Entangling carbon lock-in: India's coal constituency

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Abstract

This article investigates how energy security in the Anthropocene is entangled in diffuse ways with materiality. In particular we examine the social-material entanglement of humans and coal in India and how coal manifests itself differently across social life in the country. Focusing on a single material allows us to study how the Anthropocene creates, and is created by, particular appropriations of the material world. It offers a corrective to some Anthropocene literature that avoids discussing the complex, "everyday," social impacts that fossil fuels have, particularly in the developing world. These intertwined impacts add to the complexity and difficulty in the process of decarbonizing societies, or in transitioning to a sustainable energy future.

Keywords: carbon lock-in; India; materialism; coal crime; Anthropocene

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Introduction

It is increasingly recognized that the material composition of fossil fuels has social implications (see Mitchell, 2011; Sheller, 2014). Our analysis follows in this spirit by adding some conceptual nuance to a well-established metaphor in the energy transitions literature: "carbon lock-in." Though we too believe that escaping dependence on carbon is a wicked problem that should be prioritized, we argue that the interpretation of carbon that is advanced in the "lock-in" literature, popularized by Gregory Unruh (Unruh, 2000; 2002; Unruh & Carrillo-Hermosilla, 2006) alienates us from the diverse social and material embeddedness of fossil fuels. In many ways, carbon lock-in abstracts carbon to such a degree that the material more closely resembles what Timothy Morton (2013) refers to as a "hyperobject" – something massively distributed across space and time relative to humans. Such a reading, while certainly illuminating, also obscures the "different lives" of carbon. Carbon lock-in generally overlooks the materiality forms of carbon and the important practices that bind humans to fossil fuels at each stage of the materials" social life, from production to distribution to consumption. When abstracted and narrowly framed as "carbon" (and its surrounding techno-institutional complex), the threats and risks of this new geological era tend to be conceptualized in problematic terms as a war against an essential element, and solutions are generally limited to exogenous shocks, mitigation efforts and technological fixes, like carbon capture and storage. While these can be important correctives to fossil energy dependence, we feel they obscure other important elements of the Anthropocene challenge.

We thus decide to start, quite literally, from the ground up. We argue that the material characteristics of coal help make possible the resilience of the coal regime in India and highlights how humans and our energy materials are entangled. Our case also emphasizes the important security dimension to this relationship, in which informal and criminal institutions are partially created and sustained by the physical properties of the coal rock.

Starting from the materials themselves, and tracing outwards, it becomes possible to make certain "unseen" social worlds visible. This can better account for the long chain of dependence upon fossil fuels that makes our disentanglement from them more challenging.

When framed more broadly in terms of the social ordering of the world around fossil carbon, the challenge of the Anthropocene becomes even more daunting; a matter of disentangling the complex interrelations between humans and their fossil carbon resources. It also raises important questions about the character of "just" transitions. By thinking more deeply about social-material entanglement, it may be possible to inject thicker forms of ethics in studies of energy transitions in emerging economies. Ironically, focusing on the material of coal might make us "see" the invisible people who create, populate, and sustain the supply chain.

To illustrate the importance of tracing the material lives of fossil fuels, we probe the complex interrelationships between coal and people in India – focusing on the spectrum of coal crime (from petty pilfering to an organized "coal mob") that contributes to the nation's carbon-coal lock-in. This example highlights how the social life of carbon in India extends beyond the provision of energy (and its deleterious climate effects) and involves diverse forces of criminality, development, security, and informal governance. At the macro level, the use of coal contributes to the insecurity of vulnerable populations both in India and abroad, as global warming and associated climate disasters disproportionately impact these populations. Yet, at the local level, coal is both a source of security and insecurity in India. Increasing electrification is responsible for important social, developmental, and health gains in the country, and the official coal mining sector provides jobs for upwards of 4,000 people (Jena, 2014). In its raw form, coal also supports vast informal networks of petty and organized crime and provides a robust black market that feeds influence and money to formal and informal networks of power and dispossession. This of course belies the larger destructive environmental impacts.

The article proceeds in three parts. First, it sets out what it means to take materiality seriously, reflecting on recent studies to demonstrate how thinking about materials shifts our approach to studying energy transitions and security in the Anthropocene. Second, we examine coal in India and focus in particular on the informal economies surrounding the "black diamond." Using original data from 20 semi-structured interviews conducted in New Delhi in April 2015, we explore the earliest stages of the supply chain - the production and transport of the coal rock - in order to argue that human entanglement with coal begins long before the mineral is transformed into energy and the resultant emissions are released into the atmosphere. The paper concludes by tracing the effects of human-material entanglement upon the concept of carbon lock-in, which we expand to take into account the social life of materials. We agree that carbon lock-in helps attune us to the path dependencies that make energy transitions so difficult to achieve, but we hope to add to a more nuanced understanding of lock-in in light of the diverse security entanglements of the Anthropocene. In so doing, the steepness of the challenge of "unlocking" human dependence on fossil fuels becomes apparent.

Security and Materiality

Ironically, the Anthropocene compels us to take seriously a conception of agency not tied to human minds and bodies. On the one hand the Anthropocene warns us of the new powers of humans to match the timeless, world-making powers of inhuman forces. In this reading, we are meant to focus our attention on the actions and outcomes of human agency. However, the Anthropocene is also, at a fundamental level, the extensive geological artefacts of human action. It can only be formally declared when geologists are convinced that geological formations are unique enough to detect planetary shifts. This illustrates the power and effect of non-human Earth system processes, which grow particularly apparent when they shift into new states and those effects become unpredictable. This version of the Anthropocene looks at how nonhuman things create, impact and sustain the larger social milieu. In this reading, it is not humans alone who create the world, but matter, objects, *nature* itself. As Kathryn Yusoff has recently

described it, the Anthropocene is "a social geology" (2013, p. 779). It compels us to "interrogate these geologic capacities, not just in terms of impacts *on* the Earth, but as forces that subjects *share*—geologic forces that compose and differentiate corporeal and collective biopolitical formations" (Yusoff, 2013, p. 779).

This (re)turn to materialism is reflected in the broader social sciences. Recent interventions by a wide range of scholars working in different traditions highlight how different, disparate strands of scholarship have been drawn together, including "actor-network theory, artificial intelligence, biophilosophy, evolutionary theory, feminism, neuroscience, post-humanism, queer theory, quantum physics and Spinozist monism" (Fox & Alldred, 2014, p. 400). What links these approaches is a focus on non-human agency and how assemblages of animate and inanimate matter work to enliven the world. As Diana Coole and Samantha Frost have put it:

> Our existence depends from one moment to the next on myriad micro-organisms and diverse higher species, on our own hazily understood bodily and cellular reactions and on pitiless cosmic motions, on the material artifacts and natural stuff that populate our environment, as well as on socioeconomic structures that produce and reproduce the conditions of our everyday lives (Coole & Frost, 2010, p. 1).

The point of much of this literature is to emphasize an ontology of immanence; that is, a philosophy of becoming. This contrasts with historical forms of materialism and transcendental philosophies that have concentrated on the mechanistic structural forces of the world. In its stead come ideas about "how life and mind evolve out of nonlife…" (Connolly, 2013, pp. 399–400). Matter is not dead, but "alive" in the sense that a vitality emanates from it, helping to create the world in which it exists. In such a view, "materialization contains its own energies and transformations. It is self-organising, *sui generis*. Matter is lively, vibrant, dynamic" (Coole, 2013, p. 453). The human world is surrounded by, composed of, entangled with matter understood in these terms.

We believe that security scholars, particularly criminologists would be well-served if they further incorporated materiality into their work. As Mark Salter recently put it:

> Security cannot be understood solely as a set of speech-acts, but also requires guns, tanks, drones, tear-gas, badges, and fences. In each of these areas, there are non-human actants that fundamentally alter the condition of human possibility, in ways that are unpredictable and irreducible to their constituent elements (2015, p. viii).

How might this all translate to a study on energy transitions in India? Are we not better served sticking to the traditional indicators, such as the ideas, institutions, and practices of energy governance? Is regulation not a better indicator of how energy systems become entrenched? Our study acknowledges these vexing challenges and variables but also adds new layers of complexity in order to better comprehend the character of carbon lock-in. Energy systems are created and sustained not simply through discourse or economic rationality, but through the materials of energy themselves.

In this sense we follow Timothy Mitchell, whose authoritative work, *Carbon Democracy* (2011), argued that the form of energy available has radical effects on the political culture of a given place. Carbon energy manufactures specific forms of agency and therefore conditions the limits of possibility of socio-political power. It becomes possible then to trace the coevolution of carbon energy with the construction of urban industrial modernity. He argues that the conditions and limits to contemporary democracy were shaped by two influential hydrocarbons: coal and oil. In his historical account, the nature of the coal supply chain was a precondition for the social democracy that arose in Britain in the 19th and 20th centuries. Because coal flowed along narrow channels with high concentrations of laborers at each junction, this critical industry was vulnerable to the general strike; subsequently, mass democracy became powerful at this time, and new forms of labor reform and welfare democracy were introduced in order to appease the working class and mitigate the frequent, crippling strikes (Mitchell, 2011, pp. 12–43). In other words, the flow, circulation, and interruption of coal supplies directly contributed to the development, expression, and adoption of democratic claims and norms. Mitchell claims that, "people forged successful political demands by acquiring a power of action

from within the new energy system. They assembled themselves into a political machine using its processes of operation" (2011, p. 12). Since the end of the Second World War, as governments switched from a strict reliance on coal to oil and other alternative energies, they likewise have weakened the power that workers acquired and altered the mechanics of democracy. The material circuits of energy provide a level of analysis separate from the state or the local/individual level, yet remarkably important for understanding societal change. Given this, we now turn to the Indian coal sector, and examine the different ways that coal resources impact the shape and character of energy sector resilience.

India's coal sector and material-based lock-ins

The geological conditions of India provide the basis for a complex set of coal sector lock-ins in the country. At each node along the coal supply chain—from mining to transportation—formal and informal industry has cropped up, tapping into the coal vein that runs through India's economic life. This section details the complex and under-examined effects of this vast coal supply world, and highlights an alternative "identity" of coal beyond simply a medium for energy production. Using original interview data and secondary research, this section follows the social life of coal, and highlights its multifaceted roles: a consumer of the nation's limited land resources; a producer of the nation's laborers; and a continued source of power, money, and influence for black market profiteers. The objective here is to, in the words of Clark and Yussoff, "bring collective human life into closer contact with the geochemical and geologic conditions of earthly existence" (Clark & Yusoff, 2014, p. 206).

Methodology

Our analysis is based, in part, on original interview data. A series of semi-structured interviews were conducted in and around New Delhi, India in April 2015. In total, 20 interviews were conducted with a range of stakeholders in the national power sector:

eight industry officials, three government and three NGO representatives were interviewed. To complement these views, India"s energy experts—think tank researchers, academics, and legal professionals—were consulted: six interviews, in total, were conducted with such individuals. Interviewees were granted anonymity, and as such will be referred to only by number (for example, "Interviewee 6"). Appendix 1 provides further details on the interviewees.

Interviewees were selected to represent a range of senior and experienced stakeholders in the Indian power sector, and snowballing was utilized after the initial selection in order to identify further potential interviewees. Interviews were semi-structured, and ranged from 40 minutes to two hours. Questions focused on perceived barriers and incentives to power sector reform. In addition to gathering up-to-date information on energy sector development, interviews were broken down into two primary sections. First, interview questions were designed to glean how stakeholders perceived the functioning of the overall power system. For example, interviewees were asked to identify what they perceived to be bottlenecks in the system, or elements of the sector most crucially in need of reform. Second, questions were aimed at eliciting interviewees" views on the relative power or influence of the range of actors involved in the sector; for example "Which actor is most capable of affecting reform X?" or "What might be potential "spoilers" to policy Y?" These questions, in particular, provoked significant discussion about the role of crime and the informal sector in anchoring the current system and creating disincentives to a transition away from coal-based energy in India.[1]

The Indian coal sector

[1] We should note that it was not our intention in our research interviews to seek out these informal sector forces, or understand the role they play in perpetuating the existing energy system in India. Rather, interviewees raised these points unprompted. As a result, our interview data pointed us in the direction of a phenomenon that we have come to find is understudied. That said, the frequency with which the informal coal sector was mentioned—in roughly a quarter of our interviews — compelled us to probe this phenomenon and present these nascent findings in hopes of spurring further research (by criminologists in particular).

Coal is the single largest source of energy in India. In 2015, the country consumed 407.2 MT of coal, making it the third largest consumer of coal in the world, behind China and Indonesia (BP, 2016). Between 2015 and 2016, nearly 80% of all domestically produced coal was used by the power sector, and nearly two thirds of the country's installed generation capacity is coal-based (IEA, 2015; Ministry of Coal, 2016a). The rest of the country's coal goes to the iron, steel and cement sectors as well as assorted medium and small industries (ICC, 2012).

India has significant coal resources. As of 2014, the Ministry of Coal estimated over 300 billion tons of coal resources in the country, with 126 billion tons in proven reserves (Ministry of Coal, 2014a). India is the world's third largest producer of coal by volume, churning out 283.9 MT of coal per year (BP, 2016). By 2040, it is projected to overtake the United States to become the second largest producer worldwide (IEA, 2015). The coal sector was nationalized in 1973, and as a result the government currently enjoys a near-monopoly in producing coal, with roughly 90% of nationally-produced coal coming from government-controlled mines. Production is controlled largely by state-owned coal companies (or Public Sector Units as they are called in India): between 2013 and 2014, the public sector produced over 93% of the countries coal, while the private sector produced just over 6% of the total amount of Indian coal (Ministry of Coal, 2014b). Of that, the Indian para-statal, Coal India Ltd., accounted for roughly 81% of the nation's production (ibid.).

Despite the country's rapid pace of industrialization and fast-growing population, coal production has not kept pace with national demand, which has risen by nearly 7% yearly. As a consequence, the country is the third largest importer of coal in the world (ICC, 2012). India imported nearly 200 million tons of coal for 2015-2016, most of which came from Indonesia, Australia and South Africa (Ministry of Coal, 2016a). The rising costs of coal imports and chronic energy shortages have compelled the government of Prime Minister Modi to set ambitious domestic production targets: they vowed to triple India's coal production to a monstrous 1.5 billion tons a year, a move that would make it the second largest producer behind only China. Though this rhetoric has recently been scaled back, as Keith Johnson speculates, this "relentless development push… will likely

amount to a near tripling of India's carbon emissions by 2030" (Johnson, 2015, p. 94). In 2013, India ranked fourth among global GHG emitters, and its emissions are projected to rise as the country industrializes further and per capital emissions edge closer to global averages (World Resources Institute, 2017).

India"s coal has distinct physical characteristics around which the socio-industrial sector is shaped. For one, the high ash content (45%) and low calorific value of India's indigenous coal means that greater amounts are needed to produce a single unit of energy (ICC, 2012; World Energy Council, 2017). As the International Energy Agency (IEA) notes, "miners in India have to extract around 1.5 tonnes of coal to get the same amount of energy as that contained in one tonne of Australian coal" (IEA, 2015, p. 105). Furthermore, most of the country's coal is within 300 meters of the surface, and the result is a reliance on open cast mines, which tend to be land and labor intensive (Ghose, 2007). In general, 455.58 ha of land are needed for producing 1 MT of coal through open cast mines. Between 2013 and 2014, roughly 280,000 ha of land were under coal production, and about 27% of that was on forested land (Ghose, 2007).

The production methods for coal itself are greatly inefficient. As the IEA notes, an average Indian coal miner produces less than 2.5 kt of coal per year, while an Indonesian counterpart is at least 50% more productive, a miner in China produces more than 5 kt per year and an Australian worker mines up to 13 kt per year on average (IEA, 2015). In India wages are still low and consequently the mines exhibit a higher labor-intensity than elsewhere (IEA, 2015, p. 102).

The result of these trends is a vast coal industry that must produce more, employ more, and mine more, all of which contribute to carbon lock-in in the traditional sense. Coal India Limited, the largest state-owned coal production company, employs over 350,000 people, and as such wields considerable power and influence ("Coal India Ltd.," 2017). Since 2014, for example, the government has considered breaking the monopoly up on numerous occasions but has backed down in the face of strong union protests (Interviewee 1).

Within this context, there are four key factors that contribute to India's locked-in relationship with coal, and these factors are well-captured using traditional carbon lock-in frameworks. First, India enjoys the world's cheapest fossil fuel resources at bargain prices: in 2010, domestic coal cost was about 80% cheaper than imported coal from Australia and nearly 60% cheaper than coal imported from Indonesia (Ahn & Graczyk, 2012).[2] Second, India's demand for coal and current power shortages create a political environment in which moving away from coal seems antithetical to economic growth objectives. Third, the country is building, and plans to continue building, thermal coal power plants: continued investment in these capital-intensive and long-lasting power infrastructures is a policy that all but ensures the continued use of coal. Finally, the coal sector is not merely an energy supplier in a power hungry developing country: it is also a job supplier. As Interviewee 9, an NGO official, noted:

> [It is] very hard to change [the coal sector] because historically the coal mining sector has been very labor intensive—we have tended to use labor rather than technology for mining… To change that, to bring in efficiency and to say "All of you will not have jobs because we are bringing in mining equipment," it is politically not possible. I don't see that happening…It's a very sensitive issue...

Combined with the normative environment, which prescribes short-term development thinking over long-term sustainability concerns, the prospect of unsettling an industry that provides employment to so many people is a challenging one. Indeed, since 2014, the government has considered breaking up this monopoly, but has been deterred by strong union protests (Interviewee 1).

Grounding coal carbon lock-in

[2] Some of this pricing is artificial due to the country's generous subsidies for coal (Interviewee 4). According to the IMF, India ranks fourth in the world in terms of total dollars spent on energy subsidies: in 2015 alone, it spent over 277 billion USD in post-tax subsidies on coal, natural gas, and petroleum, or over 12% of total GDP (Coady et al., 2015).

The traditional carbon lock-in framework highlights important dimensions to India's locked-in relationship with coal. The relative cost-competitiveness of the domestically-abundant mineral, the nation's rapidly increasing demand, the labor-intensity of the country's mining process, and the pressures of infrastructural lock-in all contribute to the nation's close relationship with the mineral. However, there are additional forms of lock-in that are not being captured by the traditional carbon lock-in approaches. Starting literally from the ground up, this section highlights two key forms of social and economic activity that flow from the material nature of the coal itself, and create further reliance on the mineral resource. These activities are the organized crime of the coal mob, and the pilfering and illegal mining undertaken by the country's coal cycle *wallahs*.[3] Interviewees noted both of these sets of activities as important and underemphasized forces that act as disincentives to energy sector change.

The informal coal sector can be thought of as a socio-material lock-in, a series of social phenomenon made possible by the material nature of coal itself. In general, the informal sector revolves around the illegal acquisition and distribution of coal, though bribery and other forms of elite corruption also constitute a portion of these activities. While precise data on this phenomenon is limited—indeed, former Coal Minister Sriprakash Jaiswal himself noted "no one can tell how much coal is diverted" — estimates suggest that for the country's largest coal producer, Coal India Ltd., as much as one-fifth to one quarter of its output is stolen, costing the company up to a billion dollars per year (Das, 2016; Mehdudia, 2011). The issues of theft and diversion have become so acute that a number of anti-theft security measures are currently being implemented in the coal sector, including GPS-based vehicle tracking systems, electronic surveillance at material stores and stockyards, electronic "fences" at mines, and radio frequency identification RFID access control systems in transport trucks (Ministry of Coal, 2016b).

This section will treat the activities of the coal mob and the coal cycle *wallahs* separately, since their existence is made possible by different elements of the coal mineral's

[3] Wallah is a label derived from Bengali, Marathi, and Hindustani to denote a person who is involved in a specific activity, from a specific location, or what they wear.

materiality. The coal mob's activities center largely around the illegal distribution of coal, whereas the coal cycle *wallahs* engage in both the illegal mining and distribution of coal. The former utilizes the transit system around coal, while the latter benefits from the mining methods used in India. These phenomena are closely tied to the physical properties of the coal rock and both feed into a vast social system upon which many in India rely.

The Indian coal mob exists due to a confluence of regulatory and material conditions surrounding the country's coal sector. Coal's energetic value as a driver of Indian economic growth lead it to be classified as a Schedule A "major mineral" under the Mines and Minerals (Development and Regulation) Act 1957, meaning it has strategic importance and is therefore reserved exclusively for the public sector (Lahiri-Dutt, 2016). Coal mining, too, was legally declared an exclusive right of the state under the Coal Mines (Nationalisation) Act 1973 (Lahiri-Dutt, 2016). Finally, in the 1980s, amidst the demands of growing Indian industry and the rise of alternative forms of small-scale energy (eg, liquefied petroleum gas containers), the government phased out the use of public depots, which allowed people to buy small amounts of coal from Coal India Ltd (Singh, 2013). As Lahiri-Dutt notes, "coal is not freely sold to small and domestic consumers, and throughout the entire coal-producing region in eastern India there are no distribution depots designed to cater to small and domestic consumers" (Lahiri-Dutt, 2014, p. 55). The result of all of these policies is a regulatory environment in which mining, distributing, or purchasing coal becomes illegal or impossible for the Indian public writ large. Under these conditions, organized crime has become a way to service this demand for coal by small industries and everyday users.

While the regulatory context creates a demand for illegal coal, the activities of the Indian coal mob are made possible by physical properties of the mineral itself. Specifically, the way in which coal is transported is distinct from other fossil fuels: rather than flowing in liquid form through pipelines or moving in tanks by truck and rail, coal in India is transported in more traditional ways, including in open bed trucks and in standard rail cars. Between 2013 and 2014, roughly 50% of coal in India was transported via the

country's overburdened rail system, while another 27% was moved by road (Saraf, 2015). This transit system is a key condition for the coal mob's activities, which relies upon the diversion of coal trucks for the illegal acquisition and sale of legally-mined coal (Lahiri-Dutt, 2014). In this sense, the tactics and activities of the coal mob are constituted by the physical properties of coal. One cannot imagine this system existing, for instance, with natural gas or petroleum, and examining these actions under the rubric of energy security yields little helpful comparison. Rather, given the characteristics of coal, these criminal activities are more comparable to the operations of another organized crime syndicate in India, the so-called "sand mafia"(Sugden, 2013).

According to some interviewees, the interests of the coal mob are influential, and make policies, designed to phase the industry out, challenging to put forth. Interviewee 18, a private sector official in the energy industry, explained:

> In India there is a legal coal market and then there is a grey coal market. Around 60 million tons (which is the volume that we are importing right now) is sold through the grey market which is controlled by ...we call it the mafia, but it is a very politically connected mafia.

Another respondent, Interviewee 20 (also a private sector official in the energy industry) put it more bluntly: "the source of resistance to change in the coal mining system is the mafia." Five respondents in total noted the impact that the coal mob has on the coal sector, and the potential challenge this might pose when considering energy sector reform. For some, this was because of the corruption issues the coal mob creates within the industry (Interviewees 4, 10, 18, 20), whereas for others, organized crime was a source of inefficiency that undermined the financial capacity for intra-sector change (Interviewees 19). This suggests that organized crime represents a notable, but misunderstood, vested interest in the coal sector.

The second social organization that demonstrates an entangled relationship with the materiality of coal is the cycle *wallahs*. Notable figures along highways and roadsides

throughout the eastern coal-bearing states of India, these actors use specially reinforced bikes to transport coal pilfered or illegally mined to small local consumers. A *Guardian* report in 2013 noted:

> As India's overlooked energy suppliers – a vast, unrecorded network – the cycle wallahs keep brick kilns, sponge-iron factories, roadside eateries and chai stalls ticking over, and families in city and village alive. About 45,000 coal cycle wallahs transport 7.5 tonnes of coal each day in Jharkhand alone. Yet they are outlaws: buying a bag of coal on a city or village street from them is proscribed by the penal code and laws governing forests and coal bearing tracts. *De facto, they are India"s largest criminalised community*. (Singh, 2013. Our emphasis)

Official numbers about the national scale of informal coal sector employment are not available. However, a survey conducted in 2012 suggested 3.7 million tons of coal were moved by the cycle *wallahs* in the eastern states of Jharkhand and West Bengal alone (Lahiri-Dutt, 2016). Notably, this is a considerable increase over the number of cycle *wallahs* estimated in a previous survey conducted by the same author in the early 2000s, where only 2.5 million tons were estimated to be transported in the region (Lahiri-Dutt & Williams, 2005). Another estimate suggests the coal *wallahs* handle between 1 and 2% of the overall coal trade (Pearce, 2016). While not as vast a phenomenon as the organized crime industry, these actors demonstrate a unique relationship with coal that is emblematic of the diverse forms of security and insecurity in the Anthropocene.

The coal *wallahs* are made possible, in part, by the regulatory environment noted above, under which their activities are deemed illegal or criminal. Additionally, the existence of this informal practice is fueled by two interlinked phenomena related to coal mining: displacement and environmental degradation. Alongside the legal provisions mentioned earlier, which prioritize and nationalize coal production in India, the Coal Bearing Areas (Acquisition and Development) Act 1957 (CBAA) gives legal power to the Coal India Ltd. and its subsidiaries to acquire land for the purpose of coal mining, and as Nesar Ahmad notes, "except for payment of compensation at the market rate (which is not

required before taking possession), the Act does not provide for any solatium or other payment" (Ahmad, 2014, p. 262). As Lahiri-Dutt notes,

> [b]y invoking CBAA, the State can overrule tribal or indigenous communities" (Scheduled Tribes as they are known officially, or the *adivasis*) ownership of land which is non-transferable or inalienable. In coal mining, the CBAA and the Land Acquisition Act 1894 (LAA) together give the state the ultimate power of usurping any property belonging to any citizen for the extraction of coal (Lahiri-Dutt, 2016, p. 204).

The displacement of peoples from lands seized for coal mining feeds into the cycle *wallah* system, producing swaths of local, unemployed and disenfranchised Indians, some of whom come to participate in the coal industry as formal laborers, but many of whom are forced to enter the informal sector for lack of better alternative work. This phenomenon of displacement and dispossession, and the subsequent re-enrolment of these populations into the informal coal industry, is understudied. This is due, in part, to the fact that comprehensive data on the numbers of internally displaced people as a result of coal mining are unavailable. While there are certainly political reasons for this, especially given the fact that the coal sector in India is nationalized, the material nature of coal also contributes to this absence of data. As Nesar Ahmad and Kuntala Lahiri-Dutt note:

> Minerals are often spread over large tracts, and therefore cut across multiple administrative units. Even with coal, which comes under a central administration, the state-owned mining company Coal India Limited (CIL), the project-oriented nature of mining operations makes it difficult to obtain any reliable data on displacement caused in extracting the resource (Ahmad & Lahiri-Dutt, 2006, p. 314).

That said, even single examples can demonstrate the huge scale of displacement that can occur as a result of coal. Currently, Prime Minister Modi is seeking to relocate 100,000 people in order to expand the Jharia coal field in the state of Jharkhand (Das, 2015), a coal field that consists of nine large open pits and dozens of deep mines and smaller pits,

which collectively account for about a quarter of India's coal production (Pearce, 2016). This figure represents only the immediate displacement that comes as a result of mine expansion. However, displacement also occurs later, as a result of the longer-term environmental impacts of coal mining. One notable cause of later-stage displacement is the coal fires that burn in about a tenth of all Indian mines. These fires spontaneously begin when minerals in the exposed coal are oxidized and heated up.[4] As Pearce notes in his expository about displacement around the Jharia coal field, "[a]side from blackening the air, (the fires) cause widespread subsidence as they eat away the coal and cause the ground above to fissure and collapse." One individual interviewed by Pearce lived only 30 feet away from the mine as a result of the area's gradual erosion (Pearce, 2016).

These long- and short-term forms of displacement as a result of coal mining contribute to the phenomenon of the coal *wallahs*. In the short term, the physical displacement of people as a result of mining can contribute to the creation of joblessness in the coal regions. As Ahmad and Lahiri-Dutt note*:*

> Giving jobs to the displaced families in its subsidiary companies is one of the major planks of the CIL's R&R policy. But the CIL was not able to give employment to persons from about 30 percent of the displaced families during 1980–85, according to a Ministry of Home Affairs" study, which is the latest available data on CIL"s compensatory jobs (Ahmad & Lahiri-Dutt, 2006, p. 330, internal references omitted).

Second, the longer-term environmental transformation of a coal region disrupts local economies. Environmental degradation that occurs as a result of local pollution, water shortages, and subsidence creates "occupational displacement," during which traditional livelihoods, including subsistence forestry and agriculture, no longer become sustainable. The well-known effects of local coal mining lead to the degradation of farming and forest land, forcing communities from these sectors (Ghose, 2012; Ghose, 2007; Lechner et al.,

[4] The phenomenon of coal fires is exacerbated by the fact that about 163 out of Coal India Ltd.'s 471 mines are opencast (Coal India Ltd., 2017), meaning more coal is exposed to oxidation.

2016; Tiakaba, 2016). As Nigel Singh (2013) notes, "[i]Increasing demands on a water table ravaged by the coal industry, together with population increase, have left (farmers") fields insufficiently watered to bear them a living". Both of these pressures create an idle and willing workforce in proximity to India's coal mines.

As a result of being displaced from the agricultural and forestry sectors, these individuals are compelled to take up illegal coal mining. A particular irony is that the conditions for these communities" occupational and social dislocation are also the conditions which make coal pilfering and theft possible. The use of open-cast mining in India, which makes up over 30% of all of Coal India Ltd.'s mining operations (Coal India Ltd., 2017), increases the risk of local pollution and destructive coal fires, but also makes illegal mining more accessible (though still very dangerous) compared to underground and incline mines (Lahiri-Dutt, 2014).

Like the phenomenon of organized coal crime, the coal cycle *wallahs* highlight yet another social entanglement that exists in the coal sector, but beyond the scope of our traditional analyses. Centered around the physical and material life of coal in the mining regions of India, this practice of illegal mining and distribution highlights key human, environmental, and economic security issues that are overlooked in traditional analyses of the coal sector.

Thinking materially: implications for transitions research

The notion of carbon lock-in refers to the tendency of carbon-intensive techno-social systems to persist over time, while subsequently locking-out lower-carbon alternatives (Erickson et al., 2015). In Unruh's and others" framing, carbon-energy systems become locked-in in three mutually-reinforcing ways: through technological lock-in, behavioral lock-in, and institutional lock-in (Seto et al., 2016). Technological lock-in refers to a lock-in assured by the technologies and infrastructure that indirectly or directly emit CO2 and shape the energy supply. Institutional lock-in arises through particular governance,

institutions, and decision-making forms that affect energy-related production and consumption and shape energy supply and demand. Finally, behavioral lock-in is related to behaviors, habits, and norms associated with the demand for energy-related goods and services (Seto et al., 2016, p. 427). Each framing offers a multi-tiered analysis of how systems become entrenched. Indeed, the number of identified lock-ins is not small.

In terms of materiality, the lock-in literature does recognize a few different ways that materials produce wider social systems. Some studies have examined how certain building materials, either through their cost or the durability, influence the lifetimes of carbon-intensive systems (Ramesh, Prakash, & Shukla, 2010). Likewise, it is possible to connect how certain behavioral and cultural norms like hygiene, modernity, and convenience (in addition to increased household access to energy) create, and are reinforced by, the development of material technologies like the refrigerator (Miller, 1998; Seto et al., 2016). Materials thus play influential roles in both establishing the economic costs of transitioning to new sustainable systems in addition to demonstrating how lifestyle choices (and expectations) contribute to the persistence of carbon-intensive societies. Overall though, there remains a gap in the transitions literature on how the energy material itself entangles technological, behavioral, and institutional lock-ins.

The case of India's coal sector demonstrates that the material substance of the thing helps determine the nature of specific carbon lock-ins. The fact that the materiality of coal comprises an important node in the lock-in of India's overall energy system adds some complexity to conventional understandings of energy transitions. Take for instance, the problem of "escaping" carbon lock-in. Gregory Unruh's conditions for escaping carbon lock-in are limited to exogenous technological shocks and/or social/institutional change caused by the costs of climate change (Unruh, 2002). Neither fully captures the complexity of security entanglements. To be sure, both conditions may undermine the carbon energy system in India but neither of these can account for the resilience of Indian coal and its contribution to the reproduction of labor, criminality, and political power, which offer powerful disincentives to change. While the market for coal is likely to diminish eventually, a significant rift in the social and economic fabric will take some

time. Indeed, as the case highlights, the speed and scope of change are directly impacted by the complex connections between ideational views of development in India that are wedded to utilizing seemingly vast stores of carbon, and the material sources—namely coal—that contribute to powerful social lock-ins such as employment, influential governance institutions/mechanisms, and criminal networks. This suggests that carbon lock-in is more convincingly characterized by heterogeneous systemic interactions that cannot be easily segmented.

In a sense, our argument follows Heather Lovell's conception of "heterogeneous networks" as a way to account for the full complexity of energy transitions (Lovell, 2014). For Lovell, heterogeneous networks are dynamic and fragile sociotechnical networks comprising a mix of humans and nonhumans (objects, technologies, etc). They extend the subject of research *beyond* individuals, organizations, and institutions to include the material substance of economies and societies. Drawing heavily from Science and Technology Studies (STS) and actor-network theory (ANT), Lovell takes into account how both human and non-human actants construct markets and economies. In her 2014 book, *The Making of Low Carbon Economies*, Lovell examines how carbon markets are heterogeneous networks comprised of new and existing technologies, things, expertise, and ways of doing. They also are reliant on things - pipes, wires, buildings, institutions – that were in place before climate change became a problem, and which contribute to locking-in existing unsustainable infrastructure (Lovell, 2014). For Lovell, people, things, and practices hold markets and economies together. As a result, heterogeneous networks are inherently fragile, and constant work is needed to maintain the illusion of stability. While examining the social life of materials leaves policymakers and scholars with an even more complex picture of lock-in, it also offers the possibility for new, creative innovative pathways that would otherwise be absent or deemed irrelevant.

Thinking "materially" does not undermine existing work on carbon lock-in, but it does offer a corrective to it. It adds nuance to the framework, demonstrating the depth, complexity and distributed nature of coal lock-ins. Beginning our analysis from the

bottom up, starting with the material substance of coal, captures a new set of actants influencing the construction of the sociotechnical system. It helps reflect the diversity of the Indian power sector, which comprises various groups, institutions, ideas, discourses, and materials. Adding materiality to the analysis of carbon lock-in produces a "heterogeneous" framing of this theory and acknowledges the complex interactions and relationality between diversified social actors (cycle *wallahs*, organized crime, politicians, etc) in addition to the phenomenological role of carbon fuel (in this instance, coal) and carbon technology as a physical thing. It also shifts the focus away from the modernist tendencies of traditional carbon lock-in studies, which sees post-carbon transitions primarily as an issue for *homo economicus*. In this view, the human actor (and the societies in which she exists) is beholden to a rational calculation of costs and benefits, incentives and disincentives. According to this logic, the human creature *behaves* but does not *act*. Amartya Sen famously wrote that, "purely economic man is indeed close to being a social moron. Economic theory has been much preoccupied with this rational fool decked in the glory of his one all-purpose preference ordering" (Sen, 1977, p. 336). In contrast, we have found that the human actor is entangled at multiple scales and points with complex energy forces in ways that force an appreciation of alternative points of analysis that contrast with reductive economic rationality. This, because, as Bruce Braun and Sarah Whatmore write, it is "perhaps no longer possible to imagine either the human as a living being or the collectivities in which we live apart from the more-than-human company that is now so self-evidently integral to what it means to be human and from which collectivities are made" (Braun & Whatmore, 2010, p. xvii).

At face value, security scholars would not be expected to contribute much insight into sustainable energy systems in India. However, when looking at the specific characteristics of coal crime in the country and its role in locking-in an environmentally unsustainable system, it becomes apparent how energy transitions entangle social and material phenomena in security relationships. The relationships between coal and crime, between environmental and human security, demonstrate the forms of resilience and

resistance to change currently embedded within Indian social life and its physical geography.

The case of India helps modify conventional lock-in analyses by demonstrating the various nodes of social, political, ideational, and material entities making up the complex system of energy. Our study emphasizes the interplay between governance nodes (both inside and outside the purview of the state), entrenched ideas about development pathways out of poverty, and finally, the material things that can be exploited for national gain. We thus encourage future studies of energy systems transitions to include new actants and extend the subject of research beyond individuals, markets and economies and include their technologies, gadgets, material sites of production and consumption and so on(Lovell, 2014, p. 15). Introducing a focus on materiality into the study of carbon lock-in compels us to open up the "black box" of technology, and examine the conditioning effects that materials and things have on social development. For example, current approaches to carbon lock-in treat energy infrastructure as a barrier to change on financial grounds: having invested significant sums of money into generation stations and power lines, actors face powerful disincentives to abandon these investments. Ultimately, the treatment of objects and things in conventional carbon lock-in approaches falls on an economic logic of incentives and disincentives to economic agents. This obfuscates the power and resilience of the material-social infrastructure built by, and for, carbon.

Conclusion

The separation between material and social worlds continues to dissolve. As authors like Timothy Mitchell (2011) have made clear, fossil fuels quite literally structure and shape the social lives of humans. It is increasingly acknowledged that our world is an entanglement of social, technical and nonhuman forces. The Anthropocene brings this into stark relief, demonstrating the monumental changes to the Earth system caused by human action. Consequently our traditional ideas and practices of security are now coping with the implications of new, decentered human subjects, existing in-relation with

a multitude of worldly forces. In this article we have followed the call from political philosopher Jane Bennett (2009) to take serious the "vitality" and "liveliness" of nonhuman bodies. In this respect, Bennett means the capacity of things "to not only impede or block the will and designs of humans, but to also act as quasi agents or forces with trajectories, propensities, or tendencies of their own" (Bennett, 2009, viii). This compels scholars and policymakers to reconsider agency and causation.

Our study has argued that coal has manifested itself as a key social force existing across multiple facets of Indian society. We have examined how energy transitions and, more specifically, the concept of carbon lock-in are refigured by tracing the liveliness of coal rock in India – its material composition and its encounters with various bodies, technologies, and political institutions. In the context of our study, energy transitions do not occur solely through the development and imposition of external forces (like say technological advancements) onto society, but are themselves part of socio-technical worlds. Humans create, receive and participate in the shape of energy transitions yet agency and outcomes also arise from nonhuman materials like coal. Coal in India causes and conditions the particular forms of lock-in and path dependency. In other words, it has a "thing-power" to make connections and form networks of relations that have varying degrees of stability (Bennett, 2004, p. 354). It entrenches political practices – from informal economies and industries to rent-seeking politics – which comprise a vast "coal constituency" that is directly and indirectly invested in the life of coal.

Appendix 1

Interviewee Number	Interviewee Sector Affiliation
1	Think Tank Analyst • Phone interview,
2	Journalist; Environmental Specialist
3	Government Official
4	Private Sector Official (Energy)
5	Private Sector Official (Energy)
6	Private Sector Official (Business Analyst)
7	Private Sector Official (Energy)
8	Private Sector Official (Energy)
9	NGO Official
10	Private Sector Official (Energy)
11	Government Official
12	Government Official
13	Government Official
14	NGO Official
15	Government Official
16	NGO Official
17	NGO Official
18	Think Tank Analyst
19	Private Sector Official (Energy)
20	Private Sector Official (Energy)
** Interviews by sector: Media: 1 Think Tanks: 2 NGOs: 4 Government: 5 Private Sector: 8	

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