policy of Poland Until 2030*, Ministry of Economy (Ministerstwo Gospodarki), Warsaw, 2009 Adopted by the Council of Ministers on 10 November 2009.
- [70] MG, *Energy Policy of Poland Until 2050*, (2015) Project document prepared by the Ministry of Economy (Ministerstwo Gospodarki), August 2015.
- [71] MR, *Strategy for Responsible Development*, Ministry of Development (Ministerstwo Rozwoju), Warsaw, 2017 Adopted by the Council of Ministers (Rada Ministrów) on 14 February 2017.
- [72] GUS, *Energy Statistics in 2014 and 2015*, Central Statistical Office of Poland (Główny Urząd Statystyczny), Warszawa, 2016.
- [73] URE, *The President of Energy Regulatory Office in Poland: National Report 2016*, Energy Regulatory Office (Urząd Regulacji Energetyki), Warsaw, 2016.
- [74] FAE, *Polska na fali megatrendów*, Forum Analiz Energii, Warszawa, 2016.
- [75] M. Wilczyński, *Węgiel brunatny paliwem bez przyszłości*, Instytut na Rzecz Ekorozwoju, Warszawa, 2012.
- [76] M. Wilczyński, *Zmierzch węgla kamiennego w Polsce*, Instytut na Rzecz Ekorozwoju, Warszawa, 2013.
- [77] NIK, *Informacja o wynikach kontroli bezpieczeństwa zaopatrzenia Polski w węgiel kamienny (ze złóż krajowych)*, Najwyższa Izba Kontroli, Warszawa, 2011.
- [78] KPRM, *Polska Grupa Górnicza powołana*, The Chancellery of the Prime Minister (Kancelaria Prezesa Rady Ministrów), Warsaw, 2016 26 April 2016. Available at: <https://www.premier.gov.pl/wydarzenia/aktualnosci/polska-grupa-gornicza-powolana.html>. (Accessed 22 January 2018).
- [79] *Wysokie Napięcie, Węgla ofensywa rządu*, (2016) 20 December 2016. Available at: <http://wysokienapiecie.pl/energetyka-konwencjonalna/1961-weglowa-ofensywa-rzadu>. (Accessed 30 July 2017).
- [80] KOBIZE, *Poland's National Inventory Report: Greenhouse Gas Inventory for 1988–2015*, The National Centre for Emissions Management, Warsaw, 2017.
- [81] EURACTIVE, *Katowice gospodarzem COP24–międzynarodowej konferencji klimatycznej*, (2017) 02 June 2017. Available at: <http://www.euractiv.pl/section/energia-i-srodowisko/news/katowice-gospodarzem-miedzynarodowej-konferencji-klimatycznej-cop24/>. (Accessed 1 November 2017).
- [82] COM, *Transforming Europe's Energy System – Commission's Energy Summer Package Leads the Way*, European Commission, Brussels, 2015 Available at: http://europa.eu/rapid/press-release_IP-15-5358_en.htm. (Accessed 30 July 2017).
- [83] COM, *Clean Energy for All Europeans–Unlocking Europe's Growth Potential*, European Commission, Brussels, 2016 Available at: http://europa.eu/rapid/press-release_IP-16-4009_en.htm. (Accessed 11 June 2017).
- [84] PKEE, *PKEE's Position on the Clean Energy for All Europeans Package*, Polish Electricity Association, Warszawa, 2016 01 December 2016. Available at: [http://www.pkee.pl/upload/files/PKEE_position_Winter_Package_english\[2\].pdf](http://www.pkee.pl/upload/files/PKEE_position_Winter_Package_english[2].pdf). (Accessed 30 June 2017).
- [85] COM, *Factsheet on the Commission's Proposal on Binding Greenhouse Gas Emission Reductions for Member States (2021–2030)*, European Commission, Brussels, 2016 Available at: http://europa.eu/rapid/press-release_MEMO-16-2499_en.htm. (Accessed 30 June 2017).
- [86] EC, *Reform of the EU Emissions Trading System–Council Endorses Deal with European Parliament*, European Council, Brussels, 2017 22 November 2017. Available at: <http://www.consilium.europa.eu/en/press/press-releases/2017/11/22-reform-of-the-eu-emissions-trading-system-council-endorses-deal-with-european-parliament/>. (Accessed 22 January 2018).
- [87] M. Berkenkamp, P. Götz, M.-L. Heddrich, T. Lenck, *European Power Market Integration. Poland and Regional Development in the Baltic Sea*, Energy Brainpool, Frankfurt, 2016.
- [88] *Wysokie Napięcie, Wyrok na stare elektrownie wydany*, (2016) 21 February 2016. Available at: <http://wysokienapiecie.pl/energetyka-konwencjonalna/1305-wyrok-na-stare-elektrownie-wydany>. (Accessed 30 June 2017).
- [89] *Parlamentarny, Szydło na Śląsku: nie ma przyszłości bez czystych technologii*, (2015) 05 October 2015. Available at: <http://www.parlamentarny.pl/wydarzenia/szydlo-na-slasku-nie-ma-przyszlosci-bez-czystych-technologii,917.html>. (Accessed 30 June 2017).
- [90] ARP, *ARP, GIG i ICHPW będą współpracować na rzecz wsparcia innowacji w zagospodarowaniu węgla*, Industrial Development Agency (Agencja Rozwoju Przemysłu), Warsaw, 2015 19 October 2015. Available at: <https://www.arp.pl/dla-mediow/aktualnosci/arp-gig-i-ichpw-beda-wspolpracowac-na-rzecz-wsparcia-innowacji-w-zagospodarowaniu-węgla>. (Accessed 19 May 2017).
- [91] NETTG, *Jednym głosem w Brukseli*, (2017) 02 June 2017. Available at: <http://nettg.pl/news/142937/jednym-glosem-w-brukseli>. (Accessed 19 May 2017).
- [92] ME, *Programme for the Mining Sector in Poland*, Ministry of Energy (Ministerstwo Energii), Warsaw, 2018 Adopted by the Council of Ministers on 23 January 2018.
- [93] ME, *Innovations for the Energy Sector*, Ministry of Energy (Ministerstwo Energii), Warsaw, 2017.
- [94] *Grupa Azoty, TAURON and Grupa Azoty Team up on Coal Gasification Project*, (2017) 20 April 2017. Available at: <http://grupaazoty.com/en/wydarzenia/zgazowanie-węgla.html>. (Accessed 30 June 2017).
- [95] ME, *Plan Rozwoju Elektromobilności w Polsce „Energia do przyszłości*, Ministry of Energy (Ministerstwo Energii), Warsaw, 2017.
- [96] *Wysokie Napięcie, Auta elektryczne napędzą popyt na prąd*, (2017) 11 July 2017. Available at: <http://wysokienapiecie.pl/technologie/2406-auta-elektryczne-napedza-popyt-na-prad>. (Accessed 11 July 2017).
- [97] J.B. Skjærseth, *Implementing EU climate and energy policies in Poland: policy*

- feedback and reform, *Environ. Polit.* 27 (3) (2018) 498–518.
- [98] K. Jankowska, Poland's clash over energy and climate policy: green economy or grey status quo? in: R.K.W. Wurzel, J. Connelly, D. Liefferink (Eds.), *The European Union in International Climate Change Politics: Still Taking a Lead?* Routledge, London & New York, 2016, pp. 145–158.
- [99] K. Szulecki, S. Fischer, A. Gullberg, O. Sartor, Shaping the 'Energy Union': between national positions and governance innovation in EU energy and climate policy, *Clim. Policy* 16 (5) (2016) 548–567.
- [100] COM, **No Region Left Behind: Launch of the Platform for Coal Regions in Transition**, European Commission, Strasbourg, 2017 11 December 2017. Available at: http://europa.eu/rapid/press-release_IP-17-5165_en.htm . (Accessed 23 March 2018).
- [101] ME, Wiceminister Kurtyka: wsparcie regionów górniczych to inwestycja w przyszłość, Ministry of Energy (Ministerstwo Energii), Warsaw, 2017 15 December 2017. Available at: <http://www.me.gov.pl/node/27924> . (Accessed 23 March 2018).
- [102] WNP, W Ministerstwie Energii rozmawiali o wsparciu regionów górniczych w ramach projektu unijnego, WNP Górnictwo, 2017 12 October 2017. Available at: http://gornictwo.wnp.pl/w-ministerstwie-energii-rozmawiali-o-wsparciu-regionow-gornicznych-w-ramach-projektu-unijnego,308271_1_0_1.html . (Accessed 23 March 2018).
- [103] J. Childs, J. Hearn, 'New' nations: resource-based development imaginaries in Ghana and Ecuador, *Third World Q.* 38 (4) (2017) 844–861.
- [104] L. Rickards, E. Oppermann, Battling the tropics to settle a nation: energy geographies in Northern Australia, *Energy Res. Soc. Sci.* (2018) in this issue.
- [105] E. Tarasova, (Non-) Alternative energy transitions: examining neoliberal rationality in nuclear energy discourses of Russia and Poland, *Energy Res. Soc. Sci.* (2018) in this issue.
- [106] J. Peebles, P. Bsumek, S.J. Schwarze, J. Schneider, *Industrial Apocalyptic: Neoliberalism, Coal, and the Burlesque Frame*, Communication Studies Faculty Publications, 2014 Paper 14.
- [107] D.A. McDonald (Ed.), *Electric Capitalism: Recolonising Africa on the Power Grid*, Routledge, 2012.
- [108] P.N. Edwards, G. Hecht, History and the technopolitics of identity: the case of apartheid South Africa, *J. South. Afr. Stud.* 36 (3) (2010) 619–639.
- [109] S. Bell, R. York, Community economic identity: the coal industry and ideology construction in West Virginia, *Rural Sociol.* 75 (1) (2010) 111–143.
- [110] S. Bell, R. York, Coal, injustice, and environmental destruction: introduction to the special issue on coal and the environment, *Organ. Environ.* 25 (4) (2012) 359–367.