14 Past peak oil: political economy of energy crises

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Introduction

Energy is one of modernity's fundamental mediums and metrics. Defined as the capacity to do work, energy is the productive force at the heart of many economic, social and environmental changes associated with modernist transformation. Social mastery of the earth's energies is also one of the most potent of modernity's ideological tropes. Measures of national development centre on the growing availability, accessibility, and efficiency of energy over time: bodily calorie intake, installed electricity generating capacity, kilometers of paved roads – these and others are used to distinguish whether, when, and where modernity's fuse has been lit. Governments seeking short cuts to modernity plough resources into nuclear power, large-scale hydro, and rural electrification as a means of spreading the light of development across a territory, drawing citizens out of the metaphorical darkness of tradition, and forging a national imaginary (Coronil 1997, Nye 1998).

Energy, then, is one of the principal components of modernity in both a statistical and an ideological sense. Figure 14.1 evidences the strong, positive correlation between energy consumption and economic output for around sixty countries. A similar association is found at the world scale, where economic output and total commercial primary energy supply have both risen about 16-fold in the last 100 years (Smil 2005: 65). Beyond graphs like Figure 14.1, ethnographies of daily life reveal how access to energy transforms experience and expectations at a personal level: comparisons of geographical mobility, or the effort expended on household chores show how increased energy availability can underwrite far-reaching domestic, urban and regional transformations. And for each person who has experienced such changes first hand, many others aspire to an energy-intensive modernity in which technologies such as the car, the fridge and the light bulb diminish distance, forestall the seasons, and render irrelevant the earth's rotation.

Given the centrality of energy to modernity, what is the meaning of energy *crisis?* Popular use of this powerful couplet denotes more than the technical failure of a provisioning system. "Energy crisis" strikes at the heart of modernist transformation: it suggests the moment when the grand arc of human progress stalls, and the lights of prosperity flicker and dim. Crisis signals a moment of collective existential doubt, a historic and geographic conjuncture when the ability of energy

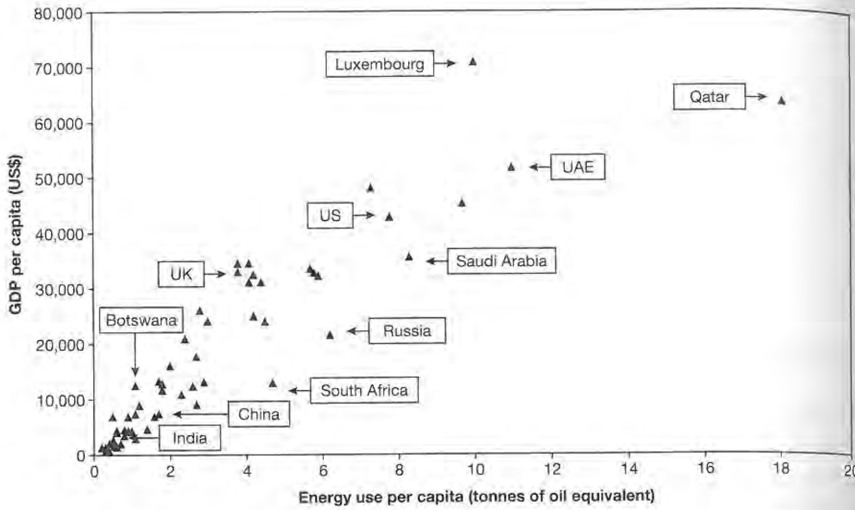

Figure 14.1 The relationship between GDP and energy consumption (data for 2005)

Assembled by the author from data sourced from World Resources Institute (2010).

consumers to continue to summon energy in familiar ways is suddenly – and perhaps permanently – called into question. "Energy crisis," then, is the existential terror of an empty tank and flaccid fuel lines: modernity, fused (Calvino 1974).

From energy crises to peak oil: anatomy of a chapter

This chapter moves from the general to the specific, engaging energy crisis as a general concept before turning to its specific materialization in "peak oil." Having highlighted the tight linkages between energy and modernity, the next section discusses the origins of "energy crisis" as a particular way of thinking about the availability of energy in a modern, high-energy society. It is followed by a brief examination of the specificity of fossil fuels and, in particular, the historical distinctiveness of liquid hydrocarbons. In the remaining sections, the phenomenon of "peak oil" is critically examined as a contemporary manifestation of "energy crisis." With a twist on its main title, the chapter seeks to move "past peak oil" in the sense that it advances a critique of peak oil's core claim that geological limits are now the primary driver of oil's availability, and that an imminent peak in global oil production constitutes a crisis. It takes issue both with the popular fixation that peak oil is the Achilles heel of a modern high-energy society, and the critical left's recent flirtation with peak oil as a crisis of capitalism.

The critical review of peak oil proceeds via four arguments: first, that peak oil's claim about an imminent provisioning crisis is misplaced, curiously irrelevant and ultimately conservative, because it identifies crisis not in the social relations of the energy system but in physical depletion; second, that critical political economy

has been too ready to embrace peak oil as a symptom of a "fossil fuel mode of production" in crisis; third, that the inequities and developmental and environmental distortions of high-energy, fossil-fuel-dependent societies constitute an on-going "crisis" even in the absence of supply interruptions, so that "crisis" is a normal state of affairs; and fourth that, through the politicization of some of these inequities and distortions, the production and consumption of conventional oil will indeed peak (and is already doing so in some countries). Importantly, however, the peak will be a "demand-side" phenomenon, as societies seek to re-allocate and prevent some of the social and environmental costs associated with conventional oil. In sum, the chapter displaces "energy crisis" from a conventional bourgeois concern with supply disruption to show how crises arise from the material forms produced by fully functioning, fossil energy provisioning systems.

Naming scarcity: energy crisis as oil shortage

"Energy" and "crisis" first became closely associated in the popular imagination following rapid rises in the price of oil in 1973 and 1979, associated with restrictions by key oil exporting states on the rate at which oil flowed to major markets. The conflation of energy with oil was no accident, given the dominant role of oil in the transportation, power and heating sectors of most industrial economies and, in particular, the United States. But the energy crisis was about more than a belated recognition by U.S. policy-makers of their dependence on imported oil. Gasoline lines and rationing cut Americans to the quick: these were material realities that confronted a national ideology of perpetual progress built on energy abundance. By shaking a cherished "faith that the days of our children would be better than our own," the energy crisis precipitated what President Carter would come to call a national "crisis of confidence" (Carter 1979).

Since the 1970s, energy crisis has been widely applied to describe a variety of short-term "supply squeezes" that threaten the reproduction of socio-economic relations. Classic examples in industrial, high-energy economies include strikes by coal miners and railway workers cutting the flow of coal to power stations, and international disputes over the transit of natural gas that interrupt a significant proportion of national supply. Occasionally scarcity reflects absolute shortage, and "fuel famine" conditions can prevail: coal famines were a feature of urban life well into the twentieth century in Europe and the United States, particularly in winter when ice blocked the ports and snow impeded rail movements of coal from the mines to cities. More often, however, scarcity is a market condition: shortage is experienced as a rise in the price of energy inputs that impinges on conventional rates of use and excludes a greater number of the poor from access to energy supplies. In either case, however, interruption of supply signals a deeper socio-political crisis: a breakdown in the "normal" processes and conventions through which techno-social networks are reproduced and prevailing socio-economic relations sustained.

By temporarily dispossessing those accustomed to energy abundance, sharp rises in the price of fuel can expose the more permanent, structural social inequalities that govern access to energy. In doing so, they can reveal geographies of deprivation that are obscured from those able to command energy during the "normal" operation of energy provisioning systems (Buzar 2007). In this way, classic supply-squeezes can reveal a very different notion of crisis: the chronic exclusion of many people from participation in the high-energy society. Crisis here is not an interruption to the normal state of affairs, but the conditions of inequality that enable some to command abundance while others go without. This alternative definition manifests itself at different spatial scales. Within industrial economies, for example, the phenomenon of "fuel poverty" highlights how access to energy in nominally "high-energy societies" is differentiated by income and quality of housing stock. At the global scale, an estimated 1.6 billion people have no access to electricity and around 2.4 billion – over a third of the world's population – rely on biomass as a primary source of energy, such as crops residues, wood and charcoal (Cleveland 2007). In many places in sub-Saharan Africa, for example, biomass accounts for over 75 percent of the energy consumed in the course of daily life (Mwampamba 2007). Addressing "energy crisis" in these contexts means significantly expanding access to energy and, in particular, improving access to the high-grade energy sources of electricity and liquid fuels. In the popular pairing of "energy" and "crisis," then, one finds an exquisite combination of abundance and scarcity – of enfranchising optimism and existential fear – in which can be glimpsed one of the driving dialectics of modernity.

The language of "energy crisis" has made a comeback in recent years. Rising energy prices, awareness of climate change and recognition of the vulnerabilities of the contemporary energy system have conspired to make redefining the social relationship to energy one of the "grand challenges" of the twenty-first century. In national and international policy arenas, the search for a "new energy paradigm" (Helm 2007) is conceived explicitly as a problem of social reproduction: that is, as a question of how to change the material basis through which a society reproduces itself while preserving social structure and function. The ambitious goal is to effect a "rapid transformation to a low-carbon, efficient and environmentally benign system of energy supply" (IEA 2008). At the centre of this problematic is management of an extended, complex and unruly *hydrocarbon commodity chain* that stretches from the upstream processes of fossil fuel extraction and processing to the downstream processes of distribution, consumption, and the sequestration of carbon (Bridge 2008). Like other modern energy crises, it is the rate of flow through this hydrocarbon chain that sets the bounds of possibility, and around which various utopian and dystopian visions of energy futures currently circulate.

At the *downstream* end of the hydrocarbon commodity chain – where hydrocarbons are combusted and carbon-dioxide released – the gap between rates of carbon emission and carbon sequestration is problematized through the science and discourse of greenhouse gas accumulation and climate change. At the *upstream* end of the chain, there is an insurgent skepticism about the ability to expand or even sustain the current rate at which conventional oil is extracted worldwide (approximately 85 million barrels per day). This skepticism is expressed in the model and narrative of "peak oil," which posits that the rate at which petroleum liquids can be pumped from the earth is nearing its global maximum. Peak oil is a classic specter of scarcity, a "hysterical concern with machine fodder" for an industrial system dependent on high energy and material throughputs (Illich 1973). In this sense, peak oil is like other incarnations of eco-scarcity that have haunted the development of the modern material economy, such as national panics over timber famines in the US and Europe at the beginning of the twentieth century, shortages of critical industrial minerals in the post-war period, and neo-Malthusian pronouncements regarding global food supply and population. Unlike the energy crisis of the 1970s, however, peak oil roots the origins of scarcity firmly below ground, rather than in the above-ground, social realm. As we shall see shortly, peak oil proclaims a particular form of "energy crisis" that is global in scope, geological in origin, and which takes the form of a permanent reduction in the rate at which conventional oil can be extracted.

Oil: the precarious incumbent

Six generations ago, oil was a bit player in an emerging lubricant market where it competed with the rendered bodies of whales, lizards, and fish. Oil now pulses through the lives of most people on earth. Profoundly distinctive, modern industrial economies are high-energy societies that have shattered historic "solar-income budget constraints" (Daly 1974, cited in Clark and York 2005: 406; McNeill 2000, Smil 2005). They bear little resemblance to the low-energy "biological old regimes" that characterize the bulk of human history, in which all energy was "derived directly from the sun: human and animal muscle power, wood, flowing water, and wind" (Marks 2002, cited in Huber 2009a; Hall *et al.* 2003: 318). However, like those previous regimes, energy's role in contemporary social metabolism is just as central, where social metabolism refers to the flows of matter and energy that enable social reproduction (Foster 1999). It is only by tapping and converting a variety of extrasomatic sources of energy over time that societies have modified environments, expanded resource bases, and generated the energy and economic surpluses that enable advanced social divisions of labor (Martinez-Alier 1987, Price 1995, Crosby 2006).

Over the last 200 years the shape and form of the material economy has been tightly linked to the discovery and development of very dense reservoirs of energy in the form of fossil fuels. The significance of these fuels is their capacity to generate tremendous energy "surpluses" (the net return on energy invested in their extraction) compared to renewable energy sources (Cleveland 2007). The raiding of fossil energy stocks in this period has enabled those who command such energies to have a scale and intensity of influence on biogeochemical flows that, in many cases, now exceeds that of natural systems (Crutzen 2002, Dalby 2007). The effective subsidies that fossil fuels provide have also underpinned huge gains in labor productivity (as fuel-based machines substitute for human labor), an unprecedented concentration of productive powers that enable massive economies of scale, and a deepening of the exploitation of nature. As such, the application of ever-greater fossil fuel inputs has been a primary means by which prodigious increases in the production of renewable and non-renewable resources have been maintained over the last 200 years, in the face of declining quality of raw materials and the exhaustion of localized stocks. Ecological economists point out how the much-vaunted productivity of agricultural and industrial systems in value terms is inversely proportional to their productivity in energy terms: rising agricultural yields have been secured only through substantial fossil fuel inputs, for example (Martinez-Alier 1987). In this way "energy crisis" – in the sense of an impending failure to provision industrial societies with the abundance of energy to which its machines and infrastructures have become accustomed – is the mother of all scarcities, a sputtering of the elixir of perpetual expansion by which economies have procured more from less, expanding resource output even while drawing on poorer and poorer quality materials (Bridge 2009).

The step change in available energy enabled by the development of fossil fuels is described by the sociological concept of "metabolic rift," a rupture in the historical patterns of material exchange through which societies reproduce themselves (Foster 1999, Clark and York 2005). Rift here refers both to changes in the scale and geography of physical flows – a massive net transfer of carbon from lithospheric stocks to the atmosphere through the combustion of coal, oil and gas, for example – and to substantial shifts in the geographical organization of economic activity and social life. Unlike wind, water or other solar-derived sources of energy, fossil fuel energies can be expanded and made to flow at will, enabling the realization of economies of scale. They are mobile in a way that wind and water power are not, and allow an unprecedented geographical concentration of production (Huber 2009a). The reliance on machines and large-scale infrastructure for the release of fossil energies also creates conditions for the concentration of capital. Capitalism pre-dates the widespread use of coal in industrial production, but the productive possibilities of fossil energies have given industrial capitalism many of its distinctive social and geographical forms so that it makes sense to talk of a "fossil fuel mode of production." Huber (2009a), for example, argues that by decisively shifting productive forces from human labor to machines, fossil fuels generalized the conditions for a class monopoly over the means of production. And in the sphere of circulation, fossil fuels overcame "the biological constraints of transporting goods" and became a primary means for expanding markets and reducing the costs of circulation.

Although coal remains a cornerstone of the world's primary energy supply, it is oil that has underpinned the modernization of agriculture, driven an unprecedented expansion in personal mobility, and underwritten global economic integration via international trade over the past 60 years (nearly two-thirds of the world's refinery output is used in transportation (Smil 2008: 15)). Energy historians describe a coal-to-oil transition in the twentieth century, in which coal's share of the world's primary energy supply fell from 75 percent in 1900 to less than 23 percent in 2000, although absolute output of coal rose nearly 6-fold in this time (Smil 2005: 13; Podobnik 2005). The significance of this transition in energetic terms is that it moved the material base of the economy up the so-called "resource pyramid," from a lower-grade source of energy (coal) to a higher-grade (liquid fuels, derived from crude oil). With the highest energy content per unit volume, liquid fuels occupy the pinnacle of the fossil-fuel resource pyramid (McCabe 1998).

Oil's high energy density and liquid properties provide "peculiarly prolific capacities for enhancing productivity" and have made it the pre-eminent *social* hydrocarbon of the twentieth century (Huber 2009a: 106). While the mix of energy sources varies widely at a regional or national scale – and one can find starkly different energy systems co-existing in places with marked social inequalities – oil has become embedded in social institutions and material infrastructure to a peculiar degree. The sheer ubiquity of oil means that it is a commodity like no other: oil's applications are more numerous, more intimate and more transformative of social life than those associated with coal, steel or uranium. Through the extensive socio-technical networks associated with mobility and mass consumption, oil has permeated throughout social and cultural life during the twentieth century. In North America, and to a lesser extent in Europe, oil was integral to the Fordist/Keynesian solutions to a crisis of under-consumption that manifested itself in the Great Depression. Through expanding automobility, suburbanization, and development of a mass market for consumer durables, demand for oil was effectively built – via physical engineering and socio-cultural convention – into the social and geographical structure of urban, national and international economies (Huber 2009b, Mitchell 2009a).

The high-energy, oil-fuelled economy, then, is a heavily incumbent energy system with a degree of political, economic and social embeddedness that makes it difficult to dislodge (Kern and Smith 2008). Yet this sprawling, self-reproducing system perches on the lofty heights of the resource pyramid, its material magnificence dependent on the continuing support of a narrow range of top-quality hydrocarbons. It is this ungainly, potentially precarious state of affairs that provides the context for concerns about peak oil.

Peak oil: a crude crisis

Peak oil is a proposition about the relationship between the rate at which conventional crude oil is currently taken from the ground and the rate at which it can be extracted in the future. Although peak oil has developed a wide and popular following since the late 1990s – and to some observers has become a "catastrophist cult" (Smil 2006a) – its narratives and models are strikingly coherent having been developed through the activities of the Association for the Study of Peak Oil (ASPO) and its network of national organizations (Bridge and Wood 2010). Peak oil consists of three distinct but sequential claims: (1) that the extraction rate for petroleum liquids (i.e. for conventional oil) is nearing its global maximum; (2) that the imminent peaking of global production marks the onset of a permanent shortage relative to demand; and (3) that permanent shortage conditions change the structural characteristics of the international oil market in ways that will be felt as an "oil shock" – a hike in price that marks "the end of cheap oil" (Campbell and Laherrère 1998). Thus one of the early proponents of peaking concludes that the next "oil shock" will be "paralyzing and permanent" and "will not be solved by any redistribution patterns or by economic cleverness, because it will be a consequence of pending and inexorable depletion of the world's inexpensive conventional crude oil supply" (Ivanhoe 1995: 88).

Underpinning these claims is an application to the global scale of the "Hubbert model" – a statistically-based model of oil depletion developed for U.S. oil production by a Shell geologist, Marion King Hubbert, in the 1950s (Deffeyes 2001). The model indicates that, for any large region, unrestrained oil production will peak when about half the reserve is gone. By comparing reliable figures on oil extraction worldwide over the last 150 years with the best assessments of remaining reserves, global applications of Hubbert's model indicate a maximum rate of extraction sometime between 2010 and 2025, depending on how conservative an estimate of reserves one adopts. Supporting evidence comes from the reduced rate at which large fields are being discovered (despite significant improvements in exploration technology), from decline curves/depletion rates at existing large fields, and from the recent history of major oil provinces (like the North Sea) which reproduce the peaking that Hubbert correctly predicted would occur in the United States in the 1970s.

The eponymous "peak" – the inflection point of the global oil supply curve – is significant because it marks the point beyond which aggregate extraction cannot be increased. Peak oil is not, then, the same as an "oil crunch," a *reversible* supply squeeze arising from a combination of historic investment rates in the oil sector and unexpectedly rapid increases in demand. The importance of the peak, in other words, is that it marks a permanent departure from the long experience of rapidly expanding oil production and consumption in the twentieth century. Aleklett (2006: 10) neatly captures both the scale and sense of historic inversion associated with the onset of a peak in production: whereas 50 years ago global consumption stood at 4 billion barrels per year, and new exploration yielded 30 billion barrels per year, now consumption worldwide is 30 billion barrels per year, and only 4 billion barrels per year are added via exploration. Post-peak is a supply-constrained world in which oil is no longer a standard commodity: rather than being determined by the marginal costs of supply (give or take some fluctuation), oil prices are a function of the economic and strategic value of oil to consumers.

A uncomfortable embrace: misplacing crisis in depletion

The relationship of resource and environmental geography to statements of physical resource scarcity and "limits talk" is complex, and reveals a continuing struggle between two different epistemological traditions that make up contemporary "resource geography." On the one hand, resource geographers and some political ecologists have found gainful employment inventorying and cataloguing natural resources and their rates of consumption at local, state, federal, and international scales in order furnish some kind of answer to contextual questions about environmental and resource limits. On the other hand, political ecology and resource geography also have a robust tradition of critical inquiry which examines how ideas about nature – and nature's limits – are integral to the production of social differentiation and domination (Harvey 1974, Peluso and Watts 2001). For this critical tradition, "natural resources" and "resource constraints" are problematic claims that express positional – as opposed to universal – appraisals of the meaning, significance and value of the non-human world. The notion of "natural limits," for example, has been used to legitimate regressive social policies that deny rights and freedoms to less powerful groups, that curb redistributive ambitions, and which regulate social behavior in the name of saving the earth. This critical epistemological tradition has broadly taken an anti-naturalist position when it comes to resource scarcity: it argues that environmental conditions are under-determined by nature, and that the criteria for deciding among different environmental futures come from within society rather than being imposed by natural limits.

It surprising, then, to find that peak oil's claims are accepted by many writers and thinkers in the critical left-tradition. One finds in their engagement with peak oil a disturbing flirtation with the "future-as-disaster" that is a consequence of having abandoned a well-honed critical position on the production of scarcity. This capitulation to "limits talk" crops up in a number of places, including, somewhat surprisingly, in the work of ecological Marxists. Altvater (2007: 46, 55), for example, sees peak oil as a sort of judgment day for "fossil capitalism": "the peak," he argues "and thus the limits, of oil production have a major effect on the capitalist accumulation process" and "the fuel driving capitalist dynamics is running out." In an extensive and largely affirming review of the peaking literature, Foster (2008: 7) posits that peak oil may represent a "global turning point" because of the way "an imminent peak in conventional oil. . .strikes at the lifeblood of the existing capitalist economy." Although he explicitly guards against a charge of environmental determinism, the peak oil condition is presented throughout as an external, geologically-based constraint, a primary influence on the rate at which oil can be made to flow from the ground, and the stage for a new round of geopolitical struggle. In other analyses – including Harvey's (2003: 23) *New Imperialism* – an increasing scarcity of oil becomes the explanatory context for oil imperialism: a generalized scarcity argument that propels a "bidding war" or "resource war" where notions of natural scarcity and national security interweave (Caffentzis 1992). Other authors pick up peak oil's arguments for different reasons: in recent work on the politics of calculation around oil and climate, for example, Mitchell (2009b) rests his careful analysis of the production and proliferation of uncertainty on peak oil's premise that the moment of maximum extraction is imminent. One finds, then, a range of writers and thinkers who are usually suspicious of natural limits echoing peak oil's core claims that (1) oil is increasingly scarce; (2) the constraints on its availability are now primarily geological; and (3) emergence of these constraints drives social and political action.

Perhaps part of what is going on here is a strategic determinism about peak oil: that is, a calculated recognition that arguments about imminent scarcity can ignite a deeply-rooted fear of running out, and provide a politically effective lever with which to drive economies away from oil. As important, however, to this consideration of oil's physicality is an effort to admit some of the materialities of oil into analysis – to engage "the properties of oil itself" (Mitchell 2009a: 401) –

and make a space in accounts of oil's political economy for the non-human. Such a motive and ambition are welcome, of course, as they are essential to developing a more thoroughly materialist, political-ecological account of the worlds produced in and through oil. Peak oil's strong sense of fixed geological constraints governing oil's future availability, however, is a crude means of introducing materiality. It snaps analysis back into a naturalist position that forecloses arguments about the social organization of oil production, the limited time-horizon of a market-based energy policy, or the ways in which the social metabolism of oil via the hydrocarbon commodity chain has effectively excluded many of oil's social and environmental costs from the calculus of market price.

The rush to embrace peak oil as a convenient example of capitalism's ecological contradictions is as surprising as it is politically problematic. In reaching too quickly to claim peak oil for its own, recent work on the critical left lets slip a rich body of empirically-grounded arguments about the fundamentally social origins of oil's availability, including historical accounts of the strategies used to organize scarcity in oil markets in the face of prodigious abundance. Peak oil hands the prevention of abundance/organization of scarcity over to geology, effectively depoliticizing the investment strategies of oil firms and the actions of resource-holding states. Empirical observation and carefully-crafted claims about the influence of "above ground" conditions on oil's availability – cartelization, the investment strategies of international oil companies, and resource nationalism – are cast aside as being of secondary importance compared to the new strictures of "below-ground" limits. The problem here is that for critical political economy the creation of scarcity is the heart of capitalist society, whereas for peak oil it is a natural condition.

The materialities of oil

Peak oil subscribes to a simple view of materiality as geological fixity: the rigid confines of the empty barrel. The aim of this penultimate section is to take forward the notion that "the properties of oil itself" matter by showing how the diverse materialities of the hydrocarbon commodity chain are much more expansive than those imagined by peak oil. Materiality here provides a way to capture and express the physicality of oil as a complex and combustible hydrocarbon but without attributing intrinsic qualities and causality to a substance whose forms, functions and geographies are defined socio-culturally, at least in part (Bakker and Bridge 2006). The materialities of oil, then, refer to the biophysical characteristics and material forms of oil as it flows in and through society and the way these are productive of particular forms of social relations.

From social metabolism to materialities

This section highlights five of the more significant of oil's diverse materialities. Each illustrates how some of the most troublesome social relations associated with the hydrocarbon commodity chain are not independent of oil's diverse materialities but bear their imprint (cf. Prudham 2005). Through these selected cases, the primary

"energy crises" of the age of oil are shown to be related not to physical depletion – *pace* peak oil – but to struggles over the distribution of economic value and socio-ecological costs of oil production and consumption. *First,* consider oil's properties as a liquid fuel and its superior capacities for work and transformation. In this usage materiality is very similar to the Marxian concept of "use values" where it refers to the qualities of materials and their usefulness to society. The point, here, however, is that these use values are neither uniform nor universal but vary geographically as part of a landscape of uneven development (Bakker 2004). The utility of gasoline, for example, is geographically and historically specific, so that the rate of gasoline consumption is not a fixed law based on its energy-to-weight ratio, but is related to patterns of use (Benton 1989). The "scarcity" of oil, then, is not a generalized physical shortage but a shortage relative to modes of living: as with other resources, oil's scarcity "presupposes certain social ends" (Harvey 1974, Bakker 2004).

Venerable and significant as this observation may be, it nonetheless tends to land with dull philosophical thud. Its implication, however, is that geographical variation in the utility of oil underpins oil trade, giving rise to an uneven landscape of oil creditor states (net exporters) and oil debtor states (net importers). Fewer than 30 countries are net exporters, and only a handful hold the majority of known conventional reserves. Accordingly, the hydrocarbon commodity chain is structured by a central tension between the interests of exporting and importing states, a tension that takes shape in the reciprocal flows of oil and finance between them. The vulnerabilities and strategic opportunities created by these flows of oil and money are at the core of international geopolitics, and structure the domestic politics of large exporting and importing states alike. Oil prices – a conventional measure of scarcity – can be read as an indication of the balance of power between oil exporting countries (symbolized institutionally by OPEC) and oil importers (institutionalized in the form of the International Energy Agency), with periods of relatively high prices corresponding to moments when exporters have the upper hand (Mommer 2001). It is here that peak oil's myopic fixation on "below-ground" constraints becomes clear. Its focus on rising oil prices and the deteriorating reserve/production ratios of many international oil companies ignores how the last decade has seen a significant swing back towards a "proprietorial" model of resource governance. This is manifested in, for example, the renegotiation of access agreements in Venezuela, Russia and Bolivia and a form of resource nationalism that sees decisions about the rate of production increasingly determined by the interests of resource-holding states.

Second, oil may have useful properties but, as a hidden, flammable and explosive liquid, it is difficult to appropriate and commodify. Popular imagery aside, crude oil does not occur as large, neatly-defined underground lakes, but as dispersed concentrations of variable chemical and physical quality trapped among ancient sediments. Some of the reservoirs targeted by international oil companies are far from markets and deeply buried – significant recent discoveries in the deepwater Gulf of Mexico are over 35,000 feet (approximately 9km) below the surface. Conventional oil's liquid character assists its transportation on the surface (it may be pumped in pipelines, for example), but underground its flow character makes it a fugitive resource. The migratory character of oil complicates the process of capture (particularly in large oil fields where there are multiple owners) because the actions of neighboring property owners are not independent. This has led historically to the development of distinctive rules of property in an effort to prevent ruinous competition (Libecap and Wiggins 1984). Commercial realization of oil's value, then, requires capturing a fugitive fluid of generally awkward physical and chemical properties, corralling it to the exclusion of others, and standardizing variations in chemical composition and flow rate so that it may be channeled in an orderly stream over long distances. Oil is not readily a "co-operative" commodity (Bakker 2004) and its proliferation as such is a remarkable feat of science, capital and law (as accounts like Yergin's (1992) *The Prize* and Chernow's *Titan* (1998) illustrate).

One indication of crude's recalcitrance when it comes to the commodity form is that the barriers to entry in the upstream oil sector are high: capital and technological requirements are forbidding, and oil production is dominated by a limited number of large firms. In turn, this organizational structure exerts an influence on the sort of oil reservoirs that are targeted: larger firms need to locate larger bodies of oil in order to replace reserves depleted by production, and large fields are far less numerous than smaller ones. This pattern has intensified following a wave of corporate mergers and acquisitions during the relatively low-price, lean years of the 1990s to produce an upstream industry structure dominated by a few companies that need to locate very large bodies of oil. Any shortage of drilling targets is, then, in part a function of the organizational structure of the industry. That apparently "geological" criteria like the type and size of reservoir are not independent of the way the industry is organized has at least two implications: the rate at which oil arrives at the surface is, to a significant degree, a function of the exploration and development strategies adopted by a few large firms; and competition to secure the requisite "giant" fields propels firms into frontier-type environments around the world, creating conflicts over access to resources and socio-ecological impacts of extraction that suggest strongly – and to no-one more so than those inhabiting the supply zones of the global economy – that maintaining a "normal flow regime" produces states of crisis.

Third, the materialities of oil also extend to the "geography of holes" – that is, to the specific material form that oil extraction takes in the field and, in particular, to the contrast between geographies of territory and extraction. An oil well represents a discrete, molecular point of access rather than a contiguous territorial claim. Compared to the expansive spaces of forestry or agriculture, for example – where production and the generation of value is diffused across a broad surface – the extraction of oil occupies a point in space rather than a laminar, extensive presence. In ecological economics, this highly concentrated spatial form is regarded as significant because oil fields have some of the highest power densities (measured in Watts per square meter) of any energy natural or anthropogenic feature on earth: compared to biomass or other renewables, an oil well produces an enormous flow of energy from a very small area (Cleveland 2007). Oil extraction, therefore, has a punctuated and discontinuous geographical expression that does not coincide with notions of national territory or development. The discontinuous geographies of extraction – their "molecular" rather than "territorial" logic – means that a principal axis of competition is the struggle to secure exclusive control over specific pieces of ground, rather than expanding a territorial domain. The extractive landscape is one of discrete spatial monopolies – patchworks of oil concessions that codify a logic of holding ground and "securing the hole," in which power comes not from the administration of territory but from the ability to control specific patches of ground. Not only does this produce in oil a particular logic of violence and possession that confounds notions of the modern state, justice and democracy (Watts 2004). It also contributes to the conspicuous failure of oil to drive nationally-based development in many parts of the world, and to the crisis of the "resource curse" – the persistence of poverty and deprivation amid enormous natural resources.

Fourth, the geographies of resource access described above mean that oil emerges into the social realm in highly concentrated, tightly-regulated streams. Oil wells are, in this regard, vertical analogues of the chokepoints and bottlenecks conventionally associated with oil shipment, concentrations of flow that generate significant opportunities for control. This vertical and horizontal chokepoint geography creates a high potential for price instability because of the relative ease – imagined or real – of shutting off significant sources of supply (via, for example, interruptions to production in the Niger Delta, hurricanes in the Gulf of Mexico, or periodic shifts in the level of geopolitical tension in the Persian Gulf). Analysts of short-term oil market shifts frequently allude to the bottleneck geographies of oil supply and, in doing so, indicate the tremendous opportunities such imaginary geographies of vulnerability create for capturing value through trading future claims to oil (i.e. oil futures) and via financially hedging against shifts in the price of oil. Since the creation of oil futures markets in the 1980s, the financialization of oil has played an increasingly important role in the production and trade of physical oil, as well as within international political economy more generally (Labban, forthcoming). Trade in oil futures changes the presumed causal relationship between physical oil supply and the market price, and seriously challenges peak oil's narrative that high oil prices and price volatility signal the inflection point of the production curve (Labban, forthcoming). By focusing on the material vulnerabilities of oil supply – and the way perceptions of supply vulnerability and risk create the conditions for the accumulation of fictitious capital via futures contracts – it is possible to see how expectations of crisis are integral to the financialization of oil. Rather than high oil prices being evidence for a geologically-determined crisis of supply, peak oil provides a crisis narrative about the fundamentals of oil supply and demand that fuels the financialization of oil.

Fifth, the materialities of oil extend to the systematic "leakage" of carbon at various points along the hydrocarbon commodity chain, via which fossil stocks of carbon are transferred from the lithosphere to atmosphere. This is not limited to cases of technical rupture – such as burst pipelines or tanker spills – but extends to the institutions of the high-energy society that make it possible for the full social effects of oil's use not to register in the price paid by consumers. The social and geographical displacement of pollution associated with oil is well-catalogued in studies of urban air quality and refinery emissions, and in accounts of environmental destruction during the extractive phase. These indicate how trade in oil is a process of ecologically unequal exchange, in which highly-ordered, high-value energy sources accrue to those with wealth and power while the socio-ecological costs of tapping, refining and using highly concentrated energy sources are displaced onto others (Martinez-Alier 2002). Since the early 1990s, the primary target of scientific and popular concern is the emission to the atmosphere of carbon dioxide from fossil fuel combustion. By taking advantage of the dispersal and mixing capacities of the atmosphere, the negative social and environmental effects of oil use can be made to fall outside the hydrocarbon commodity. Because it enables market prices for oil to be some way below oil's full social cost, the availability of the atmosphere as an unpriced external "vent" for the metabolized waste products of oil ensures oil is artificially "cheap," exerting a powerful influence on the rate at which oil flows through economies. From this perspective, peak oil's concern with an impending slow-down in the rate of oil extraction is curiously irrelevant: the primary challenge for the twenty-first century when it comes to oil (and other fossil fuels) is to slow the rate at which fossil carbon is mobilized and released to the atmosphere. *Contra* the claims of peak oil, the problem is not one of trying to get more oil (or coal or gas) out of the ground, but of finding ways to keep it shut in.

Conclusion

A conventional understanding of "energy crisis" centers on the prospect of sudden and prolonged shortage due to a failure of institutional structures that, thus far, have proven capable of collecting, converting, and distributing energy in ways that reproduce prevailing socio-economic and environmental forms. The narrative of "peak oil" re-articulates this long-standing fear, by pointing to the moment when the "immutable physics" of oil reservoirs will kick in to constrain the ambitions of a modern, high-energy society based upon expanding the throughput of conventional oil (Campbell 1998). I have argued in this chapter that the fossil-based model of social metabolism is indeed in crisis, but not because of a geologically-driven supply-side failure as imagined by the proponents of peak oil. I have suggested that the "crises" of the fossil-fuel mode of production lie not in any post-peak apocalypse, but in the everyday "normal" operation of the contemporary oil economy. The degree to which oil has become embedded in economic and social life means these crises take on a variety of forms, and I have illustrated just a handful of the different ways in which the hydrocarbon commodity chain may be considered to be "in crisis" even in the absence of significant disruptions to supply. From this perspective, crisis is the political expression of contradictions that are inherent to the social metabolism of energy and matter.

Critical geography possesses a set of well-honed tools for analyzing scarcity and, in that sense, the apparent embrace of peak oil by some commentators on the critical left is surprising. In an effort to redress the crude naturalism of peak oil, this chapter has adopted a "new materialist" understanding of scarcity (Castree 2009). It has sought to specify the materialities of oil and carbon, and the way in which these material forms give a structure to the social relations that surround the extraction, distribution and consumption of oil, in order to understand why and how oil is made simultaneously abundant and scarce over time.

In contrast to peak oil's proposition about natural limits, energy futures "past peak oil" will be socially rather than geologically determined. Oil may be incumbent, and the challenges of moving "beyond oil" should be not under-estimated. But there are encouraging signs that some of oil's "normal" contradictions are becoming increasingly politicized – around climate change, the development effects of oil extraction, and "energy security" for example – so that the political economy of energy is being reshaped now more than at any time since the early 1970s. This struggle to define the contours of a new energy regime is expressed in contemporary policy discourses about energy transition and low-carbon pathways, as well as in alternative formulations like "décroissance" and "energy descent," among others (Latouche 2009, Odum and Odum 2001). What is clear, however, is that one cannot pin hopes on peak oil's recessionary limb as a means of addressing the contradictions of oil: fossil fuels – and conventional oil – are likely to remain dominant sources of energy for a long time yet, because there is "no readily available non-fossil energy source that is large enough to be exploited on the requisite scale" (Smil 2006b). Significant increases in the use of coal, gas and oil are likely, particularly in developing economies. In fact, in economic terms there is "no urgency for an accelerated shift to a non-fossil world: fossil fuel supplies are adequate for generations to come; new energies are not qualitatively superior, and their production will not be substantially cheaper" (Smil 2006b: 23). Any transition away from fossil fuels, therefore, will be historically unique in that transition will be towards lower quality, more costly resources and largely as a political response to recognition of the incumbent energy system's social and environmental costs (Smil 2006b, Cleveland 2007).

Articulation of the contradictions inherent to the production and use of fossil fuels is currently most advanced around climate change and, in particular, in calls by "low-energy" countries in the global South for climate justice. The failure to secure binding agreements on carbon emissions at the Copenhagen Climate Change Conference in 2009, however, revealed something of the geographical political economy of fossil energy use. Copenhagen demonstrated that climate change is part of a broader crisis of social metabolism that revolves around geographically uneven rates of hydrocarbon throughput. The strong linkage between energy availability and human development (Figure 14.1) means that *expanding* the provision of high quality energy sources – such as liquid fuels and electricity – remains a priority for large numbers of people in the global South (Cleveland 2007). Technological innovation and investment in new, low-carbon energy infrastructures will certainly form a substantial part of any new energy paradigm. The analysis of "energy crises" offered here, however, suggests that because a progressive energy future will necessarily include a substantial role for fossil fuels, an important goal should be to reform the institutions of the hydrocarbon commodity chain as part of constructing a more sustainable and just energy future "past the peak."

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15 The geopolitics of energy security and the war on terror: the case for market expansion and the militarization of global space

Mazen Labban

In 2006, the prestigious journal *Foreign Policy* and the Center for American Progress surveyed "America's top foreign policy experts" to find out how the United States was faring in the war on terror (*Foreign Policy* 2006). The survey was motivated by an apparent contradiction between the Bush administration's declaration that the "war on terror is being won" and its warning that "another attack is inevitable." What is remarkable about the survey is that 82 percent of the experts interviewed by *Foreign Policy* agreed that "Becoming less dependent on foreign sources of energy will strengthen national security." What is even more remarkable is that 90 percent of the public agreed with the experts on the threat to national security from dependence on foreign sources of energy – the only matter of national security on which both the general public and the experts agree. Those experts saw that the "single most pressing priority in winning the war on terror" resided in ending the dependence of the US on foreign oil, more pressing than "killing terrorist leaders," "promoting democracy in the Muslim world" and "stopping the proliferation of nuclear weapons." Sixty-four percent of those experts believed (in 2006) that US energy policies have actually made things worse as US oil imports appeared to fund terrorism.

US dependence on foreign oil appears to undermine national security at a more immediate, material level. Two-thirds of the "highest echelons of America's foreign policy establishment" believe that direct attacks on energy infrastructure will be the most likely "method" employed by terrorists to attack the US. Yet, because the actual incidence of terrorist attacks has declined since 2001, presumably because of the "success" of the war on terror, energy and security experts have resorted to the *threat* of terrorism to justify the military protection of the global oil supply network. The mere threat of a terrorist attack, the argument goes, is enough to spike oil prices because the decline in the expansion of oil production capacity behind rising global demand has created a very tight market. This has largely resulted from the investment strategies of state-owned companies that continue to block the flow of capital into expanding reserves and production. This structural condition has magnified the effect of any potential disruption, or threat of disruption, to the supply of oil – effects that would not be confined to the US, but would have global repercussions. The threat of terrorism thus requires the *securitization* of global space in its entirety as a preventive measure against the risk of terrorist attacks: