Lifeblood

OIL, FREEDOM, AND THE FORCES OF CAPITAL

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A Quadrant Book

University of Minnesota Press
Minneapolis
London

INTRODUCTION

Oil, Life, Politics

In the summer of 2008, the global price of oil skyrocketed to $147 per barrel, and in the United States, gasoline prices reached a historic peak of $4.11 per gallon. President George W. Bush was acting very much like an "addict" leader of the country he accused of being "addicted to oil" in 2006.[1] Bush made two visits to Saudi Arabia within five months to plead with the kingdom to open up its valves to lower oil prices.[2] Later in the summer, claiming to speak for "American families,"[3] Bush attempted to lift a twenty-seven-year-old ban on offshore drilling on most of the eastern and western coasts of the United States.[4] In May, presidential candidates John McCain and Hilary Clinton found common ground in a proposal to offer a federal "gasoline tax holiday" for the summer driving season.[5] Both struck populist tones as Clinton spoke out for "hard pressed Americans who are trying to pay their gas bills at the gas station" and McCain said he just wanted "to give low-income Americans . . . a little relief." Although the proposal would serve to lower prices and guarantee more oil consumption, Clinton bizarrely claimed that opposing the policy would "stand with the big oil companies."[6] Perhaps the high point in McCain's otherwise floundering campaign was his mobilization of popular energy through pro-oil development slogans such as "Drill, Baby, Drill" and Newt Gingrich's illogical rallying cry, "Drill here, drill now, pay less" (published as a book).[7] Later in the summer, McCain held a rally of motorbike enthusiasts in South Dakota ridiculing then Democratic nominee Barack Obama's call for energy conservation measures such as basic tire inflation. He declared, "My opponent doesn't want to drill . . . he wants you to inflate your tires," as the crowd roared in laughter.[8]

With less than 5 percent of the global population, the United States is by far the largest global consumer of oil, using 19.1 million barrels per day—around 22 percent of total consumption (see Table 1). Despite popular fears of skyrocketing demand from emerging economies, it is worth pointing out that the United States still consumes more than the so-called BRIC (Brazil, Russia, India, and China) countries *combined*. Thus the gas tax holiday stood in stark contrast to opposite policy analysis that suggests the need to increase the already miniscule gasoline taxes in the United States in line with European levels in order to curb driving and oil consumption.[9] Yet such an increase is viewed as politically impossible.[10] As evidence of this political impossibility Barack Obama's campaign also placed the *lowering* of gas prices as the ultimate priority: "We do need to bring down gas prices, and as President, I will."[11] He also focused on the populist suffering of the American working class: "I hear from families every single day who are feeling the crushing burden of higher gas prices."[12] Sensing the political risk of opposing domestic drilling, in early August 2008, Obama reversed his early opposition and announced openness to some forms offshore drilling.[13] The concession was followed by President Obama's real proposal for the expansion of offshore drilling three weeks before the biggest maritime oil spill in U.S. history in the Gulf of Mexico in April of 2010.

Table 1. Top Ten Oil World Consumers, 2010

Country	*Petroleum consumption (million barrels per day)*	*Percentage of world total*
1. United States	19.1	22 percent
2. China	9.4	11 percent
3. Japan	4.4	5 percent
4. India	3.1	4 percent
5. Russia	3	4 percent
6. Saudi Arabia	2.7	3 percent
7. Brazil	2.6	3 percent
8. Germany	2.5	2.9 percent
9. South Korea	2.2	2.5 percent
10. Canada	2.2	2.5 percent
Total world consumption	**87.02**	**100 percent**

Source: Energy Information Administration, 2011.

After the release of Al Gore's *An Inconvenient Truth* in 2006 and the 2007 Intergovernmental Panel on Climate Change report, it seemed that real change of the U.S. energy system was not only necessary but actually possible. Yet the summer of 2008 revealed that hope of such change was false and that, more accurately, the winning campaign would be the one that promised more oil at cheaper prices. The 2012 campaign promised more of the same with a 2011–12 gasoline price surge constructed as danger for Obama's reelection bid.[14] The popularity of "Drill, Baby, Drill" sentiments and public outrage over high gas prices reveal the bewildering paralysis of energy politics in the United States. Since at least the 1970s, there has been a substantial consensus that levels of U.S. oil consumption forebode deepening ecological, geopolitical, and social crises. Yet no political coalition has been able to actually tackle this problem. While many on the environmentalist left are comfortable attributing this impasse to a conspiracy between the oil industry and the U.S. state, the uncomfortable fact, underscored by populist rhetoric, is that policies meant to curb oil consumption—such as gasoline taxes and fuel efficiency standards—are unpopular to a U.S. electorate for whom cheap gasoline has become a basic aspect of everyday survival in an era of eroding economic security. It seems that no amount of wars or oil spills—not even the prospect of the extinction of our species—is enough to push U.S. politics away from this kind of energy populism based on cheap-fossil-fueled livelihoods. It certainly does appear that the United States is indeed as a society addicted to oil. Yet the "addiction" metaphor presumes that oil is an overarching, uncontrollable force hovering over society. The question posed by this book is how this came to be.

Problematizing U.S. Oil Addiction

It has become "common sense" that the level of U.S. oil consumption is a massive yet intractable problem. It is important to be precise about the specific consumptive practices that rely on oil. In popular discourse oil is too often conflated with energy in general, but oil is mainly a source of energy as *liquid fuel* for the transportation sector—gasoline for automobiles, diesel fuel for trucks, jet fuel for airplanes, and heavy fuel oils for ocean tankers, railroads, and other kinds of mobile machinery.[15] Overall, 71 percent of U.S. petroleum consumption goes toward transportation, and 93 percent of all energy consumed in transportation comes from petroleum. The bulk of the rest of oil is used in the industrial production of a whole host of products from chemicals to plastics.[16] Ever since the oil shock of the 1970s, virtually none of the oil consumed in the United States

is used to generate electricity, which is, of course, a major and quite different aspect of everyday energy consumption, from using televisions and lights to recharging batteries for iPods and cell phones (and increasingly automobile batteries now and in the future). Oil is primarily about powering a certain kind of mobility characterized by an individuated command over space, or what Raymond Williams called "mobile privatization."[17] Thus, when it comes to "oil addiction," most agree the problem is rooted in the particular form of auto-centric suburban development prevalent in the United States.[18]

We are well aware of the problems of "oil addiction." Ecologically, the combustion of petroleum in the United States is the leading emitter of carbon dioxide (43 percent of the total), and the extraction, transportation, and refining of petroleum produces ecological degradation all along the commodity chain.[19] Ever since the oil embargo in the 1970s, U.S. oil consumption also produces geopolitical discourses of anxiety over dependence upon foreign sources of oil from racialized zones of the Middle East implicated with authoritarianism, terrorism, and greed.[20] The sociospatial patterns of suburban life made possible by automobility and massive oil consumption create crisis narratives of declining social solidarity and community and the individualization of American culture.[21] Moreover, this geography of dependence is framed as utterly doomed because of the imminent arrival of "peak oil" and geological scarcity that will yield explosive price increases and usher in a *Mad Max*–style dystopia structured by scarcity and conflict.[22]

The "addiction" metaphor frames oil as an uncontrollable thing trapped in the American bloodstream—pernicious, yet practically unavoidable. A 2011 *National Public Radio* story featured citizens trying to "quit" oil, but they soon were overwhelmed by the inundation of petroleum products within common everyday practices: "Even those who carry on the most ascetic, pared-down existence depend on petroleum in some form or other."[23] Of course, there is the automobile, but plastics, food, and *any commodity* that is transported by truck is also tied to the use of oil. Clearly, the unavoidability of oil is central to the addiction narrative, which positions oil as an overarching force hovering over the public.

More than anything else, the discourse of addiction *naturalizes* petroleum consumption as an unavoidable aspect of life that cannot be changed through politics or culture. The very idea of addiction presupposes a *physicality* that supposedly escapes psychology, culture, and politics. Thus the "prescription" for ending this material addiction requires a form of technocratic behavioralism—policy mechanisms that influence behavioral change (e.g., traffic congestion pricing), subsidies

that encourage alternative energy technological innovation (e.g., federal loans for electric vehicles), and market mechanisms that put a price on ecological destruction (e.g., a tax on carbon). Moreover, the problem of "oil addiction" is too often imagined as a *purely* material problem composed of the sheer amount of demand, the absolute space between home and work, the convenience of plastics, and the energetics of fossilized food production. In this book, however, I argue that the problem of oil addiction is about not only our material relation with energy resources but also how energized practices shape particular forms of thinking and feeling about politics. If the textbook definition of energy is the ability to do work, I pose a different question: can energy do political work? What if the most problematic relation to oil is the way it powers forms of social life that allow individuals to imagine themselves as severed from society and public life? Oil is a powerful force not only because of the material geographies of mobility it makes possible but also because its combustion often accompanies deeply felt visions of freedom and individualism. It turns out these ideals are much harder to shake than the built environment of petroleum-fired suburbanization. This is not an "idealist" proposition of the need to think about culture and politics *against* materialism but rather a perspective on materiality that is always already cultural and political.[24]

Those who emphasize the political and historical roots of our oil predicament often focus on large powerful forces shaping the social use of energy. Many scholars have told the history of "oil addiction" as simply the product of a class alliance of oil, automobile, and real-estate capitalists who conspired to destroy public transit and lock in internal combustion–fired automobility and suburbanization.[25] In this story, oil consumers are featured as "dupes" in the master plans of profiteering capitalists. In a broader sense, the story of oil is almost always told from the perspective of "big" forces—geopolitical strategy, oil kingdoms, titans of oil finance, and global oil capital.[26] The struggle for the oil 'prize' is a "great game" between powerful actors with the globe as their stage.[27] Yet the problem with these big stories of oil is they ignore the fact that oil is also incredibly *ordinary* because it is embedded in everyday patterns of life. In the realm of petroleum and everyday life, others have importantly focused on the more pernicious forms of injustice along the petroleum commodity chain—from the destruction of livelihoods in the Niger Delta to the segregation and violence imposed on the oil workers in Saudi Arabia[28]—but this injustice is reproduced through the other, ordinary ways in which oil consumption becomes naturalized in the United States and elsewhere. Approaching oil from the perspective of everyday life leads to much

different understandings of oil politics: less big, geopolitical, and strategic and more banal, taken for granted, and "commonsense."

This approach focused on everyday practices of consumption is anchored through a focus on a quite ordinary idea—that of "life." The centrality of oil is not simply the product of self-interested capitalists seeking a market but also a product of wider struggles over the sociospatial stuff of everyday life—housing, transportation, and urban spatial form. Timothy Mitchell's important new work instructs us to "follow the . . . oil itself," but in order to understand the complex relations between oil and ideas of "the American way of life" we must also follow social relations, politics, and struggles over how life is lived that stretch far beyond the wells, pipelines, and refineries immediately stained with oil's toxic residues.[29] In the chapters that follow, I will trace the history of how oil became constitutive of a specific cultural politics of life in the United States. Indeed, as a recent Gulf Oil campaign suggests (Figure 1), oil is now *equated* with life itself, a life that *necessitates* a form of spatial practice "one mile at a time." Although the easy shorthand—"the American way of life"—best approximates this cultural politics, this phrase is all too often vague and all encompassing. My aim is to untangle the specific political logics underlying this vision of life and suggest that this broader politics has as much to do with the persistence of our "oil addiction" than anything else.

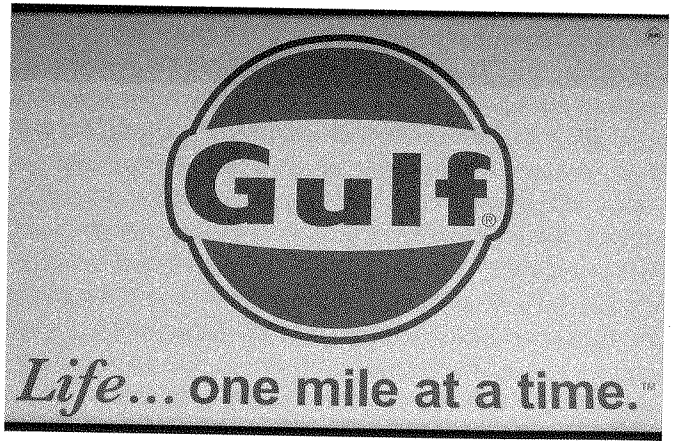

FIGURE 1. "*LIFE* . . . ONE MILE AT A TIME."
Gulf Oil's ad campaign "*Life* . . . One Mile at a Time" was developed in the mid-2000s and persists today. It not only equates life with oil but also invokes a specific geography of mileage. Photograph by Michael Wall.

Oil and the Meaning of Life

In the aftermath of September 11, 2001, and specifically the revelation that fifteen of the nineteen hijackers came from oil-rich U.S. ally Saudi Arabia, U.S. oil consumption habits were increasingly framed as having specific linkages to emerging discourses of "terrorism."[30] Such a linkage obviously created much anxiety after a decade framed by low gas prices and the rising popularity of sport-utility vehicles (SUVs).[31] A November 2001 *New York Times* article titled "Made in America, and Never Mind the Gas Mileage" raised the question of a possible hypocrisy within a culture that both bought SUVs "like crazy," in the words of one car salesperson, and equated big American-made cars with a certain level of patriotism.[32] The reporter spoke with one woman loading groceries into her Chevy Tahoe; she said: "I don't think it's unpatriotic to use so much gas. . . . It's very patriotic. It's our way of life. . . . Why should we cut back? . . . We're an affluent society. Should I hate my neighbor because she has a better house, a better car, more money?"[33] It is easy to caricature such views as evidence of American profligacy, excess, and arrogance. Indeed, according to certain perspectives aligned with the consumer-as-dupe outlook, American culture is easily ridiculed as wasteful and blithely unaware of the profound relations of destruction bound up within each tank of gas. Take peak oil icon James Howard Kunstler, who is well known for his infantilization of U.S. culture and "the American way of life": "We've become a nation of overfed clowns and crybabies, afraid of the truth, indifferent to the common good, hardly even a common culture, selfish, belligerent, narcissistic whiners seeking every means possible to live outside a reality-based community."[34] In essence, according to Kunstler, we are a zombie nation of cultural dupes too self-absorbed to wake up and face the "real world" of impending energy constraints.[35]

Yet such easy caricatures belie the complex subjectivities and cultural politics that underlie such an equation of "using so much gas" with "our way of life." The concept of "way of life" or *livelihood* is commonly mobilized as a claim to justify access to resources.[36] Whether articulated by indigenous groups or shared ideals of national ways of living, these claims create moral economies around resource practices. Again, as political ecologists have so often shown, what is most important is not purely the material relation to those resources but the cultural and political depth of such livelihood claims.[37] Thus it is essential to dig deep into this *moral* economy of "the American way of life." It is not simply a cultural form of entitlement to the resource-intensive geographies but rather a vision of life itself as "made" within a field of competitive market subjects. The woman

quoted crucially asks, "Should I hate my neighbor because she has a better house, a better car, more money?" This question fundamentally interrogates the assertion that the money and material commodities accorded to individuals are not deserved. Rather, it suggests that this particular way of life is structured by a social field wherein wealth and material goods *justifiably flow* into privatized hands that "worked hard" to achieve a particular material standard of life.

Following Michel Foucault's recently translated lectures on neoliberalism, I call this imaginary "entrepreneurial life."[38] I argue that this vision of life came to be equated with what is known as "the American way of life" based on privatized social reproduction, single-family housing, and automobility. This vision of "entrepreneurial life" has deep roots in American culture and politics. From Jeffersonian agrarianism to Emersonian self-reliance, from Horatio Alger tales of rags to riches to the Protestant work ethic, American politics has always been shaped by an ideology of self-made lives.[39] Yet I propose that prior to World War II, it was rather difficult to translate this vision of life into a popular mass appeal—the lives of the majority of workers in the United States were too structured by material deprivation and either an urban proletarian or rural smallholder sense of injustice. In the U.S. context, the absolute despotism of machine production and the deprivation of working life reached its ideological and economic limits with the Great Depression of the 1930s. To create a populist politics of entrepreneurial life—a view that one could actually shape a life as one's own—it took, in a word, *energy*—political and biophysical. It is well known that during the New Deal, mass political movements among workers and consumers pushed the state to profoundly restructure capitalist social relations around high wages (for some) and the Keynesian Welfare State.[40] Out of the crisis emerged social struggles and political projects reconfiguring the geographies of social reproduction—what Cindi Katz calls "the messy, fleshy stuff of everyday life"[41]—for a specific stratum of workers in the United States: a postwar social construction of life as composed of homes, cars, and yards.

It took biophysical energy as well—access to the prodigious powers of fossil fuel was further generalized to the public in the form of internal combustion engine–powered cars and a whole host of household appliances.[42] Therefore, rooted in the *material transformation* of social reproduction centered upon the spatiality of single-family home ownership and automobility, oil helps power what others have called "the real subsumption of life under capital," where subjectivity itself mirrors the entrepreneurial logics of capital.[43] This transformation gave millions of Americans the wages, the public infrastructure, and the financial institutions to mobilize

a whole host of energy-intensive machines in everyday life that surrounded what was once called the "electric-oil-auto complex."[44] Energy powered the privatization of social space. By extending the productive forces of capital—large-scale industry powered by fossil fuel—to the reproductive forces of everyday life, a specific stratum of American workers could now live, think, and feel an individuated sense of *power* over the geographies of everyday practices. Life appeared to some as a coherent space of privatized freedom—the house, the car, the family, the yard—that was entirely produced by and reducible to one's own life choices and entrepreneurial efforts. This way of life became synonymous with capital—an entrepreneurial life of choice and freedom to *make* a life for oneself.

Understanding the meaning of life cannot become a transhistorical, speculative exercise but rather must make clear the historical specificity of *capitalist* life. Too often injustice and environmental destruction is blamed on the noun *capitalism*. Yet, as Marx instructs, "capital is not a thing but a social relation."[45] Capitalism should not be an explanatory concept; capital's reproduction must be the object of explanation. "Life" under capitalism is only made possible through working for a wage (working under the command of capital) and thereby gaining access to the commodified means of subsistence. The precarious dependence of life upon capital must continually be produced and reproduced through what might be called the cultural politics of capital: the lived practices and meanings that naturalize capitalist forms of power and hegemony. For my purposes, the distinction between production (work) and reproduction (life) is critical.[46] The centrality of oil to a particular construction of "the American way of life" is itself a specifically capitalist construction of "life" opposed to "work." As Marx put it, "life for [the worker] begins where this [work] activity ceases."[47] As I will discuss at length, fossil-fuel-powered machinery is critical to the construction of a specifically capitalist form of despotism over "work"—or the labor process. On the other hand, oil specifically has become important in efforts to compensate for that despotism through the construction of a "way of life" aligned with the logics of capital—freedom, property, and entrepreneurialism.

Toward a Historical Ecology of Neoliberalism

In this book, I argue that oil's relation to "the American way of life" is central to the rise of neoliberal hegemony in the United States. In so doing, I aim to intervene in debates on neoliberalism in two ways. First, I follow recent historical research examining how the rise of conservatism in the United States was based on the mobilization of suburban populist anger

over high taxes and government efforts at wealth redistribution.[48] While most of these studies have focused on the particular cultural and political discourses emanating from suburban geographies, I focus on the material and ecological relationships that make those geographies possible in the first place.[49] Oil is but one of many of a whole host of material- and energy-intensive products that came to saturate suburban life in the post–World War II period. I'm specifically interested in the ways in which the incredible reservoir of "work" provided by fossil energy has provided the ecological foundation for a peculiarly privatized sociospatial existence. Rather than simply lament the ecological "footprint" of these practices, I seek to understand the ways in which their very materiality actively shapes political structures of feeling, reinforcing what Evan McKenzie calls "an ideology of hostile privatism."[50] It is the entrenchment of oil within these cherished ideas of property, freedom, family, and home that makes its deleterious ecological consequences that much harder to reverse. Indeed, while there has been considerable work on the neoliberalization of "the environment" or "nature" as a contained field of governance over naturalized realms of water, forests, wetlands, and fisheries,[51] we need to further understand neoliberalism itself—its ideologies, its core practices and policy prescriptions—as fundamentally shaped by the societal relation to resources, energy, and waste. In short, we need to move from understanding the politics of ecology and toward the ecology of politics.[52]

Second, I aim to complicate the standard *periodization* of neoliberalism as emerging out of the crisis of the 1970s and reigning until the present.[53] Although there are tremendous accounts of the *intellectual* prehistory of neoliberalism in the post–World War II period—from Mont Pèlerin to Milton Friedman's steady work in the 1950s—the popular roots of neoliberal hegemony were also *laid* in the postwar era through the steady expansion of suburban geographies in the Sunbelt and throughout the United States.[54] My contention is that the postwar period must be viewed as neoliberalism's *incubation period* wherein popular resentment of government, taxes, and Keynesianism festered and built itself until the political moment of opportunity in the 1970s emerged—a moment structured in no small part by concerns over "oil shocks." In fact, the historical roots of neoliberalism stretch back to the contradictions of the New Deal project itself (if not much earlier). Although New Deal liberalism was based around collective narratives of public solidarity and the beneficial role of state intervention, it created the conditions for a privatized geography of suburbanization. Despite the substantive gains achieved by a specific white male breadwinning factory worker, what has been called the "golden age" of capitalism or the "capital–labor accord"

was structured by profound exclusions based on race, gender, and ideas of citizenship.[55] It was precisely those divisions that were mobilized by the forces on the right in the 1960s and 1970s to construct efforts to extend civil and economic rights to African Americans, migrant farm workers, and women as forms of "unfair" redistribution of wealth from working-class white males to an "undeserving" underclass.[56] Thus the rise of neoliberal hegemony can be seen as a rather predictable consequence of the limitations of the ultimately liberal–reformist nature of the New Deal project to *restore capital* rather than as a fundamental challenge to its core precepts.[57] Specifically, the "capital–labor accord" maintained what Marx calls "the despotism of capital" in the realm of social life called "work" or "production" and fundamentally reproduced a class of workers who depended upon commodity relations and wages (however "high") to survive in the realm of "life."

Ecology and the Forces of Capital

As a natural resource and key element in contemporary discussions of climate change, a political economic perspective on energy must also speak to what Margaret Fitzsimmons famously referred to as "the matter of nature."[58] The theoretical analysis of the ecology of capital has been primarily concerned with the ways in which capitalism is inherently destructive of a domain called "nature." Many ecological Marxists argue that ecological degradation—the pollution of water or the spewing of greenhouse gases into the atmosphere and consequent climate effects—is not a form of market or regulatory failure but rather an internal product of specifically capitalist forms of competition and accumulation. James O'Connor argues that capitalist competition drives individual capitalists to systematically externalize costs onto the environment and society.[59] Thus the "second contradiction of capitalism" is its inherent tendency to degrade the *conditions* of production, which include the *ecological systems* such as water systems, soil fertility, and the climate. John Bellamy Foster and others have also charged a social realm called capitalism with inducing a "metabolic" rift with natural patterns of ecological circulation from soil nutrient recycling to the overloading of the biosphere with greenhouse gases.[60] Overall, these perspectives tend to construct a curious and undialectical dualism between capitalism and nature—as if nature is solely the depository of capitalist waste and destruction.[61] This not only ignores the many theoretical debates over the impossibility of pure distinctions between nature and society, but also assumes there is a realm called "capitalism" that is purely social.[62] Thus theories of the capitalist

destruction of an externalized nature fail to consider how ecological relationships with resources, wastes, and ecosystems already constitute the social and material geographies of capitalism itself. Focusing only on the moments where socialized capital confronts an externalized nature only skims the surface of the deeper metabolic relation between nature and society. While we cannot downplay the spectacular history of capitalist degradation of an externalized and imagined nature, an effective ecological critique of capital must also seek to understand the ecology internal to capital itself. By focusing on fossil fuel, we can begin to construct an ecology of capital where nature is not only seen as something "produced" by capitalism or as an external, uncommodified "condition" of production but is constitutive of and internal to the productive forces and social relations of capital.[63]

More empirically, there is a rich tradition of political ecology and resource geography that seeks to uncover place-based engagements between society and nature.[64] Yet these studies as a whole also assume that the real societal relation to nature is visible on the ground in specific sites of "nature-based" engagement (mines, forests, agricultural fields, and even urban parks and water systems) or the expulsion of waste into nature as "sink" or "environment." This allows one to assume that the societal relation to nature begins and ends in these naturalized spaces.[65] I contend that we must seek to also confront *denaturalized* geographies of nature–society relations—geographies constructed as highly unnatural and dominated by large-scale technologies and the built environments of intensive material and energy consumption and waste production. Indeed, it is these industrial spaces of massive energy and material throughput that are most responsible not only for global environmental concerns like climate change but also for more local concerns with air and water pollution. As this book will show, understanding the geographies of petro-capitalism requires understanding not only the politics of extraction or refinery pollution (although this is critical—see chapters 2 and 3) but also the socioecological relations of gasoline stations, single-family homes, automobility, and the dominance of petrochemicals and plastics in everyday life.

Materiality and the Plan of This Work

This book centers upon oil and the role of energy in shaping a particular regime of mass consumption.[66] But consumption, or consumerism, is often spoken of in the very abstract terms of the market itself—as an undifferentiated "mass" of goods and commodities that serve to

reproduce a standard of living. Ben Fine's "vertical" approach to the "world of consumption" insists that each particular commodity—as a specific use value—is contained within its own "system of provision": "Each commodity or commodity group is best understood in terms of a unity of economic and social processes which vary significantly from one commodity to another, each creating and reflecting upon what will be referred to as its own system of provision."[67] While this approach is often used to focus on cultural and economic processes underlying consumption, each commodity is also situated in a specific *ecology* of provision.[68]

Oil is too often constructed as a fetishized *object* of geopolitical conflict, state formation, corporate profits, or profligate consumption habits and not as an active material force in itself. The system of petroleum provision is structured by the specific materiality of the processes of extraction, distribution, refining, and consumption. Indeed, understanding the ecology of the forces of capital means a deeper understanding of the materiality of oil: how the biophysical attributes of oil itself—its dense energy, its liquid propensity to flow, its chemical composition—actively shape not only "the politics of oil" but also *politics* more broadly. This book is structured chronologically, but also materially—each chapter focuses on a specific aspect of the materiality of oil and how it shapes its "system of provision." Chapter 1 provides a theoretical introduction. Chapters 2 through 5 examine particular moments of crisis and stability in the long-term development of petro-capitalism in the United States (e.g., 1930s, 1945–73, 1970s, and 2000s). In chapter 1, I offer a theoretical critique of what I call the "fetishism of oil" that is reproduced in much of the critical political economy literature. I propose a broader historical–materialist perspective, taking into account the role of energy (and fossil fuel specifically) in the production and reproduction of life under capitalism. In sections on production and reproduction respectively, I argue that fossil fuel in general, and oil in particular, needs to be theorized as a specifically material aspect of the alienated—seemingly autonomous—power of capital over living labor. Specifically, I situate oil as a central energy resource shaping the forces of social reproduction, or what I call the real subsumption of life under capital. Under this form of subsumption, life *appears as capital*, or what Foucault's calls the "the enterprise form" so central to neoliberal subjectivities.

In chapter 2, I argue that the social struggle to produce the conditions for an oil-fired and commodified "American way of life" were complicated by problems of oil overproduction rooted the contradiction between a U.S. legal regime of private property and the materiality of petroleum

as a *subterranean resource*. During the 1930s, this property regime led to massive overproduction, glut, collapsing prices, and eventually a political regime dedicated to curtailing how oil reached the U.S. market. This created what was called the prorationing system that set "allowable" production quotas for thousands of wells across the United States. My goal is to situate these struggles over oil with the larger reconstruction of capitalist life surrounding New Deal reforms in housing, labor, and infrastructure policy.

Mitchell instructs that we need to "follow the carbon," but, in the case of petroleum-based life, it is perhaps more important to follow the *hydrocarbons*.[69] In chapter 3, it is oil's status as a complex chemical assemblage of hydrocarbons that allows the oil industry not only to extricate thousands (millions?) of petroleum-based products from a given barrel of oil but also to craft narratives emphasizing the unavoidability of oil through the saturation of chemicals, plastics, medicine, food, and gasoline in everyday life. The torrent of petroleum products produced through the refining process not only came to symbolize a specific set of cultural practices encircling "the good life" but also increasingly supplemented a vision of entrepreneurial life as an atomized project made possible through a specific set of material products in the postwar period.

Perhaps the most important material feature of oil in shaping larger visions of scarcity and geopolitics is its exhaustibility and the uneven geography of reserves. In chapter 4, I discuss how the peaking of U.S. oil production combined with the concentration of massive and highly productive (low-cost) fields in the Middle East shaped the geopolitical anxieties of the "oil shocks." Although these concerns of scarcity and geopolitics proliferated throughout the public imagination, I argue that the popular interpretation of the "oil shocks" was that the crisis itself was not "real"—if by "real" we mean natural scarcity and a market response of high prices—but rather a *contrived* crisis engineered by anticompetitive forces intervening within what should be an apolitical and pure space of the market. Drawing from letters written to newspaper editors and the Nixon administration, I show how popular disdain for monopolistic oil companies, racialized oil sheiks, and government oil price controls all coalesced to reproduce an emerging neoliberal idolatry of a pure, free, and, most important, *competitive* market. For the decentralized suburban "Silent Majority" of Richard Nixon and Ronald Regan's America, fairness was only realizable through the expurgation of large, centralized and visible forces intervening in the market—of which oil cartels, unions, and governmental redistribution were all representative forms.

Finally, in chapter 5, it is the liquid nature of petroleum that represents the condition of possibility of the *liquid landscapes* of mass gasoline availability in pumping stations scattered throughout the urban, suburban, and rural geographies of American life. It is this *omnipresence* of gasoline and its price that structures what I call the pain at the pump discourse of the 2000s, which bemoans high gas prices as a pervasive form of everyday oppression under neoliberalism. I argue that populist anger at high gas prices was less about cultural entitlement and excess, and more about life (and death) under the neoliberalism characterized by falling wages, mounting debt, and increasing job insecurity. Although cheap energy and natural resources represented a short-term reprieve from these forces in the 1980s and 1990s, the rising cost of energy and food in the 2000s represented the last in a long line of threats to social reproduction for working people in the United States. Yet the popular resistance to high energy prices—often framed in neoliberal terms as "energy taxes"—has disturbing implications for an ecological and anti-imperial politics.

I conclude by interrogating the relationship between oil, energy, and a central idea of "entrepreneurial life"—freedom. Just like imaginaries of freedom beyond work implicit in the idea of "the American way of life," Karl Marx hoped for a society beyond capital based on a "realm of freedom" made possible through the capitalist development of the productive forces and quarantined in a space for individual creative development *apart* from material production. Yet for Marx, this vision of freedom was only emancipatory *for all* if was achieved through the democratic control over society's productive powers. The neoliberal concept of freedom certainly created expansive geographies of *privatized* social control over the home, the car, and the family (for some small sectors of the global working class), but even for the suburbanites of the United States, it ultimately ceded the world of work, production, and the market to the despotism of capital. The ecological and economic crisis before us lays bare the need to assert democratic social control over not only the production and distribution of energy resources but also economic life in general.

Journal of American Studies
http://journals.cambridge.org/AMS

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Journal of American Studies / Volume 46 / Special Issue 02 / May 2012, pp 273 - 293
DOI: 10.1017/S0021875812000102, Published online: 30 May 2012

Journal of American Studies, **46** (2012), 2, 273–293
doi:10.1017/S0021875812000102

A Short History of Oil Cultures: Or, the Marriage of Catastrophe and Exuberance

FREDERICK BUELL

In opposition to energy historian Vaclav Smil, who argues that "timeless literature . . . show[s] no correlation with advances in energy consumption," this essay makes the general claim that energy history is significantly entwined with cultural history. Energy history is in fact entwined with changing cultural conceptualizations and representations of psyche, body, society, and environment; it is correlated not just with changing material cultures, but with symbolic cultures as well. To see this, the essay argues, one must conceptualize energy history in terms of a succession of energy systems – systems that are constituted by sociocultural, economic, environmental, and technological relationships. The essay's specific argument then traces the effects on symbolic culture, especially literature, of the nineteenth – and twentieth-century shift from coal capitalism to oil–electric capitalism. It starts by looking at the features of early oil extraction culture, from Drake's 1859 oil strike in Titusville, Pennsylvania to Upton Sinclair's novel *Oil!*, and examines how oil–electric capitalism develops and defines itself culturally against the previous era of coal capitalism. Then the essay considers how the consolidation of the oil–electric capitalist system is significantly related to the emergence of modernist culture, affecting the production of both popular culture and high art. By the end of the twentieth century, a new phase in oil–electric capitalism emerges with the expansion of the postwar petrochemical industry, the dramatic expansion of environmental crisis discourse in the 1960s and 1970s, and the return of peak-oil discourse to the mainstream in the last decade. The essay examines how the material features of oil, as well as its dominant uses as luminant, motor fuel, lubricant, and eventually petrochemical feedstock, take on cultural importance. Exemplifying both the cultural innovations and reinventions of oil capitalism from the extraction era to the consolidation era and the post-World War II period, the essay focusses throughout on the two recurring motifs, exuberance and catastrophe, as they play out in a wide range of literary texts and popular enthusiasms.

I

Vaclav Smil begins *Energy in World History* with a daring proposition. He considers Leslie White's assertion that the link between energy and culture is the first important law of cultural development. "Other things being equal," White writes, "the degree of cultural development varies directly as the amount of energy per capita per hour harnessed and put to work." Smil then cites the further claim by Ronald Cox that a "refinement in cultural

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mechanisms has occurred with every refinement of energy flux coupling."[1] Smil's book, he then says, is an attempt to evaluate these assertions.

Only at the end of his survey of energy history does Smil return to the subject. His conclusion is plain. "The amount of energy at a society's disposal puts clear limits on the overall scope of action" but does little more than that. Still more pointedly, Smil goes on to assert that "timeless literature, painting, sculpture, architecture, and music show no correlation with advances in energy consumption."[2] Case closed.

Yet today, oil presents society with a large portfolio of dread problems: rapid global warming that threatens lives, lifestyles, and ecosystems; an expanding number of serious, world-altering globalized environmental crises all related to fossil-fuel-fueled population and economic growth; increasing geopolitical instability, conflict, and terrorism related to control of oil supplies or affecting the production/distribution of oil; and a possibly imminent failure of supply – peak oil – that would wreck the world's economic and social systems. All of these crises have led to new, widespread awareness of just how completely oil has become essential to all aspects of humans' way of life, from agriculture to healthcare, transportation to consumer goods. Oil has become an obsessive point of reference in and clear determinant over the daily lives of many, either victimizing them directly and cruelly as with Shell in Nigeria, or Texaco in Ecuador, or making them increasingly feel that their developed-world normalities are a shaky house of cards. Indeed, it has become impossible not to feel that oil at least partially determines cultural production and reproduction on many levels. Nowadays, energy is more than a constraint; it (especially oil) remains an essential (and, to many, *the* essential) prop underneath humanity's material and symbolic cultures.

Yet no effective response to the huge conceptual gulf between energy and culture that Smil found has been made. Is asking how oil inflects culture like asking how the weather (or, worse, how air, or, worse still, how oxygen) affects it? Clearly, without weather, air, or oxygen no culture would exist. But can one say with any specificity that any of these is a cultural determinant? Jonathan Bate and others have made connections between weather and culture; indeed, links between air and culture would engage pollution studies (which, in turn, would engage a small niche in literary/artistic tradition and theory). But these movements are peripheral at best – or nonexistent, as in the case of oxygen.[3]

[1] Vaclav Smil, *Energy in World History* (Boulder: Westview Press, 1994), 2.

[2] Ibid., 252.

[3] See the chapter entitled "Major Weather" in Jonathan Bate, *The Song of the Earth* (Cambridge, MA: Harvard University Press, 2000). The closest thing I know to oxygen history is Peter D. Ward's *Out of Thin Air: Dinosaurs, Birds, and Earth's Ancient Atmosphere* (Washington, DC: Joseph Henry Press, 2006). It is a history calibrated in million-year intervals that speculatively relates the evolution of larger brains in early hominids to rising

And unlike most of today's theory-inspired advances in cultural study that have focussed on race, colonialism, gender, class, sexuality, and, most recently, environment, oil study does not uncover a large trove of important old literature, even though it does feature a growing body of contemporary art, literature, and popular cultural work. But what oil does have, unlike oxygen, weather, and air, is a reasonably well elaborated and defined human history, one with a complex set of filiations, fissures, ruptures, and breaks. And oil's possible collapse, as imagined today, provides both motivation and a heuristic for asking many interesting questions about oil's relationships with culture, in both the past and the present. We need to ask what we start finding when we cease living in oil as if it were our oxygen and look back on its histories – material, technological, social, and cultural – from the standpoint of today's startled awareness of the fragility of the system "Colonel" E. L. Drake and John D. Rockefeller built. Perhaps the gap between energy and culture can be credibly bridged and made available to the traffic of a new field of study.

II

William Catton's book *Overshoot: The Ecological Basis of Revolutionary Change*, takes the first step in building this necessary bridge. Modern Westerners and their immediate ancestors, Catton declares, "have lived through an age of exuberant growth, overshooting permanent carrying capacity [of the Earth] without knowing what we were doing." This historically novel exuberance came, Catton argues, from two sources: "(a) discovery of a second hemisphere, and (b) development of ways to exploit the planet's energy savings deposits, the fossil fuels."[4] The first method, which Catton calls "takeover," was simply "behaving as all creatures do. Each living species has won for itself a place in the web of life by adapting more effectively than some alternative form." European colonization, which took over land and developed its ecosystem resources more completely than the hunter-gatherers it displaced, multiplied Europe's per capita resources by five times. Far less "natural" and more determinative was the second method, which Catton calls "drawdown." This involved "digging up energy that had been stored underground millions of years ago" and then "drawing down a finite reservoir of the remains of prehistoric organisms."[5]

oxygen levels on Earth and forecasts further change in 250 million years, when oxygen levels might drop. These speculations make me doubt that oxygen history will become an important theme in cultural history any time soon.

[4] William R. Catton Jr., *Overshoot: The Ecological Basis of Revolutionary Change* (Urbana and Chicago: University of Illinois Press, 1982), 5–6.

[5] Ibid., 28–29.

Catton's inflexible, single-step dialectical narrative (ending in disaster) limits his ability to say much about the specifics of fossil-fuel culture. Nonetheless, it does allow him to make a few important macro-observations about it. Colonialism and then, more importantly, fossil-fuel energy use allowed "quite a marked rise in prosperity *and* . . . a phenomenal acceleration of population increase."[6] These, in turn, helped create in the West an important cultural attitude: a faith in progress so strong that "the idea that mankind could encounter hardships that simply will not go away" was not just unlikely but in fact "unthinkable."[7] Fossil-fuel culture can be, in short, described as an "age of exuberance" – an age which is also, given the dwindling finitude of the resources it increasingly makes social life dependent on, haunted by catastrophe.[8]

III

A far more sophisticated theoretical lens is required to see the welter of smaller shapes in this larger history. Again there is an excellent place to start: Jean-Claude Debeir, Jean-Paul Deléage, and Daniel Hémery's *In the Servitude of Power*. Unlike Smil, Debeir, Deléage, and Hémery do not just chronicle a history of energy-related technical advances, but find a way to theorize that process to reveal a much more finely grained social history of energy than ever before. All of this will allow me to move to a still finer resolution and to extend the process into culture as well as history.

For Debeir, Deléage, and Hémery, energy materializes as energy only with the development of technologies they call "converters" – which include everything from sails to atomic reactors. Only thus does a resource or environmental process become, in fact, "energy." Further, these converters do not exist singularly; they emerge and develop as parts of "converter chains," ones that run throughout society. The Neolithic revolution in food energetics, for example, did not occur only with the domestication of animals and plants. A whole chain of converters materialized: "the deployment of new capacities for large-scale harvesting, transporting, and storage (silos for cereals, drying of fish, for example) and the diversification of culinary preparation methods

[6] Ibid., 30.

[7] Ibid., 6.

[8] Catastrophe and exuberance are Catton's terms, but they need far more sensitive and complex descriptions than he gives them – and also need to be far more variable, specific and context-dependent. Consistently, however, the two terms interpenetrate, albeit in different fashions. For example, the term "exuberance" properly suggests a certain precariousness and even a measure of bad faith; it represents a departure from a sturdy sense of likelihood and normality. Even when used robustly, then, it is always shadowed by what fossil-fuel discourse persistently structures as its opposite partner – catastrophe. The two terms also vary for different times, places, issues, discourses, and speakers.

(grinding grain, pottery for cooking)" were equally necessary. But with converter chains, a third theoretical entity also appears: converters and converter chains are always a part of a society, and the three together materialize as an "energy system." This is a system which "includes, on the one hand, the ecological and technological characteristics of the chains (evolution of sources, converters, and their efficiency) and, on the other hand, the social structures for the appropriation and management of these sources and converters." In an energy system, simple energy determinism does not exist. For example, the "first converter of thermal energy into mechanical energy," the steam engine fed by coal, was not what "produced the factory system by replacing human labor, but quite the opposite": it was "the factory system that made possible the use of steam engines," something which then had the "effect, if not the goal, of establishing the domination of capital over labor."[9] Causation is not simple; a whole environmental, technical, and social system ultimately bootstraps itself into existence. This system is "a determination [that] is itself determined: it is the result of the interplay of economic, demographic, psychological, intellectual, social and political parameters operating in the various human societies."[10]

Debeir, Deléage, and Hémery then use this framework to historicize energy. History becomes a succession of distinct energy systems. In considering oil history and ultimately culture, then, we need to consider the previous energy system it disrupted and transformed: we need to orient oil in relation to the energy system it emerged within and also disrupted, the system Deleir and colleagues call "coal capitalism." Coal capitalism deployed the steam engine, humanity's first converter capable of turning thermal into mechanical power; coal, thus converted, extended itself far beyond its extensive precapitalist uses (for heating and medieval industry once firewood became scarce), transforming the previous medieval energy system into the more modern coal-capitalist one. Importantly, however, the new coal capitalism was not just the latest in a series of energy systems; it "signaled a radical break with all previous energy systems known to humanity. With it, the primacy of biological energies ended and that of fossil energies was established."[11]

[9] Jean-Claude Debeir, Jean-Paul Deléage, and Daniel Hémery, *In the Servitude of Power: Energy and Civilization through the Ages*, trans. John Barzman (London and New Jersey: Zed Books, 1991), 7.

[10] Ibid., 13. A determination that is itself determined is, of course, very different from the determinisms that are regularly used to inspire or dismiss work on culture and technology, environment, and biology.

[11] Ibid., 87. In looking at this break and the era that follows, one must acknowledge that both "exuberance" and "catastrophism" are cultural concomitants not just of fossil-fuel development, but also of the larger acceleration of demographic–technological–economic–social growth that the combination of fossil fuels and capitalism inaugurated. In this complex,

Coal capitalism was thus unique among previous systems in being the first truly exuberant one. Debeir, Deléage, and Hémery (along with many other writers on fossil fuels) regularly describe it as liberatory. For example, Debeir, Deléage, and Hémery repeatedly claim that coal capitalism freed "societies from the restrictive relationship to nature imposed upon land-based production, a liberation which came about thanks to the ever-growing use of energy"; "it enabled the European economies to by-pass the natural limitations of organic energy."[12] Steam engines placed in coal mines – all of which in England had been pioneered during medieval times – pumped away water that would flood them, allowed them to go deeper and become more productive. Improved steam engines in ships and railroads made the coal's energy more portable than ever before, freeing English industrialism and empire thereby from geographic limits. Coal refined into coke removed another "critical organic constraint on the growth of the industrial economy"; the limit imposed on the iron-making process by charcoal fell away, thereby liberating the manufacture of machinery (including steam engines).[13] The factory system itself was liberated from an organic constraint – geography in this case – as steam power replaced water power: factories no longer had to be placed on one of the rapidly dwindling number of sites on the banks of usable rivers but could be put anywhere. All these "liberations" paid off. As Barbara Freese puts it, they were crucial to Britain's rise as an industrial and colonial power. "By the time London held the first World's Fair in 1851," Freese writes, "Britain was hailed as the workshop of the world, and its markets and its empire reached global scale."[14]

Liberation from "nature" released "mechanical power," decisively changing both the discourse of nature and that of machinery. Eighteenth-century characterizations of nature as lawful and orderly and their persistent imaging of that order as a clockwork mechanism clearly accommodated Enlightenment enthusiasm for "improvement": a delicate mechanism could be perfected. Now, however, coal-fueled mechanical power – embodied eventually in huge

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capitalism temporally preceded fossil-fuel development, but fossil-fuel exploitation soon became arguably as fundamental.

[12] Ibid., 91, 99.

[13] Barbara Freese, *Coal: A Human History* (New York: Penguin Books, 2003), 66.

[14] Ibid., 69. The well-known domestic effects of the new coal capitalism were supplemented by coal-facilitated reorganization in the colonies. To note one concrete example: by 1826, the steam-powered gunship *Diana* (called the "fire devil") entered Burmese waters, easily destroying local opposition. More important, the *Indus*, in 1837, sailed up into Indian rivers, and, in 1841, the *Nemesis* did the same in China. About this process, historian Daniel Hedrick comments: "we cannot claim that technological innovation caused imperialism, nor that imperialist motives led to technological innovation. Rather the means and the motives stimulated each other in a relationship of positive mutual feedback." Daniel Hedrick, *The Tools of Empire: Technology and European Imperialism in the Nineteenth Century* (New York and Oxford: Oxford University Press, 1981), 54.

locomotives – rumbled into town, took over the machine metaphor, and promised open-ended progress. Steam engines, engines of motion and change, replaced clocks as the paradigm of machinery. A contributor to a journal edited by Charles Dickens evoked a specter that, though frightful, took the story's protagonist into the depths of a coal mine to teach him that coal was placed on Earth so that man "may hereafter live, not merely a savage life, but one civilized and refined, with the sense of a soul within . . . Thus upward, and thus onward ever."[15] Similarly, Leo Marx, in his classic study *The Machine in the Garden* notes how, in the US, writers in the leading magazines "adduce the power of machines (steam engines, factories, railroads, and, after 1844, the telegraph) as the conclusive sanction for faith in the unceasing progress of mankind." In both high cultural and popular discourse, Marx concludes, "[t]he fable of Prometheus [was] invoked on all sides."[16]

But if exuberance ran high, the growth of coal capitalism also produced the opposite: Britain, the workshop of the world, became also (most famously in the views of Karl Marx and Friedrich Engels) the workhouse of the world, even as it sought to globalize that condition by becoming the world's preeminent colonial power. Initially, Romantic Prometheanism opposed this new mechanical power, demonizing the machine; at the same time, however, it offered its own augmentation of power on another level, as it transformed "nature" from clockwork regularity into a dynamic organic/organicist force, one operating both in nature and in the human imagination.[17] Subsequent literary naturalism, however, gave a decisive victory to the demonic power of machinery over its organic/imaginative competitor; think of the sheep destroyed by the steam engine in Frank Norris's *The Octopus*. More significantly, naturalism represented how the liberation of human society from organic constraints ironically ended up creating a variety of machine-made organic nightmares, from Dickensian miasmic environments to Dickensian oppression of the poor. In the process, coal capitalism developed (appropriately, given its mode of extraction) a sinister cultural geography of depths and instructive descents. The narrator of Rebecca Harding Davis's "Life in the Iron Mills" tells her readers at the start,

> This is what I want you to do. I want you to hide your disgust, take no heed to your clean clothes, and come right down with me, – here, into the thickest of the fog and

[15] Freese, 11.

[16] Leo Marx, *The Machine in the Garden: Technology and the Pastoral Ideal in America* (London and New York: Oxford University Press, 1964), 192–93.

[17] Mary Shelley's *Frankenstein* is an excellent (and extreme) attempt to represent and measure the stresses of this double endeavor: a destructively powerful, yet tenderly, poetically sensitive and intelligent monster is assembled mechanically out of scavenged biological parts and then galvanized (doubtless by electricity, thought by many to be the *élan vital*) into life.

mud and foul effluvia. I want you to hear this story. There is a secret down here, in this nightmare fog.[18]

The fossil-fueled fires of Hell were brought close to hand, "down" in the factory district.

IV

Thus historicized, exuberance is no longer just surplus energy creating optimism, and its catastrophe is not hapless dependency on what is running out. Exuberance and catastrophe materialized as historically specific forms of capitalist triumph and oppression, of environmental domination and destruction, and of human liberation and psychic and bodily oppression. All of these versions of the two motifs were, moreover, embedded in the materiality of coal itself, be it Promethean coal that gave humanity its new modes of and uses for fire, or Stygian coal, that re-created the ancient fiery nether region as polluted industrial district and city. With these reflections, clearly, we have moved energy history into cultural history.[19]

Oil entered this history and began reshaping it in two phases: first as part of what I will call the culture of extraction, and second as a key part of a new culture for a new energy system, which I will call "oil–electric–coal capitalism." In its first phase, oil (formerly used as a medicine) appeared quickly and exuberantly as a remarkable, new energy source within a bootstrapped system of extraction, refining, transportation, and marketing.[20] Oil, in this phase, also had a role in creating what I call "extraction culture," a specific formation that is still alive today. In its second phase, oil proceeded to thoroughly reshape

[18] Rebecca Harding Davis, *Life in the Iron Mills and Other Stories* (New York: The Feminist Press at CUNY, 1993; first published 1861), 13.

[19] The Promethean myth, of course, was woven into old cultural and techno-cultural traditions; its fusion with coal came only with the invention of the steam engine. Coal's Stygian features, however, are part of an old tradition of coal as a pollutant, one that begins well before the Industrial Revolution, in medieval and Renaissance accounts of the appalling conditions in the English mines and of massive air-pollution events. Fossil fuels, moreover, lit Milton's hell, and perhaps were also implicated in its brimstone, as English coal had a very perceptible sulphur content, and fossil fuels were lively features of depictions of Hell all the way back to early Christian sources. For a general discussion, see Freese, 14–42; in Milton's *Paradise Lost*, see Book I, lines 725–29; for early Christian depictions of Hell, see Book 8, lines 100–6 of the Christian Sybillines in the *New Testament Apocrypha*, Volume II, ed. Wilhelm Schneemelcher, trans. Robert McLoed Wilson (Nashville, TN: James Clarke & Co., 1992).

[20] In fact, the (logical) order in which I have listed these converters is misleading. Before the development of extraction techniques came experiments with refining oil and the development of lamps suited for its use as a luminant. Also before extraction, capital accumulation began and marketing was pioneered, two other crucial parts of the oil converter chain. And together with extraction, storage and transportation converters had to be immediately developed – and go through many phases, as teamsters hauling carts with barrels yielded to railroad tankers and then to pipelines.

coal capitalism and do so culturally as well as technologically, expanding dynamically not into just new industries but also into new areas of cultural life. The new system integrated industry with society and culture more completely than ever before, even as it erased or sublimated most of the highly visible evils of the previous era of Stygian coal capitalism.

First, oil extraction culture. The opening of this era in the US began when Drake struck oil in Titusville. This was, Ida Tarbell wrote, the "signal for a rush such as the country had not seen since the gold rush of '4."[21] It was a triumph of wildcatting, speculation, development, pollution, booms, and crashes, a moment of legendary exuberance in American history. Unlike coal mining which was a capital-intensive operation, with a large labor force working underground, often in appalling conditions, oil in Pennsylvania promised immense reward for little investment and less hard labor. So much for the workhouse of the world. Oil, tapped, came up to the surface by itself – albeit sometimes calamitously – to reward the efforts of a few daring and lucky men. Thus oil's geography of depth differed greatly from coal's. People did not have to go underground to get it; they stayed on the surface to tap it, already pressurized and ready to go.[22]

But the oil boom was no mere gold rush. It was not a one-shot, extract-and-run proposition. It established a new industry and brought wealth and power to the US. As such, Tarbell saw oil extraction as signaling a resurgence of the old, epic–heroic ideology of democratic, self-reliant, community- and nation-building individualism. Oil extraction

> used men of imagination who dared to risk all they had on the adventure of seeking oil . . . used capital wherever it could be found . . . used the promoter and the speculator . . . called on the chemist to evaluate the products and had set him up a laboratory to enlarge and improve them . . . [and] called on the engineer to apply all known mechanical devices.

Evoking this epic-scale mobilization of talents in nationalist, Whitman-like prose, Tarbell concluded,

> The way that all these varied activities fell in line, promptly and automatically organizing themselves, is one of the most illuminating exhibits the history of our industry affords, of how things came about under a self-directed, democratic, individualistic system: the degree to which men who act on "the instant need of things" naturally supplement each other – pull together.[23]

[21] Ida Tarbell, introduction to Paul H. Giddens, *The Birth of the Oil Industry* (New York: The Macmillan Company, 1938), xix.

[22] Oil geography suggests fascinating homologies with psychoanalytic theory and modern cultural practice, from therapy to poetry and art. The subject lies, unfortunately, beyond the reach of this essay. The new cultural geography of the later oil system is a separate but also important and interesting topic; see footnote 29.

[23] Tarbell, xxxvii–xxxviii.

Though Tarbell, writing this as an introduction to Paul Giddens's 1938 *The Birth of the Oil Industry*, also foregrounds the excesses of speculators, the sometimes spectacular environmental and human disasters brought on by rapid growth (Pithole went from seven to 15,000 people in just a few weeks), she dismisses these as peripheral to the epic of oil individualism. "Men did not wait to ask if they might go into the Oil Region," Tarbell wrote, "they went. They did not ask how to put down a well: they quickly took the processes which other men had developed for other purposes and adapted them to their purpose . . . It was a triumph of individualism."[24] Thus coal's backbreaking labor in extraction became the thrill of creation; coal's widening of social castes became individualist opportunity; and the gloom of impoverished cities and dismantled, wrecked environments seemed to lift.

But more interesting still, with oil extraction, catastrophe did not simply remain on the periphery of exuberance. It became, for Giddens and even Tarbell, an integral part of the exuberance of oil, not, as with coal, its squalid nemesis. Enthusiastically describing one such catastrophe, Giddens writes how a well at the lower end of Oil Creek sent up a large gusher – three thousand barrels per hour. A hundred and fifty people gathered to watch, when

> a sheet of fire, as sudden as lightning, burst forth . . . [and] [i]nstantly, an acre of ground with two wells, oil vats, a barn, and over 100 barrels of oil were ablaze . . . The well continued to spout oil high into the air, which fell to the ground, igniting as soon as it fell and adding dense smoke and sheets of flame to the horrors of the scene.[25]

Most of the onlookers became "human torches and frantically tried to escape from the fiery furnace." Epic catastrophe came with epic actions. This tone prevails even in writing about slower, seamier aspects of oil damage. Huge volumes of oil poured out into rivers and onto the ground due to the failure or absence of containers; oil river transport featured the exciting release of "freshets" downstream to float the barges – an event that ended often in wreckage that blackened the streams; boomtowns like Pithole famously lacked all sanitation ("The whole place smells like a camp of soldiers when they have the diarrhoea"; fights, drunkenness, and "garroting [were] almost common"); and so much oil spilled from teamsters' wagons onto the already muddy roads they became a "perpetual paste, which destroyed the capillary glands and hair of the horses," many of which died along the way, so that "hundreds of dead horses could be seen along the banks of Oil Creek."[26] Add to this wildly fluctuating oil prices and boom and then bust land prices, and it becomes almost impossible to separate out catastrophe from exuberance and vice versa.

[24] Ibid., xxxix.
[25] Giddens, *The Birth of the Oil Industry*, 76–7.
[26] Ibid., 137, 139, 102.

Indeed, the two were mutually reinforcing in Giddens's and even Tarbell's prose.

V

Things changed quickly, Tarbell's *History of Standard Oil* makes clear, as Rockefeller transformed extraction culture into a vertically integrated monopoly that stifled this resurgence of American individualism and frontier spirit. Oil, once systematized, began transforming social life – sending out tentacles into people's private lifeworlds to change them in what seemed, to many (but not all), exuberantly positive ways. Unlike coal capitalism, oil did not remain culturally inscribed as mostly an affair of production machinery for industry and commercial transport. "Give the poor man his cheap light, gentlemen," Rockefeller famously told his colleagues, and the ancient organic constraint of darkness was gone, and the lives of the poor were "lightened."[27] Huge machinery now shrank in size and scattered about the factory floor, and then drove in the form of new Fords out the door as parts of a new consumer culture, ones even the working class could enjoy. Old constraints on both physical and social mobility for even the working class were suddenly relieved. Everyman seemed to have now individual access to real power: oil concentrated into one gallon of energy "equal to the amount in almost five kilograms of the best coal" – itself the equivalent of fifty "well-fed human slaves toiling all day."[28]

Urban environments also began to lose the customary organic miasma caused by coal; pollution abated significantly at industrial sites and in cities. Oil–electric industrial production was materially and culturally refigured as clean, efficient, and modern (think, for example, of Henry Ford's Rouge River Plant and Charles Sheeler's images of it). At the same time, oil–electric capitalism exported coal's miasma as far away as it could. The hellish depths were resited as backward, stagnant, unpleasant spots outside the system.

[27] Sonia Shah, *Crude: The Story of Oil* (New York: Seven Stories Press, 2004), 6. The new oil-flavored exuberance was distinctive in yet another way. No longer a Promethean intervention from above, or agent of capitalist oppression creating underworlds, energy became fused with widespread social desire. Indeed, it and the invention it stimulated and fetishized became an important attractor of peoples' imaginations and fantasies. Henry Adams's concept of history as a response to attractive, not compulsive, forces, and his use of energy production (the dynamo) as a central symbol for these was one response. More concrete was another change noted by Debeir, Déleage, and Hémery. By the twentieth century, energy production "reversed the demand–supply relation [a scarcity of supply relative to demand] which characterized early industrialization" (as indeed it had all previous energy systems). Now "energy production acquired unprecedented elasticity," and it "anticipated demand" and even "generated new needs." Debeir, Déleage, and Hémery, *In the Servitude of Power*, 108.

[28] Shah, 3.

Ironically, in retrospect, even cars were hailed as a great sanitary improvement, replacing the thousands of animals which had daily deposited millions of tons of waste in the streets – and therefore also the atmosphere, as dried dung particles were swept into the air. In consequence, cultural geography changed again: people more and more valorized living within the clean, new apparatus of oil–electric production–consumption, not apart from it.

In doing all this, oil had a partner: electricity.[29] What oil did, electricity furthered, taking over the role of light-giver from oil, increasing cleanliness, mobility, and speed with electric motors for factories, trains, and appliances. Together, oil and electricity wrapped people within their many infrastructures – roads, pipelines, telephone lines, power cables – even as it began doing something else of great cultural importance: reaching into and restructuring peoples' private worlds, identities, bodies, thoughts, sense of geography, emotions.[30] Perhaps the most important product of oil–electric capitalism was modern consumerism. Half-concealed, half-fetishized oil–electric infrastructures extruded numerous cultural infrastructures (converters), which modern people, including modern artists and writers, chose as preferred dwelling places.

In this transformation, the extraction era's exuberance modulated into the exuberance of a new dynamic system that sought stability in change. The oil

[29] Oil was a new energy source, materialized as such by the growth of complex sets of converter chains; electricity was, however, simply a converter, sometimes connected to oil, sometimes to coal. But both allowed the miasmas of the coal era to be situated farther and farther away (culturally and geographically) not just from the well-to-do, but from the growing middle classes. Early observers, like Henry Adams in *The Education of Henry Adams* (1918), were well aware of this. In his famous celebration of the dynamo, Adams writes that, clean and quiet, "it would not wake the baby lying close to its frame." Adams meaningfully explains why this is the case, noting that the dynamo utilized an "ingenious channel for conveying somewhere the heat latent in a few tons of poor coal hidden in a dirty engine house carefully kept out of sight." Henry Adams, *The Education of Henry Adams* (Boston: Houghton Mifflin, 1961), 380. Jill Jonnes also emphasizes how important oil's and electricity's ability to distance or erase coal was to the very idea of modernity. Writing about the dynamo in the 1893 World's Columbian Exposition and Fair in Chicago, Jonnes notes that, installed for the "White City's magnificent lighting displays, [it] was powered by one great 2000-horsepower Allis Chalmers engine, as well as numerous 1000-horspower engines, all fueled with oil (supplied by Standard Oil) rather than coal." The reason was that the display was meant to symbolize an ideal modern world displacing/replacing the miseries of actual Chicago: "The White City would have no smoky pall." Jill Jonnes, *Empires of Light: Edison, Tesla, Westinghouse, and the Race to Electrify the World* (New York: Random House, 2003), 261. Theodore Dreiser made the same point in writing about "A Certain Oil Refinery," a highly polluting oil facility that was banished to the hinterland of Bayonne. Theodore Dreiser, "A Certain Oil Refinery," *American Earth: Environmental Writing since Thoreau*, ed. Bill McKibben (New York: Literary Classics of the United States, 2008), 188–91.

[30] Jacques Ellul has pithily (if androcentrically) characterized this key modern transformation as a move from "man and the machine" to "man in the machine." Jacques Ellul, *The Technological Society* (New York: Vintage, 1964), 6.

industry pioneered that goal; oil historians Harold Williamson, Ralph Andreano, Arnold Daum, and Gilbert Klose discuss how attempts to stabilize the boom-and-bust oil industry appeared first in Oklahoma in 1914, and then nationally, as industry and government, impelled by fear of scarcity, came tensely together to manage oil during World War I. These efforts continued after the war, resulting, by World War II, in a dynamically growing system "far from perfect" but nonetheless "the basic, essential structure" necessary for "attempts to meet old and new difficulties" even today.[31] If oil, first illuminant and then automobile fuel, was essential to the construction of the new system, it also, in its third major use as a lubricant, may be seen metaphorically as equally essential to the dynamic stability and stable dynamism of oil–electric–coal capitalism.

Upton Sinclair's novel *Oil!* chronicles one aspect of this immense social and cultural change. We meet its father and son protagonists as "Dad" (J. Arnold Ross, already a multimillionaire "big operator" in the oil business) takes his son, "Bunny," for a high-speed drive along a California highway. Dad appears to his son, Bunny, as a figure of epic proportions: accessing an "engine full of power" by the mere pressure of "the ball of [his] . . . foot" and rocketing down roads "twisting, turning, tilting inward on the outside curves, tilting outward on the inside curves, [the road having been engineered] so that you were always balanced, always safe." Dad was a man of money who had commanded the magic necessary to create all this. He "said the word,"

> and surveyors and engineers had come, and diggers, by the thousand, swarming Mexicans and Indians, bronze of skin, armed with picks and shovels; and great steam shovels with long hanging lobster-claws of steel . . . All these had come, and for a year or two they had toiled, and yard by yard they had unrolled the magic ribbon . . . Never since the world began had there been men of power equal to this.[32]

Though the novel goes on to expose this system as predatory and corrupt, Dad is nonetheless far from the big capitalists Sinclair depicted in his earlier novel *The Jungle*, a novel which dramatized as few American texts have the hellish underworld of coal capitalism. Dad never quite loses completely his new oil-era, Tarbell-like appeal as an epic individualist and adventurer remarkable for "the ingenuity by which [he] . . . overcame Nature's obstacles."[33] He is also a loving father who never lets his son's radical, anti-oil-corporation politics interrupt their close relationship. Dad is, in short, positioned in between: in between Tarbell's democratic extractor epic and a

[31] Harold Williamson, Ralph Andreano, Arnold Daum, and Gilbert Klose, *The American Petroleum Industry: The Age of Energy 1899–1959* (Evanston: Northwestern University Press, 1963), 565–66.
[32] Upton Sinclair, *Oil!* (New York: Penguin, 2006; first published 1926), 6.
[33] Ibid., 76–77.

system in the process of forming its top-down, vertically integrated combinations. He drives at high speed, yet he does this on a road engineered for both speed and safety.

If Dad is favorably depicted, so are the physical operations of his industry, which have none of the coal-capitalist miasma that infused every aspect of *The Jungle*. At the site of one of Dad's new wells, Bunny thinks,

> it was all nice and clean and new, and Dad would let you climb, and you could see the view, clear over the houses and trees, to the blue waters of the Pacific – gee, it was great! And then came the fleet of motor trucks, thundering in just at sunset, dusty and travel-stained, but full of "pep" . . . [The men] went to it with a will; for they were working under the eye of the "old man," the master of the pay-roll and their destinies. They respected this "old man," because he knew his business, and nobody could fool him. Also, they liked him, because he combined a proper amount of kindliness with his sternness; he was simple and unpretentious . . .[34]

Though clearly portraying Bunny as naive, Sinclair shares Bunny's excitement about the ingenuity involved in oil extraction, as Sinclair's subsequent fascinated description of the intricacies of drilling shows. Depicting the industry, Sinclair once again channels some of Tarbell's exuberance, which in turn channeled a previous era of US national ideology.

VI

This exuberant portrayal of oil drilling is not, however, solely retrospective. It also faces forward. Sinclair shows how, incorporated into the oil–electric system, exuberance takes on key new forms. In the new energy system, men have "pep" and Dad is a "real guy" who has "'the stuff,' barrels of it."[35] Dad is, in short, an enlivened, positive, capable, always energetic machine himself – one that is fueled by oil. Dad thus is part of a long line of figures styled and self-styled as "modern." That identification, along with the new energetics that is one of its chief signs, exuberantly marks off these individuals, together with the larger US oil–electric capitalist energy system, as part of a new and, for some, exuberantly better world.

In this new era, American exceptionalism leaves the frontier and invests itself in the modernity of the US, and the gap between it and the world outside modernity becomes reinscribed as a gulf between advanced and developing or backward places. This new societal exceptionalism promotes a new notion of individualism, which in turn becomes a new place for oil–electric cultural invention. In popular and also high cultural discourse, people's bodies and psyches are refigured as oil–electric-energized systems, and avant-garde artists

[34] Ibid., 59.

[35] Ibid., 61.

become the experts who most aggressively convert these energetics into new styles, new aesthetics, new poetics.[36]

I will let Dad stand as a sufficient early example of a new kind of bio-energetics, pep, produced by oil. His foot connected him to engine power that augmented him, even as his charisma as a "big operator" yet a "real guy" gave him attractive force over his men. As it was with Dad, so it was with many. Slang was a fertile seedbed for their invention. People started (bodily and psychically) to "rev up" and "step on the gas." Sometimes they operated on all their cylinders and stopped, when necessary, to refuel. Electricity, oil's partner in the new energy system, provided a seedbed for even more fertile invention: as David Nye, in *Electrifying America*, puts it, electricity became "a metaphor for mental power, psychological energy, and sexual attraction," and it "merged with new therapeutic conceptions of the psyche and the self." Examples include "'She really got a charge out of seeing you,' or 'He's gone on a vacation to recharge his batteries . . . An 'energetic' person was 'a human dynamo,' a powerful performance was 'electrifying.'"[37] The kinetics in all of these examples are so pronounced, catastrophe is not simply banished or geographically relocated to a hell; as in extraction culture, it is fused with exuberance. Thus people also crash, undergo crackups; they blow a fuse; they burn out. But unlike extraction culture, this fusion – as modernist art and aesthetic invention reveal – is complex and polyvalent, anything but simple.

Sinclair Lewis's title character Babbitt, for example, "whose god was Modern Appliances," embodied his ego in his Dutch colonial home in Floral Heights and his automobile, which he drives and parks in "a virile adventure masterfully executed."[38] He commutes to work in Zenith, a city transformed, so that new "clean towers . . . thrust" "old . . . factories with stingy and sooted windows, wooden tenements colored like mud" from the business center. Further, he smugly sees himself as filled with new energy, as "capable, an

[36] True, this development is not wholly novel: Whitman, in his remarkable poem "To a Locomotive in Winter," enthusiastically converted a steam engine into a new energetics for American bodies, psyches, and art. He also did the same with electricity in "I Sing the Body Electric," absorbing a widespread romantic discourse of electricity and bodies, as Paul Gilmore discusses at length. Paul Gilmore, *Aesthetic Materialism: Electricity and American Romanticism* (Stanford: Stanford University Press, 2009), 143–76. Oil–electricity's revision and great expansion of both these discourses subsequently did much to constitute "the modern."

[37] David E. Nye, *Electrifying America: Social Meanings of a New Technology, 1880–1940* (Cambridge, MA: MIT Press, 1992), 155. Nye's conclusion was that "electricity was not merely one more commodity; rather it played a central role in the creation of a twentieth-century sensibility. Electricity seemed linked to the structure of social reality; it seemed both to underlie physical and psychic health and to guarantee economic progress." Ibid., 156.

[38] Sinclair Lewis, *Babbitt* (New York: Oxford University Press, 2010; first published 1922), 15.

official, a man to contrive, to direct, to get things done."[39] Exuberant in his views of himself and his world, Babbitt is, however, Lewis makes abundantly clear, psychologically, socially, and aesthetically a catastrophe – an emblem of the stupidity and vulgarity that the new modern energies are in fact bringing about. These are qualities Babbitt has mostly not because he partakes too fully of modern energetics, but because he partakes too little: he is, in short, a dim bulb.

At the other extreme end of the spectrum of modern energetics is Hart Crane, who styled himself as "quite fit to become a suitable *Pindar* for the dawn of the machine age, so called." Crane's stylistic innovations sought to "absorb" the machine into poetry, and he pursued it by cultivating "an extraordinary capacity for surrender, at least temporarily, to the sensations of urban life" to the end of internalizing the "power of machinery" so completely it might become "like the unconscious nervous responses of our bodies, its connotations emanat[ing] from within."[40] From this stunningly romantic surrender, Crane writes poetry that creates – more than anything else in existence – the kinetic tactile and kinesthetic effects felt by bodies and psyches impelled by oil–electric-powered machinery into motion – by elevators, airplanes, trains, and subways. Packing sensations like the sudden, stomach-churning initial drop of an elevator or subway in descent into his always dynamically forward-rushing verse, Crane also incorporates into his style the new perceptual kinetics explored in oil–electric-powered film, its capacity for representing dynamic sudden motion in shifts of scene and perspective and in cut and zoomed shots. This ecstasy of motion is, however, nearly as catastrophic as it is exuberant. Kinetic catastrophe is the subject of "Kitty Hawk," and even his poems' authentic ecstasies – like "Atlantis" – are wedded to the surmounting of almost equal extremes of despair – as in "The Tunnel."

This same argument could be developed in regard to Pound, early Eliot, and Hemingway. They too self-consciously invented modern, expert-created, and widely advertised styles, styles that could perhaps be thought of as aesthetic converters, that formed a key part of their project to rescue literature and thereby civilization in a time of acute crisis. Representing a new kind of alienation and social fragmentation – a nightmare side of the modernity brought in when oil–electric capitalism banished coal to the peripheries – they also explored what seemed like qualitatively new modes of mind and perception that aestheticized those experiences, again as a new kind of

[39] Ibid., 3, 6.

[40] Hart Crane, *The Complete Poems and Selected Letters and Prose of Hart Crane*, ed. Brom Weber (Garden City: Doubleday, 1966), 262.

energetics.[41] With Hemingway and Eliot, for example, that meant a new energetics of hyperconsciousness – for example, the light in Hemingway's well-known short story "A Clean Well-Lighted Place" – that aesthetically haunted and mesmerized even as it paralyzed, rather than powered, bodies and psyches. In the midst of their portrayal of cultural and existential catastrophe, a clean catastrophe, not a coal-miasmic one, exuberance subtly accompanies even the most desolate depictions, thanks to the entrancing and self-consciously transformative novelty of the writers' styles.

Perhaps the most clear-cut example of modern catastrophic-exuberant energetics comes, however, from the new oil–electric technology of film. Arguing that film represents not just a new medium, but a change in the very "way in which human perception is organized," Walter Benjamin relates the jerky motion of (early) film to the new Fordist system of manufacture, arguing that it is embodied visibly in the assembly line.[42] In *Modern Times*, Charlie Chaplin (a favorite of Benjamin) simultaneously embodies and disrupts this new energetics, creating, with astonishing comic grace, a body that both channels and subverts the assembly line's motion – which is, of course, also the motion of his medium, the mechanism of film itself. What were the cultures of coal have become now the aesthetics, even the poetics, of oil.

VII

If modern oil–electric–coal capitalism sought both dynamism and stability, it was never more than precariously achieved. In World War I oil exuberance was wedded all too clearly to oil catastrophe in a high-profile marriage of absolute opposites. Oil powered destructive new machinery (tanks, airplanes, trucks, diesel submarines), was used in making destructive weapons (TNT and even mustard gas), and it fueled a refitted British Navy, superior to Germany's, which remained tied to coal. On the other hand, it was what saved the Allies and won the war, according to some influential voices: as Daniel Yergin writes, in his history of oil, *The Prize*, at a celebratory dinner ten days after the armistice Lord Curzon uttered the famous words, "The Allied cause had

[41] Alienation may be seen, I believe, as the oil-era replacement for/descendant of the exploitation and environmental immiseration of the coal-capitalist working class. Modernist alienation is clean, not miasmic; individualized, not collective, higher up on the class ladder than coal-misery; and an affliction of the refined consciousness, not of the degraded laboring body.

[42] Walter Benjamin, "The Work of Art in the Age of Its Technological Reproducibility," in *idem, The Work of Art in the Age of its Technological Reproducibility and Other Writings on Media*, ed. Michael W. Jennings, Brigid Doherty, and Thomas Y. Levin (Cambridge, MA: Harvard University Press, 2008), 23. See also Thomas Levin's introduction to the section on film, ibid., 315–22.

floated to victory upon a wave of oil."[43] Oil helped kill millions. Oil led to victory. Immediately after World War I, as noted above, modernist exuberance was accompanied by the attempt to structure oil and society into a dynamic yet stable system.

In the context of World War II, the same description still fits: again the allies floated to victory on a sea of oil, and again war was followed by an attempt to stabilize. Once again, one finds a period of postwar exuberance, as the 1950s–1960s saw a new expansion of consumer society. But this exuberance marked not just simple continuance; it accompanied a reinvention of and a new phase in the oil–electric energy system, as oil extruded a crucial new set of converter chains. The petrochemical industry, development of which started after World War I, but which only blossomed after World War II, created a huge new array of products to add to its consumer repertoire. As wartime petrochemistry was reworked into the chemical equivalent of ploughshares, oil, chemically metamorphosed, became central to many new productions, from plastics to pharmaceuticals, print inks to pesticides. It changed into what people dressed in, evacuated into, viewed, and even ate, not just what they put into their power machinery. Oil thus now reappeared as an agent of chemical *and* social metamorphosis. Bodies became literally oily, in what they ate, and in the cosmetics and clothes they put on; pharmaceuticals began doing the same thing for minds.

On the heels of this exuberance came a much more insistent form of catastrophe. In 1964, Rachel Carson's *Silent Spring* made chemical metamorphosis seem the start of an apocalypse. With the transformation of fear of nuclear destruction into fear of environmental self-destruction that came with the 1970s environmental crisis, an apocalypse that involved oil, in many ways beyond Carson's carcinogenic and ecocidal toxics, seemed likely. People died in New York and London from the pall of fossil-fuel air pollution. Global warming made an early appearance on the popular stage with the film *Soylent Green* (1973), even as the oil crises of the 1970s added the threat of economic chaos to environmental meltdown. But then came exuberance again, with what seemed like no transition: Ronald Reagan, arguably, was swept to power on unhappiness with oil scarcity, an unhappiness which was quickly salved by the release of a new sea of oil, one that floated his new conservatism

[43] Daniel Yergin, *The Prize: The Epic Quest for Oil, Money, and Power* (New York, The Free Press, 1991), 183. Curzon's rhetoric (and the tone of Yergin's title and book) are a perhaps a bit exaggerated, the former being a tribute to the wartime contribution of the American oil industry, and the latter clearly indebted to the (extraction-era) discourse of the epic of oil. Still, oil's contribution to World War I was great, and by World War II Curzon's comment would apply without qualification.

to new victories – the most significant of which was the collapse of the USSR, a collapse that can be linked to a resulting plunge in oil prices.

These rapid oscillations between oil exuberance and catastrophe, I would argue, signal the arrival of a new cultural regime – one that we dwell in today. This new regime involves a fusion of the two motifs and links them in a mutually reinforcing symbiosis that recalls early extraction culture. But now the fusion takes place against a background not of celebratory nationalism, or modernist neo-exceptionalism, but of a combination of multiplied scenarios for global apocalypse and theoretical advances toward antifoundationalism, the breaching of apparently secure cultural boundaries, and the embrace of disequilibrium and emergence. Stability seems to be completely gone – gone simultaneously in a runaway dynamism of exuberance and catastrophe.

On the exuberant side, the dynamic growth of new industries (computers, genetics, robotics, and nanotechnology) has been accompanied by a new, exuberant rhetoric that rejects the very notion of stability and equilibrium and that celebrates risk and even imminent catastrophe as part of this new dynamism.[44] Important also are exuberant versions of postmodern theory, celebrating human supersession of nature and evolution, and the breaching of boundaries between the human and the technological.[45] Simultaneously, psychic and bodily energetics have been taken to a catastrophically exuberant extreme in fictions like William Gibson's *Neuromancer* (1984), in which psyches wired into cyberspace experience qualitatively new and addictive kinds of out-of-body acceleration. Equally, new catastrophic–exuberant fantasies of post-evolutionary metamorphosis and hybridization have been fetishized by writers from Bruce Sterling in *Schismatrix* (1986) to China Miéville in *Perdido Street Station* (2003).

On the catastrophic side, a myriad of environmental, technological, economic, and geopolitical crisis scenarios have now become key reference points for US culture's construction of normality. Oil is central or significant in many of these crisis scenarios, even as worries about it have become a key part of today's norms.[46] More and more people today feel they dwell in what

[44] On the new exuberance see Kevin Kelly, *Our of Control: The New Biology of Machines, Social Systems, and the Economic World* (New York: Basic Books, 1995); Alvin Toffler, *The Third Wave* (New York: Bantam, 1984); and Ilya Prigogine and Isabelle Stengers, *Order out of Chaos: Man's New Dialogue with Nature* (New York: Bantam Books, 1984). On its involvement with risk see Julian Simon, *The Ultimate Resource 2* (Princeton: Princeton University Press, 1966); and Naomi Klein, *The Shock Doctrine: The Rise of Disaster Capitalism* (New York: Picador, 2008). See also the discussion of risk and the new exuberance in Frederick Buell, *From Apocalypse to Way of Life* (New York: Routledge, 2005), 177–246.

[45] See, for example, Fredric Jameson, *Postmodernism: Or, the Cultural Logic of Late Capitalism* (Durham, NC: Duke University Press, 1991); and Donna Haraway, *Simians, Cyborgs, and Women: The Reinvention of Nature* (New York: Routledge, 1990).

[46] This is the central argument of my *From Apocalypse to Way of Life*.

Ulrich Beck calls "risk society." US popular culture (in blockbuster films and video games especially) now exuberantly sets its high-tech exciting narratives in postapocalyptic milieus. Many of these films, like the James Cameron *Terminator* films (1984, 1991), *Children of Men* (2006), or *I Am Legend* (2007) are at best only very indirectly related to oil, but they do the oily cultural work of injecting exuberance into catastrophe in postapocalyptic settings. More directly engaging oil are films like *The Day after Tomorrow* (2004), a film that works to make global warming thrilling, and Cameron's *Avatar* (2009), which wrests a visually stunning utopian vision from energy woes.

A few more serious texts, however, attempt to unravel this fusion of catastrophe and exuberance. Octavia Butler's *The Parable of the Sower* (1984) and Xenogenesis Trilogy (1987–1989), Cormac McCarthy's *The Road* (2006), and Kazuo Ishiguro's *Never Let Me Go* (2005) all present meltdowns and narratives of painful, slow, on-foot struggle that resist the exuberance that is today so persistently inscribed in postapocalyptic space. A small, more recent wing of such writing is now devoted to specifically post-oil fictions, including Sarah Hale's *The Carhullan Army* (2007), James Howard Kunstler's *World Made by Hand* (2008), and Andreas Eschbach's *Ausgebrannt* (2009),[47] fictions which, in that order, focus attention on the question, possibility, and even possible character of post-exuberant societies.[48] In these texts, most notably, fantasies of post-physical acceleration and quicktime metamorphosis are stifled.[49] What the significance of these cultural attempts to resist the

[47] I include Eschbach's fiction in the list because, while it is by a German writer and has not yet been translated, it is substantially set in and influenced by reflection on US culture. Its deviation from the anglophone postapocalyptic mode is very refreshing, as it explores different post-catastrophic, post-oil futures for different societies.

[48] A slightly different, but very interesting example of resistance to fused catastrophe and exuberance is Kim Stanley Robinson's global warming trilogy (*Forty Signs of Rain* (2004), *Fifty Degrees Below* (2005), and *Sixty Days and Counting* (2007)). A speculative-fiction and alternative history of the present, the trilogy shoehorns attempts to deal with the first, catastrophically large disruptions of global climate into a realistic fiction of mixed subgenres. Partly Washington novels of political and scientific–political intrigue, partly suspense novels dealing with internal spying, partly romances, and partly novels of the education and growth of a large cast of interesting and likable good people dealing with domestic and personal issues, the trilogy not only confines exuberance and catastrophe within these different frames, but also manages to end in a strikingly complex fashion. On the one hand, it concludes nonexuberantly, as catastrophic climate disruptions (dramatized quite vividly) will certainly continue. On the other hand, it also concludes noncatastrophically, as the crisis is now in the hands of a good President and staff, elected in a narrow defeat of the scientifically illiterate far right candidate [Bush], even as characters' romantic and familial problems happily resolve.

[49] That such fantasies are directly and/or indirectly related not just to today's culture, one dependant on oil, but to oil in its contemporary material and technologically reworked forms is, I think, clearly arguable. Today's post-biological acceleration is clearly a descendant of futurist versions of modern automotive speed, and apocalypses that have characters trudging

contemporary postapocalyptic fusion of catastrophe and exuberance might be is, of course, not yet clear. But what is clear is that the old faith in stability is gone. Oil's power, complexity, and serious woes are not only transparent to people today as never before, but also themselves a hot cultural commodity in oil capitalism. In the process, the old traditions of exuberance and catastrophe, embedded in the earliest oil literature, have taken on extreme new forms.

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along disused highways pushing shopping carts play both on automobile and oil-midwifed twentieth-century consumer culture. And quicktime metamophoses, while inspired by the baby steps genetic engineering has actually taken, play on the postwar reshaping of motive energy into metamorphic energy. Motive energy literally became metamorphic with the rise of post-World War II petrochemistry and its transformation of oil into so many different forms. In a different sense, motive energy also became metamorphic with more recent cultural fascination with robotics. In fact, and far more in fantasy, today's robotics has transformed the instrumental mobile machinery of modernity (for example, automobile culture) into a wide variety of lively post-biological cyborg life forms (from malign terminators operating in militarized postapocalypse to Spielbergian AI's, active in Disneyfied postapocalypse).

BRILL

Historical Materialism 21.1 (2013) 15–68

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The Origins of Fossil Capital: From Water to Steam in the British Cotton Industry*

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Abstract
The process commonly referred to as business-as-usual has given rise to dangerous climate change, but its social history remains strangely unexplored. A key moment in its onset was the transition to steam power as a source of rotary motion in commodity production, in Britain and, first of all, in its cotton industry. This article tries to approach the dynamics of the fossil economy by examining the causes of the transition from water to steam in the British cotton industry in the second quarter of the nineteenth century. Common perceptions of the shift as driven by scarcity are refuted, and it is shown that the choice of steam was motivated by a rather different concern: power over labour. Turning away from standard interpretations of the role of energy in the industrial revolution, this article opens a dialogue with Marx on matters of carbon and outlines a theory of fossil capital, better suited for understanding the drivers of business-as-usual as it continues to this day.

Keywords
Fossil fuels, steam power, water power, cotton industry, labour, space, time, carbon dioxide, capital accumulation

> In those spacious halls the benignant power of steam summons around him his myriads of willing menials, and assigns to each the regulated task, substituting for painful muscular effort on their part, the energies of his own gigantic arm, and demanding in turn only attention and dexterity to correct such little aberrations as casually occur in workmanship.
> – Andrew Ure, *The Philosophy of Manufactures*[1]

> The chemical changes which thus take place are constantly increasing the atmosphere by large quantities of carbonic acid [i.e. carbon dioxide] and other

* Many thanks to Alf Hornborg, Stefan Anderberg, Rikard Warlenius, Max Koch, Wim Carton, Vasna Ramasar and other LUCID colleagues, and two anonymous reviewers for very helpful comments at various stages of this work.

1. Ure 1835, p. 18.

DOI: 10.1163/1569206X-12341279

> gases noxious to animal life. The means by which nature decomposes these elements, or reconverts them into a solid form, are not sufficiently known.
> – Charles Babbage, *On the Economy of Machinery and Manufactures*[2]

Introduction

Global warming is the unintended by-product par excellence. A cotton manufacturer of mid nineteenth-century Lancashire who decided to forgo his old water wheel and, at long last, invest in a steam engine, erect a chimney and order coal from a nearby pit did not, in all likelihood, entertain the possibility that this act could have any kind of relationship to the extent of Arctic sea ice, the salinity of the Nile Delta soil, the intensity of the Punjab monsoon, the altitude of the Maldives, or the diversity of amphibian species in Central American rainforests. Nonetheless, sporadic forebodings appear in the literature of the time. One notable flash of apprehension about the atmospheric consequences of employing steam power in factories can be found in the first chapter of Charles Babbage's classic treatise *On the Economy of Machinery and Manufactures*. Babbage is credited with being the father of the modern computer, and his book is considered the first to introduce 'the factory into the realm of economic analysis'.[3] He made his fleeting remark, quoted above, some two-and-a-half decades before John Tyndall explained the greenhouse effect, and more than half a century before Svante Arrhenius first calculated the rise in surface temperature of the Earth following an increase in the emissions of carbon dioxide (called 'carbonic acid' by Arrhenius as well).[4]

But the environmentally concerned enquiry of the pioneer economist was truncated, due to sheer lack of knowledge. Babbage was verging on yet uncharted territory. Instead, his book continued as one long encomium to the wonders of machinery – first and foremost 'the check which it affords against the inattention, the idleness, or the dishonesty of human agents'.[5] With that turn of phrase, Babbage established a leitmotif for mid nineteenth-century bourgeois thinking on the triumphant powers of the machine. It evolved on the basis of the operating procedures of manufacturers, continuously checking the idiosyncrasies of human agents with ever more machinery impelled by ever more powerful steam engines, unsuspecting of any particular noxious effects.

As the world teeters on the brink of unimaginable catastrophe due to global warming, it is about time we revisit the origins of our predicament. How, simply

2. Babbage 1835, p. 18.
3. Rosenberg 1994, p. 24. See also Schaffer 1994.
4. See Weart 2003; Arrhenius 1896.
5. Babbage 1835, p. 54.

put, did we get caught up in this mess? Why were modern economies put on the track of perpetually increasing consumption of fossil fuels? This is the question of the emergence of *the fossil economy*: an economy characterised by self-sustaining growth predicated on growing consumption of fossil fuels, and therefore generating a sustained growth in emissions of carbon dioxide. Thus defined, the concept refers to an expansion in the scale of material production realised through expansion in the combustion of coal, oil and/or natural gas.

In the lexicon of climate change discourse, the term 'business-as-usual' is commonly employed as a stand-in for the fossil economy. As usual as this business now appears, it is not a fact of nature, nor the product of geological or biological history. The fundamental ontological insights of climate science tell us as much, and moreover, fossil fuels should, by their very definition, be understood as a social relation: no piece of coal or drop of oil has yet turned itself into fuel. No humans have yet engaged in systematic large-scale extraction of either to satisfy subsistence needs. Rather, fossil fuels necessitate commodity production and waged or forced labour as components of their very existence. A primary scientific task should therefore be to write a social history of business-as-usual or – synonymously – the fossil economy, and yet it is sorely neglected, in a field awash with data on the disastrous effects of the process but comparatively poor on insights into the drivers of the danger. Most climate science still dwells in the noiseless atmosphere, where everything takes place on the surface, rather than entering the hidden abode of production, where fossil fuels are actually produced and consumed. What follows is a modest contribution to the filling of this gap.

The birth of the fossil economy

The obvious birthplace of the fossil economy is Britain. As late as 1850, this single country was responsible for more than 60 per cent of global CO_2 emissions from fossil fuel combustion. It raised three-and-a-half times more coal than the US, France, Germany, Belgium and Austro-Hungary combined, the lion's share of it for combustion on the British Isles; per capita consumption was more than ten times higher than in France and Germany.[6] For quite some time, Britain was the sole economy of its kind, the place of origin of business-as-usual, from which it eventually spread to other advanced capitalist countries.

By the mid-nineteenth century, however, coal had been regularly utilised as a source of heat in Britain for almost two millennia. Stumbling upon outcrops of the black stone, the Romans began to burn it for heating military garrisons and villas, working iron in smitheries, and keeping the perpetual fire alive at the

6. Boden, Marland and Andres 2011; Church 1986, p. 773; Cameron 1985, p. 12.

temple in Bath.[7] Coal fell into disuse with their departure, only to reappear in the thirteenth century – primarily in the smitheries – and experienced a surge in the late sixteenth, when it spread rapidly as a fuel for domestic heating. By 1800, most people in towns probably bought coal to heat their homes and cook their meals.[8] The household continued to be the chief hearth for combustion. It could not give rise to a fossil economy: as long as coal was mostly used in the domestic production of heat, fossil fuels remained unattached to an engine of self-sustaining economic growth. No matter how much coal British households burnt, consumption levels were constrained by the slow march of population growth, rather than boosted by the exponential expansion in the scale of material production we associate with business-as-usual. It would be absurd to date its onset to the Roman occupation or the thirteenth century.

But long before 1850, coal had also made inroads into manufacturing, as a fuel in the production of salt and soap, lime and ale, bricks and glass, copper and pottery and a range of other commodities. Most importantly, the owners of blast furnaces shifted from charcoal to coke in the last quarter of the eighteenth century, ushering in a boom in iron production. By 1800, the iron sector took some 10–15 per cent of all coal – a rapidly rising share, though still rather small in relation to that of domestic heating (somewhere between a half and two thirds).[9] In furnaces, kilns and breweries, coal served the same purpose as in cottage stoves: it provided heat for smelting, boiling or distilling the matters in hand. A substitute for wood, it was confined to the processing of substances whose properties required heating. For coal to be universalised as a fuel for *all* sorts of commodity production, it had to be turned into a source of *mechanical energy* – and, more precisely, of rotary motion.

Only by coupling the combustion of coal to the rotation of a wheel could fossil fuels be made to fire the general process of growth: increased production – and transportation – of all kinds of commodities. This is why James Watt's steam engine is widely identified as the fatal breakthrough into a warmer world.[10] Newcomen's engine had managed to force a piston up and down, up and down, in a vertical motion well suited for the pumping of water in mines, but not for driving machinery. That was the feat of the device patented by Watt in 1784, when he finally 'adapted the motion of the piston to produce *continuous circular motion*, and thereby made his engine applicable to all purposes of

7. Dearne and Branigan 1995.
8. Nef 1966; Flinn 1984; Hatcher 1993.
9. Nef 1966; Flinn 1984; Hatcher 1993; Buxton 1978; Hyde 1977; Humphrey and Stanislaw 1979.
10. See, for example, Crutzen 2002; Crutzen and Steffen 2003; Steffen, Crutzen and McNeill 2007; Zalasiewicz, Williams, Smith, Barry, Coe, Bown, Brenchley, Cantrill, Gale, Gibbard, Gregory, Hounslow, Kerr, Pearson, Knox, Powell, Waters, Marshall, Oates, Rawson and Stone 2008.

manufacture.'[11] But a patent cannot by itself spark off something like a fossil economy. The mere existence of a steam engine as certified in the legal rights of the inventor tells us nothing about the extent to which such engines were actually installed, their function in the economy, or the propensity to emit carbon dioxide. History is replete with inventions petrified into objects of exhibitions or fantasies da Vinci-style, including in the annals of steam power, the basic principles of which were known long before Watt, including in China.[12] The question of the steam engine is therefore the question of *why it was adopted and diffused* – in Britain, and, first of all, in the cotton industry.

The most advanced branch of industrial production, following Richard Arkwright's establishment of the factory system, the cotton industry was eyed by Watt as the natural outlet for his product. The assembling of machines under one roof demanded a regular, smooth and dependable propulsive force, posing the technical challenge Watt wrestled with, and promising a vast market for him and his business partner Matthew Boulton once he succeeded. And indeed, the promise was eventually realised. The steam engine owed its coming position as the defining prime mover of industrial production to its success in the cotton mills.[13] But that was by no means an automatic or predetermined affair. In fact, as we shall see, cotton manufacturers preferred another prime mover for at least four decades after Watt's patent: the water wheel.

A traditional source of mechanical energy, leaving no traces of CO_2 behind – 'carbon-neutral', in today's parlance – water was the foundation of the early cotton industry.[14] Water, not steam, carried the first generations of cotton manufacturers to their super-profits, even as Boulton & Watt did everything to advertise the advantages of their engine. The water wheel proved extraordinarily resilient to the challenge of steam, and when it finally gave way, the shift was contingent upon developments in which neither Watt nor Boulton played any role.

Water power was a barrier that had to be knocked down for the fossil economy to emerge. The British cotton industry was the historical gateway, on the other side of which the steam engine spread to other major industries, other countries, completely different applications – such as on the seas – and

11. Farey 1827, p. 13; emphasis in original.

12. On steam engines in China, see Pomeranz 2000, pp. 61–2.

13. See, for example, von Tunzelmann 1978; Lord 1965; Hills 1970; Hills 1989; Briggs 1982.

14. See, for example, Aspin 2003; Fitton and Wadsworth 1958; Chapman 1972; Chapman 1992; Tann 1970; Cooke 2010; Ingle 1997. Insofar as the wheels were built using iron, which they increasingly were in the first half of the nineteenth century, they were not completely carbon-neutral or independent of fossil fuels – compare a bicycle, a windmill or a solar panel today. However, since depreciation rates were extremely low for water wheels made of iron, the embedded carbon element in every horsepower delivered must have been all but negligible.

thereby suffused the process of self-sustaining growth with fossil energy.[15] The adoption of steam power in the British cotton industry was, so to speak, a *rite de passage* for coal, a qualitative leap into the spiral of ever expanding commodity production. Had the cotton industry – the very spearhead of industrial capitalism – stayed with water, the fossil economy would not have come about the way it did (and the first task for history-writing is to account for what actually transpired). A central question in the writing of the social history of business-as-usual will therefore be: *why did the British cotton industry switch from water to steam?*

False starts in energy studies

While global warming accords novel significance to the energy aspects of the industrial revolution, interest in them is not, of course, entirely new.[16] The doyen of modern research in the field is E.A. Wrigley. In a path-breaking article in 1962, he first broached ideas later developed into a grand narrative of the industrial revolution and, more generally, of modern economic growth.[17] In what he would come to call an 'organic economy', all forms of material production are based on the land. Raw materials, as well as thermal and mechanical energy – human and animal bodies used to put things in motion – are all drawn from the yield of present photosynthesis. But that yield is restricted. There is no way to enlarge it beyond the constant supply of land. A growing organic economy will inevitably get trapped in fierce competition for scarce resources, making 'a permanent, radical increase of industrial raw material supply' – a necessary condition for modern economic growth – 'very difficult to obtain.'[18] The dependency on the land puts a low ceiling on industrial production. Fossil fuels shatter that ceiling.

In a series of subsequent articles and books, culminating in the 2010 magnum opus *Energy and the English Industrial Revolution*, Wrigley elaborated on these theses, whose influence on the study of energy in the industrial revolution now deserves the epithet of a paradigm.[19] That paradigm, however, has deeper sources than Wrigley himself, as he developed it in continuous engagement

15. For some aspects of the transition to steam power in the British imperial navy, see Malm 2012a.

16. For an excellent overview, see Barca 2011.

17. Wrigley 1962.

18. Wrigley 1962, p. 1. See further Wrigley 1972; Wrigley 1988; Wrigley 1990; Wrigley 2000; Wrigley 2004; Wrigley 2010.

19. For applications of Wrigley's theories, see for example Thomas 1985; Mayumi 1991; Malanima 2001; Malanima 2006; Sieferle 2001; Andrews 2008; Jones 2010. On Wrigley's centrality and influence, compare Barca 2011.

with two of the classical political economists: David Ricardo and Thomas Malthus. For Ricardo, a growing economy would lay claim to more land. Inferior soils would have to be taken into cultivation: wetlands, steep slopes, fields in the mountains hitherto left untouched because of their natural infertility. Higher inputs of capital and labour into such land would inescapably produce diminishing returns, decreasing profits, falling wages, and an end to growth; in a Ricardian formulation repeatedly quoted by Wrigley, a state of stagnation will 'necessarily be rendered permanent by the laws of nature, which have limited the productive powers of the land.'[20] But coal offers a 'chance of escaping the Ricardian curse'.[21] At the end of the eighteenth century, the British economy emancipated itself from the land constraint. Digging into the stores of past photosynthesis, bypassing the restricted surface area of inflowing solar radiation, it finally broke the spell of stagnation.

One method used by Wrigley and his followers to illustrate this logic is to convert coal into acres of land required to generate the same amount of energy. In 1750, all coal produced in England would have equalled 4.3 million acres of woodland, or 13% of the national territory. In 1800, substituting wood for all coal would have required 11.2 million acres, or 35% of the British land surface; for 1850, the figures rise to 48.1 million acres and 150% respectively. A hypothetical total conversion from coal to wood in the British economy would thus, even in the year 1750, have 'represented a significant proportion of the land surface for which there were many other competing uses'; in 1800, it would have been 'quite impractical', while in 1850 it was 'self-evidently an impossibility'.[22] In a similar computation inspired by Wrigley, Rolf Pieter Sieferle, in his aptly titled *The Subterranean Forest: Energy Systems and the Industrial Revolution*, concludes that 'British coal production freed an area that was equivalent to the total surface of Britain' already in the 1820s, while Paola Malanima, likewise standing on the shoulders of Wrigley, estimates that without fossil fuels, Europe would have needed a land area more than 2.7 times its entire continental surface in 1900, rising to more than 20 times in 2000.[23]

But the pressures undone by coal were not only Ricardian in character. They emanated from reproduction as much as from production. According to Wrigley, Malthus's theorem of geometrically growing population and arithmetically growing food supplies, generating a tendency for output per head to fall with population growth, is indeed valid in an organic economy. As long as all material production derives from land, living standards will decline

20. Ricardo quoted in Wrigley 2010, pp. 10–11. The quotation also appears in Wrigley 1988, p. 36; Wrigley 1990, pp. 49–50; Wrigley 2000, pp. 128–9; twice in Wrigley 2004, pp. 55, 72.

21. Wrigley 2010, p. 174.

22. Wrigley 2010, p. 99.

23. Sieferle 2001, pp. 102–3; Malanima 2006, p. 104.

when more people divide the fixed supplies into smaller pieces. Perpetual stagnation is ensured – until coal blazes a new trail, allowing population and economy to grow hand in hand.[24]

The Malthusian component of the paradigm has received its most articulate expression in a study by Richard G. Wilkinson. In *Poverty and Progress: An Ecological Model of Economic Development*, appearing in 1973, Wilkinson – fortunately now better known for his work on the unhealthy impacts of social inequality – constructed a model of technological and economic development in general, and of the industrial revolution in particular. People do not invent new methods of procurement because they are affluent, but because – and only when – they are poor. Poverty is a symptom of resource scarcity. Such a condition comes about when a human population succumbs to its innate tendency, common to 'every animal population', to reproduce beyond the bounds of its resource base.[25] This is, Wilkinson argued, what happened on the eve of the industrial revolution: the self-restraint of English couples broke down, fertility rose sharply, hitherto existing ecological equilibria collapsed and gave way to acute scarcity.

The growing population initially resorted to the 'available slack in the resource-base'.[26] But by the eighteenth century, the combined Ricardian-Malthusian curse had, according to Wilkinson, reached intolerable levels, forcing England into 'the substitution of mineral resources for landbased ones.'[27] The stimulus to the industrial revolution came 'directly from resource shortages and other ecological effects of an economic system expanding to meet the needs of a population growing within a limited area.'[28] Coal was the natural resolution of the crisis, taking the place of wood in cottages and smitheries under the dictates of 'population growth and the consequent extension of the economic system'.[29] Like every other change the industrial revolution brought about, the turn to fossil fuels was the outcome of 'a valiant struggle of a society with its back to the ecological wall', a decision 'made under duress'.[30]

We may designate this the *Ricardian-Malthusian paradigm* for studying the role of energy in the industrial revolution.[31] Another Wrigley-inspired

24. For example, Wrigley 2010.
25. Wilkinson 1973, pp. 4–5, 19–52. 'Every animal population': Wilkinson 1973, p. 20.
26. Wilkinson 1973, p. 76.
27. Wilkinson 1973, p. 101.
28. Wilkinson 1973, p. 112.
29. Wilkinson 1973, p. 115.
30. Wilkinson 1973, pp. 126, 134.
31. Robert Brenner speaks of a 'Malthusian-Ricardian model' in the closely related context of the debate on the origins of capitalism (see Brenner 2007). The terms have been swapped here, since the Ricardian component appears determinant, primarily in Wrigley. An ironic illustration

scholar, Brinley Thomas, sums up its basic tenets: 'The industrial revolution was Britain's response to *an energy shortage* which afflicted its economy in the second half of the eighteenth century. A population explosion intensified the need to change its energy base from wood fuel to fossilized fuel.'[32]

How, then, does the Ricardian-Malthusian paradigm account for the rise of the steam engine? In his original 1962 piece, Wrigley noted the delay between Watt's invention and its diffusion in the cotton industry, concluding that 'only after a generation of expansion had caused the need for power to outstrip the capabilities of the human arm and the water wheel was the steam engine brought into use'.[33] The great advantage of the engine was its independence from 'the annual round of plant photosynthesis', as hitherto embodied in human or animal muscle.[34] According to Wilkinson, 'the use of water power was limited by the number of streams with suitable sites for mills: new sites became scarce in many parts of the country during the *seventeenth* century.' By the time of the late eighteenth, the rise in British fertility had created a situation where 'good mill sites were no longer available', whereas 'coal to fuel the steam engine was plentiful – especially at the pit head. *The spread of steam power was ecologically favoured.*'[35] For Kenneth Pomeranz, whose magisterial and extremely influential *The Great Divergence: China, Europe, and the Making of the Modern World Economy* is based on Ricardian-Malthusian – and Smithian – conceptions of growth, 'water power, no matter how much the wheels were improved, simply did not have the same potential to provide energy inputs that would significantly outpace a rapidly growing population'.[36] In this version of events, water wheels and other traditional prime movers were discarded in favour of the steam engine *because they could not deliver the requisite absolute quantities of energy*.

Critique of the paradigm

The Ricardian-Malthusian paradigm has a number of conspicuous shortcomings. Wrigley's terminology is imprecise, to begin with: fossil fuels are no less organic than wood or people, which is why their combustion releases carbon dioxide. Denoting our current economy 'inorganic' or 'mineral-based' –

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of the power of the Ricardian-Malthusian paradigm is the apparently thoughtless recent endorsement of it by Timothy Mitchell, who is, of course, sharply anti-Malthusian. Mitchell 2011, pp. 12–15; compare p. 238; Mitchell 2002.

32. Thomas 1985, p. 729; emphasis added.
33. Wrigley 1962, p. 12.
34. Wrigley 2010, p. 100.
35. Wilkinson 1973, p. 120; emphases added.
36. Pomeranz 2000, p. 61.

Wrigley's antitheses to 'the organic economy' – makes little sense; both terms would encompass the Bronze Age as well as the Iron Age.

Semantic pedantry aside, the paradigm fits ill with the transition we are concerned with here. Prime movers derived from photosynthesis – animal and human bodies – were never capable of delivering mechanical energy to large-scale industry. In eighteenth-century British factories, they were certainly experimented with, but quickly abandoned as useless.[37] Not land but *water* was the element on which Britain's industries, cotton foremost among them, first developed. Products of present photosynthesis are eminently suitable for the generation of thermal energy, human beings having burnt wood for heat since time immemorial, but not for powering machinery: coal was never an alternative to wood, humans or animals *as fuels for rotary motion.* Thus a Ricardian exigency could not possibly have triggered the one transition we have identified as epoch-making. Ironically, Wrigley himself professes awareness of the diffusion of steam engines in industrial production as the watershed event – and yet it is an anomaly to the paradigm, since the crucial victory of steam power came at the expense of a prime mover that did not grow from plants.[38] There is still, of course, the possibility that scarcity in a more general sense, along the lines suggested by Wilkinson and Pomeranz, afflicted water power, and that steam offered relief from it. We shall see presently how that proposition chimes with the data.

A more fundamental problem of the Ricardian-Malthusian paradigm, however, lies in its form of explanation. It runs something like this: *there is a constant appetite for more energy inherent in all societies, and in the eighteenth and nineteenth centuries, Britain finally managed to satisfy it.* To construct such an explanation for the emergence of a fossil economy, the paradigm's exponents need to invoke a transhistorical factor, an urge shared by all societies finding its wanted object in Britain's mines. For Wrigley, that factor is simply the drive to perpetual economic growth. 'The move away from an exclusively organic economy was a *sine qua non* of achieving a capacity for exponential growth', he writes, or: 'The land surface of the earth was a fixed quantity and formed a barrier to indefinite growth', or: 'The energy bottleneck which set limits to growth in organic economies was widened progressively as fossil fuels replaced organic [*sic*] fuels.'[39] Similar statements are repeated *ad infinitum* in Wrigley's writings.

37. See, for example, Tann 1970.

38. For Wrigley's awareness of the centrality of mechanical energy and rotary motion in particular, see for example Wrigley 1990, pp. 6, 78, 90; Wrigley 2004, pp. 35, 78; Wrigley 2010, pp. 42–5, 100, 177–8, 190–1.

39. Wrigley 2000, p. 139; Wrigley 2010, pp. 193, 191.

For Wilkinson, a rather more avowed Malthusian, the transhistorical factor is the biological urge to breed, shared not only by all societies but by all animal populations. Since the dawn of time, it aroused a unilinear 'growth of need' that forced man 'to involve himself in more and more complicated processing and production techniques'; in hyper-fertile Britain, it finally impelled him to enter the age of fossil fuels.[40] According to Pomeranz, the English economy diverged from an equally growth-prone China because the turn to coal – via the steam engine – 'enabled it to break through the fundamental constraints of energy use and resource availability that had previously limited *everyone's* horizons.'[41] Such formulae rest precisely on the assumption that the impulse to expansion was permanently present in pre-fossil economies, bottled up throughout history, on everyone's horizon, from the Yangzi to the Thames. The growth imperative was always there, though frustrated by the dependency on land – and this explains why fossil fuels were introduced in the end.[42]

The transition then becomes a mere formality. Since that which requires explanation – the dynamics of business-as-usual – is postulated a priori as biding its time, there is not much to uncover in the passage from one form of economy to another. In Wrigley and his peers, the fossil revolution resembles the fulfilment of historical destiny, rather than a rupture separating two distinct orders from each other. There are no laws of motion specific to the fossil economy, no emergent imperatives that compel economic agents to combust fossil fuels, only an opportunity to realise age-old, universal forces – laws of nature, in effect. And hence there are no social antagonisms. 'Capitalism', according to Wrigley, 'is an elusive concept' unworthy of application; no relations of power between labour and capital appear on his radar.[43] In claiming that 'the spread of steam power was ecologically favoured', Wilkinson elevates the agents of steam to representatives of the common interests of their biological population, while Sieferle similarly refers to humanity as an undifferentiated whole: 'Fossil energy *liberated humans* from their ties to area size.'[44] As if the fossil economy was the work of humans in general, of a species in action, united and harmonious.

40. Wilkinson 1973, pp. 90, 102.
41. Pomeranz 2000, p. 207; emphasis in original.
42. This critique is derived from that developed by Ellen Meiksins Wood and Robert Brenner in the context of the debate on the origins of capitalism. See Meiksins Wood 1995; Meiksins Wood 2002; Brenner 1986; Brenner 1987a; Brenner 1987b; Brenner 2007.
43. Wrigley 2010, p. 209.
44. Sieferle 2001, p. 121.

The puzzle of superior water

In actual history, the decision to replace water with steam was not, of course, democratically taken. Choice of prime mover was the prerogative of capitalists. It presupposed the separation between the direct producers and the means of production; only when operatives were gathered under the eye of a manufacturer, who paid them to perform labour on his machines, did he have reason to weigh the relative merits of different non-human motive forces for the propulsion of machinery. Choice of prime mover, in other words, was a corollary of the factory system, and though its instigator Richard Arkwright failed in his early experiments with steam, it did not last long before cotton-mills puffed out black soot. In 1786, the brothers Robinson erected the first rotative steam engine to drive machinery for spinning cotton in their Papplewick factory on the River Leen. But they soon became disappointed. In a complaint that would long haunt steam power, the brothers faulted the engine for excessively high fuel costs: coal commanded a price of 11 to 12 shillings, to be measured against the free running water of the Leen. Instead of pursuing steam further, they fell back on the natural supply of the river, augmented it with reservoirs, and continued to spin by water.[45]

The rotative steam engine first made a home in the mills of Manchester in 1790.[46] By the middle of the decade, the technical capability of the prime mover had been thoroughly demonstrated, knowledge of steam was widespread, and cotton capitalists in some Lancashire towns eagerly embraced it. Yet water power reigned supreme, its dominance in the cotton industry barely dented.[47] Frustration surfaced in the sales efforts of Boulton & Watt. In 1791, one manufacturer explained why he turned down their offer: 'The Expense of a small engine as well as the consumption of coal and water being much greater than I apprehended would be required for our work, it seems more advisable to place our machines on a stream of water about a mile from our house'.[48] Watt himself offered a sober assessment in the same year: 'I hear that there are so many mills resting on powerful streams in the North of England that the trade must soon be over-done.'[49]

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45. Marshall 1957; Chapman 1971, pp. 5–6. On Arkwright and steam, see Fitton 1989; Tann 1973a.

46. Chaloner 1954–5.

47. See Chapman 1969; Chapman 1971; Chapman 1972; von Tunzelmann 1978; Musson 1976; Kanefsky 1979; Hills 1970; Hills 1989.

48. Letter quoted in Tann 1973b, p. 220. This particular manufacturer was in the woollen industry, but his objections summarised those 'of many small clothiers to steam power at the turn of the century' (ibid.). Compare Musson and Robinson 1959, pp. 423–4; Hills 1970, p. 145.

49. Quoted in Briggs 1982, p. 57.

By 1800, 84 Boulton & Watt engines in British cotton mills were still overshadowed by around one thousand water wheels. Water remained the foundation for the capitalist factory system, and not merely as a relic of the past: wheels were enlarged and perfected, dams and reservoirs excavated *en masse*, new and extended mills – particularly in the great cotton boom of 1823–5 – equipped with the latest wheel-models of gargantuan dimensions. More than four decades passed from Robinsons's first installation to the decisive triumph of steam. Some time between the mid-1820s and the late 1830s – no exact date can be pinned down – steam power reached parity with and, in quick succession, dethroned water in the cotton industry. This was the time of the transition, in at least three senses. New or extended mills were now only rarely fitted with water wheels, in a sharp break with the past. For the first time, the bulk of horsepower came from steam engines. But perhaps most importantly, a range of decisions were taken over the 1830s by manufacturers and legislators that, for all practical purposes, ended water power expansion in the cotton industry and cleared the way for steam, not only there, but throughout British manufacturing.[50]

The time-lag has long been considered a puzzle: 'Explaining the slow adoption of steam power in the cotton industry is an important problem for the historians of its technology', in the matter-of-fact words of a recent account of the industrial revolution.[51] But the problem could just as well be formulated in the reverse terms. The very slowness of the process – four or five decades are a blink of an eye in geological time, but they can be an aeon in the annals of capitalism – raises the question not only of why it happened so late, but *why steam power was adopted at all.* We need an explanation that can account for the adoption that took place before the mid-1820s, but *particularly* thereafter, with the 1830s standing out as the decade of the most concentrated shift.

Was steam resorted to because water was scarce by the time of the 1830s? The hypothesis of an energy crisis – a wall of water shortage confronting cotton manufacturers, leaving them no choice other than steam – was submitted to rigorous testing by Robert B. Gordon in 1983. 'If it can be shown', Gordon wrote, 'that nearly all the water power physically available in the industrial regions was exploited before steam power was much used, the energy crisis hypothesis would be proved.' But if the recoverable data rather indicated that 'there were unused water power resources throughout this period, it would be necessary to appeal to the social factors for support of this hypothesis' – or, to be exact, the

50. See, for example, Kanefsky 1979; Rose 1986; Taylor 1949; von Tunzelmann 1978; Chapman 1972; Chapman 1969, p. 75; Crafts 2004. More extensive empirical support for the claims in this article, with full sourcing, will be found in the dissertation in progress of the present author.

51. Allen 2009, p. 172.

hypothesis would be disproved, and a completely different explanation would be needed.[52]

Gordon proceeded with a scrupulous reconstruction of the meteorological, geological and topographical conditions in the industrial areas of both England and New England. To assess the potential power supply, he identified the available watersheds and computed their drainage areas, falls and stream slopes, but excluded sites where the initial costs of establishing a mill would have been prohibitive. The results for both regions were unambiguous. As for England, in the year 1838, mere fractions of the potential water power in eleven major rivers running through the textile districts were utilised. For Irwell, that fraction was 3.4%; for Derwent, 1.7%; for Dove, 0.8%; for Ribble, 3.0%; for Spodden – the most heavily exploited watercourse on the list – 7.2%. 'More water power could have been obtained by continued geographical extension of the industrial districts without encountering either high initial costs or excessive variable, transportation, or other costs. It follows', Gordon concluded, 'that physical bounds on the availability of water power at low cost was not a limitation on the development of industry.'[53] The energy-crisis hypothesis demolished, he stopped short, however, of exploring alternative explanations.

For Scotland, a cotton district second in importance only to Lancashire, the picture is similar. 'The potential of water power in Scotland was never fully realised, except in a few localities favoured by other attributes', runs the conclusion of John Shaw in his *Water Power in Scotland, 1550–1870*. 'The end of the Age of Water Power came about not so much on account of any inherent weakness as through changes in the scale of industrial units, in work patterns, populations distributions and economic goals' – factors which, again, Shaw left without further examination.[54]

Did the transition happen because steam engines had become more powerful and reliable – in short, technologically superior? In the early decades of the nineteenth century, the average output of both an iron breast-wheel and a Boulton & Watt steam engine was 20 horsepower, or slightly less. But the most powerful prime movers were invariably water wheels. In the 1820s, steam engines of 60 horsepower were considered unusually powerful, while a string of giant water mills in northern England and Scotland had a capacity of between 300 and 500 horsepower. Indeed, as late as in the early 1840s, the most imposing wheel constructions generated more power than the mightiest steam engines – a situation that would not remain for much longer, the engines

52. Gordon 1983, p. 243.
53. Gordon 1983, p. 256.
54. Shaw 1984, p. 544.

leaping ahead in the latter decades of the nineteenth century, but by then the transition in the cotton industry had long been completed.[55]

One of the greatest obstacles for Boulton & Watt was the perceived irregularity and frailty of their engines, compared to the robust wheels. Not until the mid-1830s could the finest workshops deliver steam engines capable of producing a motion as smooth and even as that of water.[56] In 1840, *The Civil Engineer and Architect's Journal* reported that factories at Stockport erected two engines to work the same machinery in order to equalise the action of steam, 'yet the motion is not so regular as that of an overshoot water-wheel, where the supply of water is uniform.'[57] In his unpublished PhD thesis from 1979 – the authoritative compilation of statistics on water and steam in British industry – John Kanefsky reckoned that 'cotton produced by water mills was still regarded as being generally superior to that produced by steam power', due to the unequalled evenness of motion in the former, all through the 1830s.[58] Well into the second half of the century, water wheels were less prone to mechanical glitches and breakdowns.[59]

Was steam cheaper than water? This is, at first sight, the most plausible explanation: cotton capitalists opted for steam because one horsepower thereof was cheaper than one of water. A water wheel represented a substantial investment. The wheel itself had to be purchased, positioned in a wheel-house, and, in most cases, supplemented with a dam to secure a regular supply of water. Then the mill-owner would have to build a system of conduits – canals, leats, sluice-gates – to lead the water onto the wheel in proper amounts, presuming that it was of the standard overshot or breast type. A steam engine, on the other hand, consisted of iron, brass and copper, fly-wheel, boiler and pipes; fixed on a solid framing in a special engine-house, its construction required skilled labour. Then there was the occasional need for extensive repairs following breakdowns and the spectacularly high depreciation rates, whereas water wheels could function with only minor maintenance for decades or even a century. Water came flowing for free. Once the capitalist had secured a lease from the landowner, paying rent for the right to utilise the stream, there were no further fuel costs. Coal had to be constantly purchased on the market. The sum of these relations is widely accepted in the literature: *water wheels were consistently cheaper per horsepower than steam engines* in

55. Musson 1976; Reynolds 1983; Hills 1970; von Tunzelmann 1978.
56. Chapman 1971, p. 12.
57. *The Civil Engineer and Architects' Journal* 1840, p. 8; emphasis added.
58. Kanefsky 1979, p. 141.
59. Kanefsky 1979, p. 142.

the early nineteenth century.[60] 'It is difficult to resist the conclusion', writes cotton historian Stanley Chapman, 'that steam was more expensive than the costliest water power installations.'[61]

But had not the balance swung in favour of steam by the time of the 1830s? Could water wheels still put up with the challenge, in pure cost terms? The 1833 Factories Inquiry, carried out by a Parliamentary commission under the leadership of Edwin Chadwick, provides some answers. One proprietor of a steam-powered mill in Manchester declared that a manufacturer with water power enjoyed an 'advantage over his competitors'. Curious, his interviewer wondered:

> Why do you think he has till now enjoyed an advantage over his competitors in trade? – Because it is a well-ascertained fact that water-power is cheaper than steam.
>
> Then if a mill-owner wishes to set up a manufactory, he can always do it cheaper by purchasing a waterfall than a steam-engine? – Yes; if he does not pay too high for his water.
>
> Suppose he does not pay too high for his steam-engine, would he be in the same condition? – No; because the price of fuel is a greater object than the price of a steam-engine.
>
> Why is it cheaper to purchase a waterfall than a steam-engine? – On this ground – *the constant supply of water is much cheaper to turn an engine with than the supply of coal.*[62]

'If I wanted to hire power to-morrow', announced Thomas Worsley, a Stockport shopkeeper, 'I can procure it in the country parts round Manchester' – i.e. along rivers – 'one-third under what I should have to give for it in Manchester or any of the manufacturing towns'. Therefore 'the owners of water power can work cheaper than the owners of steam power.'[63] One commissioner alluded to a 'jealousy of the water-mills' on the part of steam-dependent manufacturers in the cotton industry.[64] Factory philosopher Andrew Ure referred to the 'cheapness' of water 'as compared to that of steam'.[65] In 1849, the manager of Quarry Bank mill, the water-powered jewel of Samuel Greg & Co. – known as the largest cotton empire in all of Britain – calculated that running an engine of

60. See, for example, Chapman 1971; Kanefsky 1979; von Tunzelmann 1978; Tann 1970; Hills 1970; Hills 1989; Briggs 1982; Musson 1976.
61. Chapman 1971, p. 13.
62. Parliamentary Papers 1833a, p. D2.132; emphasis added (John Cheetham).
63. Parliamentary Papers 1833a, p. D1.16.
64. Parliamentary Papers 1833a, p. D2.99.
65. Ure 1835, p. xlvii.

100 horsepower instead of the current wheel of the same capacity would burden the factory with a cost of £274 per annum.[66] The computation was repeated in 1856, now against a water wheel of 172 horsepower; again, the manager found that 'our waterpower is worth about £280 a year' due to 'the saving in coal.'[67]

Such evidence dovetails with all modern reconstructions of power costs in the period. Chapman estimated the cost per unit of horsepower in a cotton mill in the year 1840 as £86 for steam and £59 for water.[68] In *Steam Power and British Industrialization to 1860*, Nick von Tunzelmann inferred that water wheels 'cost far less per horsepower for purchase and erection than did steam-engines' in the 1850s; 'for large wheels the cost was around half that of steam-engines of equal power.'[69] But the decisive factor remained the difference in fuel costs, underpinning 'the profitability of water-power up to at least the mid-nineteenth century'.[70] Kanefsky went even further. 'It is quite plain that throughout the period' – up to 1870 – 'water power was, when available, significantly cheaper in all but very exceptional circumstances and that where coal was expensive the difference could be considerable.'[71] The railways failed to close the gap, so that water was 'preferable to steam *even in 1870 if cost factors alone were under consideration*' – but then again, in 1870 the transition had been accomplished long ago.[72]

All of this points to a conclusion of rather startling implications for the history of the fossil economy. The transition from water to steam in the British cotton industry did not occur because water was scarce, less powerful, or more expensive than steam. To the contrary, steam gained supremacy *in spite of water being abundant, at least as powerful, and decidedly cheaper*. None of this is in serious dispute, *pace* Wrigley et al., but so far it has only served to deepen the mystery: then *why* did the transition occur? Was it irrational, or did it have another rationale, a different set of causes, hidden beneath the immediately visible differentials in economic and technological benefits? Neither Gordon, nor von Tunzelmann, nor Kanefsky or anyone else has systematically examined the actual motives for turning to steam. It is to this task we now turn.

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66. Rose 1986, p. 42. On the size of the firm, see for example Ure 1835, p. 347.
67. Greg archive: C5:3/2, memorandum, 'Water Wheel Power at Quarry Bank, August 4th 1856'.
68. Chapman 1971, p. 18.
69. von Tunzelmann 1978, p. 130.
70. von Tunzelmann 1978, p. 136.
71. Kanefsky 1979, p. 175.
72. Kanefsky 1979, p. 176; emphasis added.

Power to visit labour

The steam engine could not explain or promote itself. Its way had to be paved by tracts and manuals, written for manufacturers and their right-hand men, teaching them how to properly handle the boilers and the pipes, the fly-wheels and the governors, and appreciate the superior principles of steam. The specimen of the genre today regarded as most accurate – and probably wielding most influence over manufacturers at the time – is the voluminous *A Treatise on the Steam-Engine*, written in 1827 by John Farey, owner of a consulting firm through which he advised capitalists on technical matters.[73] Here he wished to 'perfect the practice of those engineers and others who require to employ steam-engines', averring that the application of the 'power of the steam-engine' was of paramount importance for the well-being of the nation. The reason was simple: 'Unless the industry of the working class is systematically applied, and aided by the use of machines, there can be but little surplus wealth to maintain an educated class in society, and produce that state of general affluence which is conducive to the progress of civilization, and the development of the intellect.'[74] The steam engine was eminently conducive to this pursuit. In the Introduction to his *Treatise*, Farey juxtaposed water and steam, without hinting at any scarcity of the former: the advantage of steam lay not in its being uniquely plentiful, nor in its commanding a lower price. Instead, Farey argued, steam 'is often preferred, because a manufactory by steam power may be established in any convenient situation where fuel can be procured', whereas 'water power can only be obtained in particular situations, which are frequently unfavourable in other respects'. Of particular significance,

> natural falls of water are mostly found on rivers in the open country; but steam-engines can be placed *in the centres of populous towns*, *where labourers are easily procured*. Steam-power is frequently preferred, as a first mover for those mills which consist of a number of small machines, each performing some delicate operation; such machines require considerable assistance from work-people to direct their actions, and supply them with the materials upon which they are to operate. As all manufactories of this nature require many work-people, they are more advantageously carried on by steam-power in populous towns, than by water-power in the country: this is fully proved by the number of large manufactories in London, Manchester, Leeds, and Glasgow.[75]

73. On Farey and the *Treatise*, see Woolrich 1997; Woolrich 1998; Woolrich 2000; Nuvolari 2004.

74. Farey 1827, pp. v–vi.

75. Farey 1827, p. 7; emphasis added.

The edge of steam, in other words, was its unique suitability not for the generation of power per se, but *for the exploitation of labour*.

John McCulloch, a leading bourgeois economist of the period, had as his mouthpiece the *Edinburgh Review*, house organ of cotton capital. He hammered away at the point throughout the 1820s and '30s, dispelling misunderstandings and speaking the truth to his audience of manufacturing interests:

> The real advantage of the application of the power of steam to give motion to the machinery of a spinning mill, or of a number of power-looms, appears to be a good deal misapprehended. It does not consist so much in any direct saving of labour, as in permitting it to be carried on in the most proper situation. The work that is done by the aid of a stream of water, is generally as cheap as that which is done by steam, and sometimes much cheaper. But the invention of the steam-engine has relieved us from the necessity of building factories in inconvenient situations merely for the sake of a waterfall. It has allowed them to be placed *in the centre of a population trained to industrious habits*.[76]

The argument was echoed on both sides of the transition. In 1818, John Kennedy, partner in McConnel & Kennedy – among the largest fine-spinners in Manchester and pioneers of steam – deplored how the dependency on water caused manufacturers to be 'removed from the experienced workmen'. But the steam engine offered salvation: 'instead of carrying the people to the power, it was found preferable to place the power amongst the people.'[77] Almost half a century later, in 1866, William Stanley Jevons, in his classic *The Coal Question*, maintained that 'when an abundant natural fall of water is at hand, nothing can be cheaper or better than water power. But everything depends upon local circumstances.' Some circumstances worked to the detriment of this source of energy, however cheap it may be: the necessity of 'carrying the work to the power, not the power to the work, is a disadvantage in water power, and wholly prevents that concentration of works in one neighbourhood which is highly advantageous to the perfection of our mechanical system.'[78]

Statements of this kind can be multiplied over and over. In steam-engine manuals, essays on the factory system, testimonies from manufacturers and other contemporary sources, this is the single most salient motive: steam was a ticket to the town, where bountiful supplies of labour waited. The steam engine did not open up new stores of badly needed energy so much as it gave access to exploitable labour. Fuelled by coal instead of streams, it untied

76. McCulloch 1833, p. 323; emphasis added. Compare *The Circulator of Useful Knowledge, Literature, Amusement, and General Information* 1825; McCulloch 1835, p. 457.

77. Kennedy 1818, pp. 10, 15–16.

78. Jevons 1866, pp. 150–1.

capital in space, an advantage large enough to outdo the continued abundance, cheapness, and technological superiority of water. But before we accept this conclusion, we need answers to at least three questions. What determined the geographical mismatch between water and labour supplies? How did it affect cotton capitalists in their daily operations? And did the locality of water become particularly burdensome during the 1830s?

The centrifugal dynamic of water mills

Water power was not without its limitations. With electric transmission far into the future, streams had to be used right on the spot, and not all spots were, of course, equally generous in their supply of moving water. As William Fairbairn, the era's super-engineer and designer of several of the most stupendous water mills, pointed out in his *Treatise on Mills and Millwork*, water wheels received their 'energy from falling or flowing water, and their power or dynamic effect clearly depends upon the amount of water supplied and the height through which it falls, or its velocity at the point of application.' Thus the wheels had to be placed 'on the banks of rivers where a large body of water is at hand, and near some considerable natural or artificial fall in the bed of the stream.'[79] Riveted to the spot, the water supply was contingent on the varying attributes of the landscape. While profuse on the whole, cotton capitalists could not take for granted that it was present in the right amount where they so wanted it to be; near or inside towns, sites might become crowded.

But there was always an exit. Manufacturers could *move out* to eschew congested areas, or simply to find the best sources. In the 1780s, master spinners from Manchester and other cotton centres fanned out across the countryside of Lancashire, the Midlands, Scotland and Wales; penetrating deep into the Pennine and Rossendale valleys, into Derwent and its sister valleys or the upper Clyde, they found untouched, spurting flows of water. Not only were the banks unoccupied uphill, but the falls tended to be steeper, the rain more frequent, and the need for extensive dams lesser.[80] Reliance on water power generated *a centrifugal dynamic* in the localisation of cotton mills. The more capitalists used water, the stronger the push to search farther afield – but the farther they went, the smaller the likelihood of them encountering a pre-existing settlement. If the water resources were the chief reason for choosing the site, as was so often the case in the late eighteenth and early nineteenth centuries, the

79. Fairbairn 1864, p. 67.

80. See, for example, Chapman 1971; Ashmore 1969; Rodgers 1960; Taylor 1949; Ashworth 1951; Atwood 1928; Turner 1958; Foulkes 1964.

other prerequisites for factory production might have to be assembled from the ground up. First of all, that meant labour power.

In order to construct a viable factory at Cromford, where the swift streams of the Derwent could power his water-frames, Richard Arkwright had to collect operatives from towns and conjure up a whole village, establishing not only the first full-fledged factory, but also the blueprint for the factory *colony*, to be copied along the rivers of northern Britain. Once collected, the operatives – primarily young women – had to be accommodated in houses built for the purpose. A colony usually also included a church or a chapel, a Sunday school, a shop for groceries, perhaps roads and bridges, maybe also an inn, and certainly a mansion for the manager. Without assistance from any authority or public budget, all of this had to be financed from the pocket of the manufacturer himself.[81]

Recruitment and maintenance of a labour-force were the defining problems of the factory colony. When a manufacturer came across a powerful stream passing through a valley or around a river peninsula, chances were slim that he also hit upon a local population predisposed to factory labour: the opportunity to come and work at machines for long, regular hours, herded together under one roof and strictly supervised by a manager, appeared repugnant to most, and particularly in rural areas. Colonisers following in the steps of Arkwright frequently encountered implacable aversion to factory discipline among whatever farmers or independent artisans they could find. Instead, the majority of the operatives had to be imported from towns such as London, Manchester, Liverpool and Nottingham, requiring steady advertisement in the press as well as attractive cottages behind leafy trees, allotment gardens, milk-cows, sick-clubs and other perks to persuade the workers to come, and to stay.[82]

While wages were generally lower in the countryside, the total costs for assembling and sustaining a labour force might well have been higher in the colonies. In 1826, an anonymous 'practical spinner' published a note 'on the comparative costs of power obtained by steam or water' in *Glasgow Mechanics' Magazine*, including in his calculation rent to the landlord, outlays on dam and sluices, expenses for transporting raw materials and a manager between mill and market and other costs associated with water. Even so, the steam engine's consumption of coal resulted in a balance in favour of water 'at the rate of £1.10s. per horse power: but this must be more than counterbalanced by the great advance of capital necessary to start such a work in the country, where

81. See, for example, Pollard 1964; Pollard 1968; Fitton and Wadsworth 1958; Chapman 1992; Ashworth 1951; Aspin 2003.

82. See, for example, Cohen 1981; Pollard 1968; Redford 1976; Cooke 2010.

a village must be built, loss of time in collecting a regular set of workers, with other innumerable inconveniences, which in many instances requires years to accomplish.'[83] The problem of labour was inherent in the centrifugal dynamic of water power: for every new colony constructed on a riverbank, there ensued the process of *ingathering of labour*, of concentrating workers from all possible directions on the spot. It was the constitutive feature of the colonies, their very structure intended to attract and keep operatives in place. When they failed – when workers left – the loss was of another magnitude than what an absent worker might cause in a town mill, since every employed piecer, spinner or mechanic was, almost literally, a living investment; their departure necessitated a new round of recruitment, posing the whole problem anew.

None of this was a fact of nature. Physical laws did not determine low concentrations of population in a water-rich area, the reluctance to enter the factories or the desire to escape once inside. These were socially determined factors, making labour difficult to capture and easy to lose, but they were played out and magnified in an immutable geography of riversides, from which the water wheels could never stray like the workers. The contradiction was generic to water power as a source of mechanical energy in capitalist commodity production, present from the very beginning. But in the late eighteenth and early nineteenth centuries, it was manageable and fully compatible with good business, for average profit rates were high, and the working class had yet to emerge as a force of organised power. By the 1830s, all of that had changed.

Crisis in the colonies

When the Combination Laws were repealed in 1824, the powder keg built up over half a century of industrialisation exploded in strikes and union activism across Britain. Cotton spinners were the most militant segment of the proletariat.[84] The epicentres of mobilisation were, of course, the towns, not the dells and brooks of the countryside, but rural colonies were always more vulnerable to the effects of disorder than urban factories. As strikes hit water mills with full force in the early 1830s – rioting workers rampaging through and partly trashing the colony of the Ashworths, operatives at the Catrine works blocking the gates and throwing dirt and stones on knobsticks, the Stanley colony turned into a bulwark of the Scottish spinners' union – that vulnerability was violently exposed.[85] Leading owners of water mills responded with unusually fanatical attacks on unions in general and those of

83. *Glasgow Mechanics' Magazine* 1826.
84. See, for example, Turner 1962; Kirby and Musson 1975.
85. *Manchester Guardian* 1830; *The Scottish Jurist* 1835; Cooke 2003, pp. 126–7.

their own workers in particular. The Ashworth brothers, major spinners of fine yarn near Bolton, referred to the legalisation of combinations as 'this indulgent Act' and sacked the entire vanguard of the strike-cum-riot in 1830. A perfectly viable tactic inside towns, the mass dismissal renewed the problem of labour supply: now the Ashworths had to advertise for spinners again, replacing the strike leaders with much difficulty and extra cost. The price of the strike was obliterated profits.[86]

By its very logic, the factory colony rendered layoffs, recruitment of strike-breakers, riots and repression risky and potentially ruinous; with the strike waves of the 1830s, the advantage of immediate access to a reserve army of labour came decisively to the fore. Adding to the pressure, profit rates in the cotton industry were falling, ever since the financial panic of 1825 set off a cycle of protracted stagnation and brief booms. In the mid-1830s, a bonanza of factory construction and expansion – the first in a decade – temporarily ended the depression. Manufacturers wishing to survive now had to keep up with the competition, introduce the latest machinery and enlarge their premises, but if they relied on water, they often faced a predicament: 'There is in this neighbourhood a greater scarcity of workpeople than I have ever known', Henry Ashworth lamented in 1835.[87]

For the Gregs, owners of Quarry Bank and two other water mills in Lancashire, the worries were similar: the scarcity of labour and the trade unions conspired to bring about 'a difficulty in obtaining labourers at extravagant wages in these northern counties.' If they would expand their water mills, there was an obvious risk that 'any further demand for labour would still further increase the unions, drunkenness, and high wages.'[88] Luckily for the Gregs, however, alternative options were available. In late 1826, the company acquired two factories inside the towns of Lancaster and Bury, both powered by steam. Most of the investment was redirected to these two mills; already in 1832, the one in Lancaster surpassed Quarry Bank mill as the largest establishment of the concern. The factories in Lancaster and Bury had one decisive advantage: they offered local supplies of labour power.[89] Throughout the 1830s, the Gregs continued to expand through their steam-powered assets – while the Ashworths, still based on water, lost their leadership position in fine spinning.[90]

Scarcity of labour was never absolute or evenly distributed. In Lancashire at large, the *Manchester Guardian* noted in 1835, there was in fact 'an abundance'

86. Boyson 1970, pp. 141–55.
87. Parliamentary Papers 1835, pp. 344–50.
88. Parliamentary Papers 1835, pp. 346–7.
89. Rose 1986, pp. 39, 43, 55; Owens 2011, p. 74.
90. See Boyson 1970.

of spinners.[91] McConnel & Kennedy never had reason to complain about a shortage of workers; 'unless they appear by Eight or Nine o'Clock on Monday Morning, we get fresh ones', they could boast.[92] It was an ever more powerful magnet. Throughout the strikes waves and business cycles of the 1830s, cotton capitalists sought to defend their positions against workers and each other by further mechanising production, introducing self-acting mules for spinning and power-looms for weaving; and with automation approaching, the premium on operatives amenable to the discipline of the machine rose. Inside the towns, a second generation of 'hands' had now grown up: 'There is always that superabundance of labour in the market that I can always attain a sufficiency of hands who have been accustomed to the work, and brought up in it, I suppose; which are always preferred', explained another Manchester manufacturer.[93] In the late eighteenth century, when factories were novel sights everywhere, the advantage of urban locations was muted. Three or four decades later, the towns of Lancashire and Scotland were brimming with the 'population trained to industrious habits' of which McCulloch spoke: young men but preferably women, born in a world of mills, resigned to bells and managers in a way country folk would rarely if ever be.[94]

A fascinating victim of the dynamics was Robert Thom. Having doubled the water supply of his cotton mill at Rothesay by excavating an ingenious system of aqueducts and reservoirs, he rose to become the foremost hydraulic engineer of Scotland and a zealous advocate of water as a superior source of energy. 'Get water if you can, and be quit of these smoky and expensive engines', ran his rallying cry to Britain's cotton manufacturers.[95] The pinnacle of his lifework was the Shaws' Water-Works at Greenock, by which water was collected and distributed to prospective mill sites, in quantities said to exceed the total power capacity of 'all the steam-engines in Glasgow and its vicinity.'[96] Deeply impressed, the *Manchester Guardian* proposed the construction of a similar system on the River Irwell, in the heart of Lancashire, to 'enable the mill-owners to dispense with the assistance of steam-engines'.[97] But in 1834, seven years after the inauguration of the Shaws' Water-Works, a dejected Thom had to concede that 'the waterfalls' he had made available to investors

91. *Manchester Guardian* 1835.

92. Quoted in Fitton 1989, p. 151. See further Lee 1972.

93. Parliamentary Papers 1834, p. D1.206 (James Fernley). On the self-acting mule, see Catling 1970; on the power-loom, see Bythell 1969.

94. Balderston 2010; Williamson 1988; Thompson 1966, p. 249; Redford 1976, p. 111; Gatrell 1977, p. 115.

95. *Mechanics' Magazine* 1832.

96. *Manchester Guardian* 1827.

97. *Manchester Guardian* 1831.

> go off very slowly – there being about thirty of them still unlet – while during the time these have been in the market, a great many Steam Factories have been erected at Glasgow, though steam power there costs about £20 per horse power, or nearly seven times the cost of water power at Greenock. And this preference is given to Glasgow, why? Because it is the principal seat of trade in Scotland with a trained population ready for such Factories.[98]

The Irwell reservoirs were planned and designed, but never built.[99]

What had happened by the 1830s was clearly not an exhaustion of the potentials of water power, in physical, technological or strictly economic terms. Instead, capitalist development had reached a point where the greatest advantage of steam power – its mobility in space – overrode all other concerns. The eruption of union struggles, the booms and busts of the post-1825 business cycle and the advancing mechanisation of cotton production enhanced the demand for workers that were substitutable, expendable and adapted to machinery. While the incentive to shift to urban steam was certainly already operative around the turn of the century, the underlying contradiction between the centrifugal dynamic of water-powered factories and the geographical concentration of suitable reservoirs of labour power became acute after the repeal of the Combination Laws and the financial crash of the mid-1820s. As profits fell, moreover, the cost of establishing a colony *de novo* became deterrent.

The boom of the 1823–5 period was the last to see a major expansion of water-powered factories. In the 1830s, colonies fell like dominoes, while mills survived and grew inside Manchester, Oldham, Stockport, Blackburn. The period marked a decisive shift from a centrifugal to a centripetal dynamic, as the cotton industry retracted into the urban core of Lancashire, in a process of urbanisation indistinguishable from the conversion to steam.[100]

The foundation of the industrial town, in other words, was fossil. Coal had the benefit of not being a part of the terrestrial landscape. Buried in its interior, it was reached through a hole in the ground – the pit-mouth – hauled up in bits and pieces and ferried off to circulate freely on the market. Unlike water, coal could be *transported* to mills and *stored* in warehouses, without the need for further attention, passively awaiting combustion. For the first time in history,

98. Thom archive: valuation report, 'On the Waterfall between Dalernie Mill and the Devils Bridge', 29 March 1834; emphasis in original.

99. For an inquiry into the fate of these reservoirs, Thom's failures, and some other aspects of the political economy of the transition from water to steam, see Malm 2013.

100. Rodgers 1960; Taylor 1949; Atwood 1928; Ashworth 1951; Balderston 2010; Chapman 1972.

the converter and the source of mechanical energy – the engine and the mine – were disassociated in space.[101]

The mobility of capital, the freedom to seek out the 'populous towns, where labourers are easily procured', was constituted by fossil fuels. That freedom was only relative – the price of coal rose with the distance from mines – but Lancashire happened to lie on top of rich coal-fields, 'sufficient to supply the consumption of its steam-engines for uncounted generations', in the estimate of industrial traveller William Cooke Taylor.[102] Lancashire was likewise bathed in rivers, but whereas extended utilisation of water at one point or another required capitalists to move *away from the labour power*, the coal deposits merely demanded that collieries were sent into the ground. Space, however, was not the only dimension in which the transition unfolded. Time mattered as well.

Power to command labour

Nailed to the landscape, the flow of water was not only immovable, but exposed to shifts in the weather. A river might freeze, overflow, ebb and peter out. In 1833, Samuel Greg described the power source of the Quarry Bank mill:

> Water, ninety horse power; stream irregular, occasionally a day or day and a half lost by floods. In dry seasons, for some weeks, only three quarters of daily work done. In ordinary seasons, a few hours lost daily for two or three weeks.[103]

A book-keeper at a cotton mill near Bingley in the West Riding, named Edward Birkett, told the commissioners of the Factories Inquiry that work normally went on for 13 hours, but in dry summer months production might have to be discontinued after a mere six.[104] In the absence of massive reservoir structures of the kind Robert Thom championed, such weather-induced irregularities were an all but ineluctable feature of water power.

By its very nature, in other words, water was subject to the whims of the seasons – but the problem was constituted socially. As long as mills catered to a local market for corn, linen, silk or whatever produce they turned out, a day of too much or too little water in the river was 'a source of inconvenience

101. Adapted and developed from Smil 2008, p. 204; Sieferle 2001, pp. 124–5; Debeir, Deléage and Hémery 1991, p. 102.

102. Cooke Taylor 1843, p. 156.

103. Parliamentary Papers 1834, p. D1.301.

104. Parliamentary Papers 1833a, pp. C2.65–6.

but nothing more serious': people simply turned to other tasks for a while.[105] The cotton mills of the early nineteenth century operated on other principles. They were oriented towards global markets, tailored to maximise output, constructed with profit as sole *raison d'être* – and thus working days had to be long. If the norm had been, say, six or eight hours of production, the demand for uninterrupted water power would have been significantly easier to satisfy, but the norm in the early 1830s was 12 hours, at a minimum. Simple arithmetic tells us that such a long day of work – compared to a hypothetical, shorter day – was exacting for any given watercourse. Furthermore, if water had been the only source of energy available, its irregularity would have been a fact of life, to be handled with anything from insurance schemes or dams to slight variations in output: it was the challenge of the steam engine that defined it as a drawback.[106]

That drawback could be easily offset, up to the 1830s. If water was insufficient, the workers were simply sent home and ordered to make up for the shortfall when the flow returned *through even longer working days*, effectively cancelling out the power shortages over time. As Birkett explained: 'The hands are dismissed, and recalled by a bell; they have that time to themselves; they are always paid as working a full day, and expected to make up the time as opportunity may occur.' In its first summary of the Factories Inquiry, the Chadwick Commission submitted that 'it is the custom for the people to work sometimes half an hour, at other times an hour, and occasionally even as much as two hours daily, until the whole of the lost time be made up.'[107] The irregularity of water was thus translated into bouts of extreme working days; from the baseline of 12 hours, capitalists pushed their workers even further, to cushion themselves against intermittent flow. Within the parameters of early capitalist commodity production, as it intersected with the nature of water, the practice appears to have been a necessity.

But it was precisely from the unbearable extension of the working day that arose some of the most passionate popular fury in the early 1830s. The demand of the factory movement – a universally applicable Ten Hours Act – was dreaded by proprietors of water mills. The Chadwick Commission found them fearing for their commercial survival. One master of a water-powered factory at Burley, Yorkshire, believed that 'the contemplated Ten Hours Bill would be exceedingly injurious to the cotton-trade; the legislature no doubt wishes to encourage health and morals, but if this Bill becomes a law the effects would be *to destroy many water-mills entirely* in rural situations in the country, and

105. Shaw 1984, p. 481.
106. von Tunzelmann 1978, pp. 154, 170.
107. Parliamentary Papers 1833a, p. 10.

drive the trade into large populous towns. . . . Steam-power is mostly in large towns, and *can be set to work at any moment*; water-mills are subject to many interruptions for want of water.'[108] Edward Birkett the book-keeper testified that a Ten Hours Act would be 'ruinous' to water mills, telling his interviewer about three he knew first-hand, which 'the masters would be compelled to abandon, such would be the injury to their profits. It would be perfectly impossible for them to carry on their mills at all during the summer season, under such restrictions.'[109] Statements of the same tenor can be piled up from the Inquiry. Though some certainly exaggerated the threat – prophesies of doom were a constant in bourgeois polemics against the Bill – the fundamental concerns were real: water supplies did fluctuate, manufacturers did make up lost time, criminalisation of the practice would cause serious trouble. The special circumstances for water mills were widely recognised, including by adherents of the factory movement. And logically, resistance to factory legislation was led by proprietors of water mills: from the early 1830s to the early 1850s, the Ashworths and the Gregs commanded the forces of the manufacturing interests, headed the associations of the Lancashire cotton masters, negotiated with Parliament, lobbied commissioners, penned pamphlets, spoke at public meetings and did everything in their power to thwart any limitation on the working day.[110] Of all cotton capitalists, those dependent on water stood to lose most, and therefore came to articulate the common interests of their class with particular urgency and stridency. Due to the nature of their prime mover – and the social demands placed on it – they found themselves first in the line of fire.

Steam engines, meanwhile, were independent of weather. While their owners were, as a rule, equally opposed to the Ten Hours Bill, their motive force could be fully adapted to a shorter working day. As it became increasingly clear in the early 1830s that popular unrest was forcing the British state to place a cap on the working day lest the country descend into full revolutionary chaos, the incentive structure was altered, the mere threat of a Ten Hours Act reducing the expected profitability of water.

Despite the protestations of the Ashworths and their kind, Parliament made a first, meagre concession to popular pressure with the Factory Act of 1833. Employment of children below the age of nine was banned in textile factories, while the working day was limited to eight hours for children up to 13 and to 12 hours for 'young persons' up to 18; factory inspectors were charged with enforcing the regulations. After extensive deliberations, the Chadwick

108. Parliamentary Papers 1834, p. C1.19 (J. Whitaker); emphases added.
109. Parliamentary Papers 1833a, p. C2.66.
110. See Howe 1984; Ward 1962; Boyson 1970; Rose 1986.

Commission, on whose recommendations the Act was based, had concluded that water mills deserved exemptions, and so they were given the right to order their children and young persons half an hour extra per day to compensate for any shortfall in power.[111] Was that enough? Half an hour was at the low end of established custom. The special needs of water capitalists were enshrined in the Act, but their latitude was severely constrained; anything beyond half an hour overtime – previously *comme il faut* – was now a crime, at least on paper.

Proprietors of water mills immediately set about flouting the law. Soon responding in force, the factory inspectors endeavoured, under the leadership of Leonard Horner, to uncover their offences and bring them to court. In 1840, a parliamentary committee reviewing the workings of the Act asked Horner where he found the greatest number of violations: 'in the detached and outlying mills' situated 'on streams', he replied.[112] Water was less compatible with lawful behaviour than steam. Howard P. Marvel has demonstrated that reliance on water was closely correlated with court action already in the years 1834–6 in Lancashire and West Riding, heartland of the English cotton industry, in a pattern that would remain in force for the coming two decades: water capitalists committed more offences, were more likely to be prosecuted, and were subject to stiffer penalties than their steam-powered competitors.[113]

To this must be added another consequence of a capped working day. The grand strategy for counteracting any reduction of hours was *to produce more in the hours left.* The disposition of labour power curtailed, more must be squeezed out of the fewer hours of work by means of installing more productive machines, speeding up those already in place, and/or enjoining operatives to work more intensely. The Factories Inquiry and subsequent reports made it abundantly clear that this was the Plan B of the manufacturers. They had, Leonard Horner reasoned in 1845, all sorts of opportunities: 'The work turned off is produced by the combined effort of the steam-engine and the workman, and the amount contributed by each varies immensely in different factories, and in different departments of the same factory.' But the opportunities on the rivers were not as promising. 'In the case of water mills', Horner wrote, '*where the intensity of the power in some seasons is continually varying during the day*, the workman cannot bring increased vigilance or attention to bear.'[114]

111. See, for example, Horner 1834. For the history of factory legislation and the factory movement, see for example Gray 1996; Ward 1962.

112. Parliamentary Papers 1840, pt. 1, pp. 5, 9.

113. Marvel 1977. On the prosecution of the Act, see also Peacock 1984; Bartrip 1985; Nardinelli 1985; Peacock 1985.

114. 'Report', in Parliamentary Papers 1845, p. 22.

The prerequisite for neutralising the effects of factory legislation was a source of mechanical energy under the complete command of the master. In the autumn of 1848, when the Ten Hours Bill had finally been passed, Horner polled the opinions of mill owners, managers and labourers in Lancashire to see how they coped with ten hours only. One manager of a cotton mill explained: 'The weavers are now producing quite as much cloth as before in 12 hours. *The engine has been speeded*.' Two cotton spinners at another factory testified that 'they work harder now during the time, and turn off nearly as much work as they did in 12 hours, *the engine having been speeded*'.[115] Steam was an integral part of the capitalist solution to the reduction in the working day.

From the prelude to the Act of 1833 to the culminating Ten Hours Act of 1847, factory legislation gradually strangled water power: 'It is obvious', one Manchester cotton manufacturer noted, 'that the more you diminish the number of hours the more you decrease the value of a water-wheel, in proportion to that of a steam-engine.'[116] The Act of 1847 eventually sounded the death-knell of water power as a viable energy source in the British cotton industry.[117]

With this, we can suggest an answer to our main question. *Cotton capital turned to steam because it offered superior power over labour.* Needless to say, there were other factors at work as well; the shift from water to steam was, indeed, over-determined by a wide range of tendencies in early nineteenth-century British capitalism, others of which we cannot investigate here. But power over labour was an outstanding keynote of the transition.

The most tractable labourer we can employ

The character of steam power as a class project was written all over it. The very appeal of the steam engine – despite its strictly economic and technological inferiority, relative to the water wheel – was precisely its unique capacity to apply 'the industry of the working class' to the production of 'surplus wealth', in Farey's words. The formula of that capacity, and a recurring theme in the bourgeois visions of steam, was what we might call its *powerless power*. In the same breath, apologists would extol the great power of steam and its complete absence of any power of its own, outside that desired by its proprietors. 'What distinguishes it from all others', renowned bourgeois economist Nassau Senior alleged in his 1848 lectures,

115. 'Report', in Parliamentary Papers 1849, pp. 47–8; emphases added.
116. Parliamentary Papers 1833b, p. D2.49 (Charles Hindley).
117. Compare von Tunzelmann 1978, p. 225; Allen 2009, pp. 173, 177.

> is its manageability. Wind power must be taken as it is given by nature. It can neither be moderated nor augmented. Water power is rather more under control. It can always be diminished and a little may sometimes be done to increase it. *The power of steam is just what we choose to make it.*[118]

While noting the noxious effects of 'carbonic acid', Babbage admired steam for being 'obedient to the hand which called into action its *resistless powers*'.[119] M.A. Alderson, author of an acclaimed 1833 steam-engine manual, emphasised that it could 'be obtained on the spot', and '*its mighty services are always at our command*, whether in winter or in summer, by day or by night – it knows no intermission but what our wishes dictate.' [120] Fairbairn marvelled at 'powers so great and so energetic as to astonish us at their immensity, while they are at the same time *perfectly docile*', while another manual author lauded not only 'the prodigious powers of steam', but just as much 'the ease and precision and *ductility* with which they can be varied, distributed, and applied.'[121] But perhaps it was John Farey who offered the most pregnant formulation. James Watt and the other modern improvers of the steam engine had, he wrote, 'rendered it capable of very rapid movements, and put its powers so completely under control, that it is now *the most tractable, as well as the most active, labourer we can employ*.'[122] A perfectly docile, ductile, tractable labourer: the wettest dream of employers come true. Here were the reasons to glorify 'the creator of six or eight million labourers, among whom the law will never have to suppress either combination or rioting', in the words of François Arago, author of the first major biography of Watt.[123]

Steam was the consummate substitute for labour, ready to step into its shoes with an infantry of machines, because it was everything that labour was not. All its virtues were constituted as the negations of working-class vices. Just as much, however, they appeared in contrast to all other available prime movers, particularly water power, whose perceived deficiencies were uncannily analogous to those of labour. Unlike water, steam was appreciated for having no ways or places of its own, no external laws, no residual existence outside that brought forth by its proprietors; it was absolutely, indeed *ontologically* subservient to those who owned it. The purpose of machinery – to secure absolute power over labour – was understood to necessitate a prime mover *over which capital could exercise absolute power* while at the same time *offering*

118. Senior papers: B18, notes for 'Course II, Lecture 8', 1848.
119. Babbage 1835, p. 49; emphasis added.
120. Alderson 1834, p. 44; emphasis added.
121. Fairbairn 1861, p. 9; Stuart 1824, p. 192; emphases added.
122. Farey 1827, p. 13.
123. Arago 1839, p. 147. On this as the first biography of Watt, see Hills 2006, pp. 175–7.

capital all the power it needed. In the powerlessness of the great powers of steam, British capital found the ideal spring of its class power. The ultimate bedrock of all that power, however, was revealed in that one little detail: the engine had to be fed with coal.

The factor in everything we do

In the final years of the 1830s, the amount of motive power derived from water in the British textile industry began to fall. Cotton drove the decline, with an ever heavier weight in Lancashire; by 1838, steam had gained ascendancy in all parts of the county except for the outlying northern areas. The rise was particularly fast in the second half of the decade, at the time of the bonanza: between 1835 and 1838, horse-power from steam in the cotton mills of Lancashire and Cheshire jumped by 62 per cent.[124] With a lag, the transition was mirrored nationwide. In 1830, steam engines supplied as much power to the British economy as water wheels – adding wind to the side of water, steam provided slightly less – but 40 years later, steam gave almost ten times more than water and wind combined. In the meantime, after the initial triumph in the cotton industry, the engine swept the factories and workshops of Britain; 'it is only of late years', noted Fairbairn in 1864, 'that in this country the steam-engine has nearly superseded the use of air and water as a prime-mover.'[125]

Since steam engines had to be fed with coal, the shares of coal consumption were redistributed with their rise. In 1800, as we have seen, domestic heating was the pre-eminent sector, and 'in no sense could the coal industry be regarded as one of the fundamental basic industries' of Britain; little more than half a century later, the situation had been reversed.[126] Domestic heating fell below the 50% line in the 1820s, but remained the single largest end-use up to 1840. By 1855, general manufacturing had eclipsed it, taking up 31% of all coal consumption in the British Isles, as against 25% for domestic heating; by 1870, three times more coal was burnt in the sectors of general manufacturing, iron and steel than in the hearths and homes of Britain.[127] In this turning of tables,

124. Kanefsky 1979, pp. 254–5, 281–90, 301; *Journal of the Statistical Society of London* 1838; Gatrell 1977, p. 101.

125. Allen 2009, pp. 172–3, 177–9; Lloyd-Jones and Lewis 1998, p. 70; Fairbairn 1864, p. 67. There were, of course, a whole spectrum of branches that had yet to be mechanised. See, for example, Samuel 1977; Greenberg 1982.

126. Mitchell 1984, p. 1.

127. Mitchell 1984, p. 12.

'the major growth point was the consumption of coal for steam-powered production in factories and workshops.'[128]

Responding to the demand, output from British coalmines leapt ahead. Lancashire was the scene of the most dramatic advance, its mines expanding on the direct and indirect stimulus from the local cotton industry. Total output in Britain entered a phase of acceleration somewhere between 1815 and 1830, reaching an apex of growth in mid-century before falling back to previous levels; the span 1831–54 saw the highest growth rate in coal production ever experienced between 1700 and 1900.[129] The new deep roots of the British economy did not escape contemporary observers. 'Without an abundant supply of coal', Farey acknowledged, 'the use of steam-engines, and the practice of the modern system of manufactures, would be very limited.'[130] No longer was coal merely used for heating homes; these days, McCulloch pointed out – in the process defining the quintessence of the fossil economy – the British coal reserves 'are the principal source and foundation of our manufacturing and commercial prosperity.'[131] In 1866, when business-as-usual already appeared entrenched in Britain, Jevons famously summed up its logic: 'Coal in truth stands not beside but entirely above all other commodities. It is the material energy of the country – the universal aid – the factor in everything we do.'[132] The railway to global warming had been laid down.

Towards a theory of fossil capital

It should be clear by now that the transition to steam in the British cotton industry presents the Ricardian-Malthusian paradigm with a serious empirical anomaly. Not only was the vanquished contender not running on present photosynthesis, but the basic tenets of the paradigm run counter to perhaps the most remarkable aspects of the process: the abundance, the technological strength, and the cheapness of water *at the time* of the transition – and anything that happened subsequently cannot, of course, be used to explain it. The fact that the total consumption of mechanical energy in the British economy much later came to exceed the potential supply from the watercourses of the country could not possibly have been a factor in the actual transition.

128. Church 1986, p. 27.

129. Pollard 1980; Mitchell 1984, pp. 7, 23–31; Church 1986, pp. 28–9; Flinn 1984, p. 26; Church 1986, p. 3.

130. Farey 1827, p. 225; emphasis added.

131. McCulloch 1837, p. 2.

132. Jevons 1866, p. viii.

But Wrigley makes an attempt to apply the Ricardian law of diminishing returns to what we have here called the centrifugal dynamic. Water power, he claims, 'was subject to rising marginal cost of provision since the better sites were naturally developed first, leaving smaller or less conveniently situated falls for later exploitation.'[133] Though this might sound a good match for the law, in fact it diverges from it in crucial respects. There is no evidence that the waterfalls at the outer rims of the centrifugal dynamic were 'smaller' or worse in any other absolute sense, whereas the inferior soils of Ricardo's law were, as both he and Wrigley assert, *less fertile by the laws of nature* (thin soil, steep slopes, poor drainage, etcetera). The disadvantage of distant watercourses was not their deficient capacity to produce power – rather the opposite: waterfalls uphill tended to be *more* powerful than in the towns – but precisely their 'inconvenience'. And that was a socially determined factor. It arose not from the fixed supply of land, but from the contradiction between the locations of streams on the one hand and the need for cotton capitalists to access concentrated supplies of labour on the other.

As for the Malthusian component of the paradigm, it was hardly a desperate struggle to satisfy the needs for the clothing of a growing number of British denizens that made the Arkwrights, the Ashworths, the Gregs or any other manufacturers establish and enlarge their mills. If a causal connection can at all be stretched out from the acceleration of population growth in the late eighteenth century to the transition from water to steam in the second quarter of the nineteenth century, it looks set to be exceedingly tenuous. As it appears in the data, the transition was nothing like 'a valiant struggle of a society with its back to the ecological wall'.

Someone of neoclassical persuasion, finally, might object that if access to labour in space and time is counted as an *associated* cost of a prime mover, water was indeed more expensive than steam – but this is merely to displace the problem, to which neoclassical theory seems oblivious. In a capitalist economy, the relative cost-efficiency of prime movers cannot be understood outside of the relations of production. The obvious alternative is Marx. An exegesis of all that he and Engels wrote on steam remains an unfulfilled task, beyond the scope of this paper. Suffice it to say that the first volume of *Capital* contains a finely textured account of the rise of steam power, including an apt précis: 'The steam-engine was from the very first an antagonist of "human power", an antagonist that enabled the capitalists to tread underfoot the

133. Wrigley 1990, p. 75. Compare Wrigley 1972, p. 249.

growing demands of the workers, which threatened to drive the infant factory system into crisis.'[134]

As a starting-point for an analysis of the fossil economy – far more promising than anything derived from earlier classical economists – we may simply take the canonical Marxian view of the specificity of capitalist growth. The compulsion to expand the scale of material production is not an attribute of the human species, present – if only in latent, bottled-up form – from the beginning of history. It is an *emergent property* of capitalist property relations. Once the direct producers and the means of production have been separated, the compulsion is inscribed in the very structure of production, in a qualitatively novel, indeed historically unprecedented way.[135] Divorced and reconstituted as commodities, labour power and means of production can only be reunified – and reunified they must be, if society is to survive – 'in the hands of the capitalist'.[136] His function is to acquire both with money. When the new commodities begotten by the rendezvous are sold, the capitalist again receives money. But why exchange money for money? The point of the process can only be the difference between the original amount thrown into circulation and the amount withdrawn at the end. If the business forecast told the capitalist that he would get back 95 per cent of his money, he would be wise to keep it in his pocket or do something else with it; if it said that he would stand a good chance to get 100 per cent of the expenses covered but no more, he would still be prudent to abstain. The effort would be pointless. Given capitalist property relations, *only the reasonable expectation of an increment in exchange-value can set the process of production in motion.*

Another word for that increment is, of course, profit, obtained from the surplus-value produced by workers. Profit is the 'driving fire' of capitalist production.[137] It recognises no end: more money can only usher in attempts to make even more money, the profit from the first circuit igniting production anew on a larger scale. This is the process commonly known as 'growth', better understood as capital accumulation, encapsulated in Marx's general formula of capital as M – C – M′, or Money – Commodities – Money-with-an-increment. More precisely, the commodities purchased by the capitalist fall into the two categories of Labour Power and Means of Production, unified in the process of Production, giving the following extended formula:

134. Marx 1990, pp. 562–3.

135. For this analysis of the growth imperative, see for example Brenner 1986; Brenner 2007; Joffe 2011. For the specifically eco-Marxist analysis, see for example Burkett 2006; Foster, Clark and York 2010; Foster 2011; Blauwhof 2012.

136. Marx 1992, p. 120. Compare Marx 1992, pp. 114–15.

137. Mandel's translation of Marx. Mandel 1990, p. 60; compare Marx 1990, p. 254.

$$M - C\,(L + MP) \ldots P \ldots C' - M'.$$

Reigniting after every circuit, the driving fire never goes out, and the general formula can thus be extrapolated in perpetuity:

$$M - C \ldots P \ldots C' - M' \rightarrow M' - C' \ldots P \ldots C'' - M'' \rightarrow M'' - C'' \ldots P \ldots C''' - M''',$$

and so on. Capital is, by its very definition, this circulatory process of valorisation, or self-expanding value. But capital is also – by its very definition – the relation between capitalists and workers. The two moments are intrinsically connected: the relation unleashes the process, which in turn reproduces the relation.

Capital, thus defined, exists 'only by sucking in living labour as its soul, vampire-like'.[138] But if labour is its soul, nature is its body. No profit from commodity production is possible without the appropriation of nature as 'the material substratum of exchange-value'.[139] The deeper meaning of P in the formulae of capital is a closely regulated *Stoffwechsel*, or metabolism, between humans and the rest of nature: materials are withdrawn and, under the command of the capitalist, placed in the hands of workers as means of production.[140] Apart from machines and other instruments, they include raw materials, a subcategory of which is 'ancillary materials' or 'accessories', in Marx's terminology. These are the substances that do not enter into the product itself – in contradistinction to, say, cotton in a thread – but form a necessary part of the *process* of production. 'An accessory may be consumed by the instruments of labour, such as coal by a steam-engine, oil by a wheel, hay by draft-horses.'[141] Coal and oil are treated by Marx as the archetypal accessories.

All required means of production – 'machines, coal, oil, etc.' – have to be present in sufficient mass 'to absorb the mass of labour which is to be turned into products through them'.[142] In the right quantities, finely tuned to labour power, the means of production will then be productively *consumed*, for the production of commodities is also a 'consumption of the means of production, which become worn through use, and are partly (e.g. *in combustion*) dissolved into their elements again.'[143] As value expands, more of the body of nature thus has to be appropriated and consumed. The fire demands its fuel.

138. Marx 1993, p. 646.
139. Ibid.
140. For this analysis of the labour process, see Burkett 1999; Foster 2000.
141. Marx 1990, p. 288.
142. Marx 1992, pp. 177, 111.
143. Marx 1993, p. 90; emphasis added.

At a certain stage in the historical development of capital, fossil fuels become a necessary material substratum for the production of surplus-value. But they are not merely necessary in the sense that raw cotton is necessary for the production of cotton textiles, wood for that of tables, or iron ore for machines: they are utilised *across the spectrum of commodity production* as the accessory that sets it in physical motion. Other sources of rotary motion are pushed to tiny fringes, while capital expands in leaps and bounds, energised by fossil fuels. These have now become *the general lever for surplus-value production*.

With F for fossil fuels, we can thus derive the general formula of fossil capital:

$$M - C\,(L + MP\,(F)) \ldots P \ldots C' - M'$$

In the circuit of capital, fossil fuels are now a portion of the means of production. The more capital expands, the larger the volumes extracted and combusted. Integral parts of the *Stoffwechsel*, fossil fuels are subjected to productive consumption in ever growing quantities, with an inevitable chemical by-product, of which Marx and Engels were aware. In the second volume of *Capital*, Marx explains that the time expended by the capitalist on buying and selling his commodities, on prowling the market and securing transactions in meetings with other businessmen, is not value-creating time, but nonetheless 'a necessary moment of the capitalist production process in its totality'. Marx draws a parallel pregnant with meaning. The time spent on buying and selling

> is somewhat like the 'work of combustion' involved in setting light to a material that is used to produce heat. This work does not itself produce any heat, although it is a necessary moment of the combustion process. For example, in order to use coal as a fuel, I must combine it with oxygen, and for this purpose transform it from the solid into the gaseous state (for carbon dioxide, the result of the combustion, is coal in this state: F.E.), i.e. effect a change in its physical form of existence or physical state. The separation of the carbon molecules that were combined into a solid whole, and the breaking down of the carbon molecule itself into its individual atoms, must precede the new combination.[144]

When Engels edited the posthumous second volume of *Capital*, using his initials to mark insertions in Marx's manuscripts, the science of chemistry had made progress since the days of Babbage. Today, we may take Marx's analogy literally and conclude that constantly increasing quantities of CO_2, just as market transactions, are a necessary part of capital accumulation; the combustion of fossil fuels in their solid form and the consequent release of CO_2

144. Marx 1992, p. 208.

do not in themselves create any value for the capitalist, but they are materially indispensable for value creation. The extended formula of fossil capital thus reads:

$$\mathrm{M - C\,(L + MP\,(F))\ldots P \overset{CO_2}{\cdots} \ldots C' - M'}$$

Since fossil energy now fuels the *perpetuum mobile* of capital accumulation, igniting itself anew, as a driving fire that never goes out, the cycle continues indefinitely:

$$\mathrm{M - C\,(L + MP\,(F))\ldots P \overset{CO_2}{\cdots} \ldots C' - M' \rightarrow M'\,(L' + MP'\,(F'))\ldots P \overset{CO_2'}{\cdots} \ldots C'' - M''}$$

and so on. Valorisation proceeds through combustion. Fossil capital, in other words, is *self-expanding value passing through the metamorphosis of fossil fuels into* CO_2. It is a *relation*, a triangular relation between capital, labour and a certain segment of extra-human nature, in which the exploitation of labour by capital is impelled by the combustion of this particular accessory. But fossil capital is also a *process*, a flow of successive valorisations, at every stage claiming a larger body of fossil energy to burn. It recognises no end. One could think of this as the biophysical shadow of Marx's general formula of capital, coming to the forefront only in the times of unexpected biospheric dusk.

The general formula of fossil capital, in these simple, extended and extrapolated versions, does not, of course, capture the entire field of fossil fuel consumption even in a capitalist society. The most obvious omission is a form of consumption preceding fossil capital by at least six centuries: the purchase of use-values whose very usage emits CO_2. Heating cottages with coal falls into this category, as does, to take but two examples, driving to work in a car, or surfing the web with a computer (in so far as these run on fossil energy). The immediate cause of combustion in these cases is the satisfaction of some need or other in the sphere of private consumption. Here the formula would rather be:

$$\mathrm{C - M - C\,(\overset{CO_2}{\cdots} F)}$$

But even though such individual consumption predates the productive consumption of fossil fuels as a source of rotary motion, it does not give rise to business-as-usual, for *individual consumption is not the ignition mechanism of capitalist growth.*

Only with the emergence of fossil capital was business-as-usual established. By placing coal right under the driving fire of capital accumulation, as the fuel transmitting physical motion to the labour process, a spiral of growing fossil fuel combustion was, for the first time, directly tied to the spiralling growth of capitalist commodity production. But why did capital strike root in fossil fuels? Why did capital in general become *fossil* capital? What tensions in the relationship between capital, labour and the rest of nature – or, what properties of the capitalist property relations – prompted this fateful step?

The abstract and fossil spatio-temporality of capitalism

The separation between direct producers and means of production means that peasants are pushed off their land. Capital hinges upon a popular exodus from the countryside. Released from their attachment to the soil, the 'free' workers congregate at particular points, where they reconnect with the means of production on someone else's property. The receptacle for this original spatial concentration of capitalist property relations is, of course, the factory, but it immediately points beyond itself: every factory 'bears in it the germ of a manufacturing town'.[145]

As the larger receptacle, the town amasses raw materials, instruments, means of subsistence and, above all, workers. The concentration of proletarians in the town is the flipside of the draining of the countryside. It is also a necessary condition for the production of surplus-value. If there are no unemployed workers knocking at the factory gates, labour will be in a perilously strong bargaining position; the 'dead weight of the industrial reserve army' has to be *in situ*, in the form a large, dense, overflowing market for labour power. In a small, thin, spatially dispersed labour-market, capitalists have to treat their workers as precious assets, circumscribing the power to extract surplus-value. Moreover, propertyless ex-peasants must become habituated to life as disciplined operatives, in a community where wage-labour has become the normal mode of existence for masses and generations of people. The town is the ideal if not the only feasible receptacle for all these mutually dependent processes.[146] Water stood in fundamental contradiction to it.

Capitalist property relations engendered concentration in space: capitalists sticking with water were obliged to expand *out from the centre.* In the colonies, they had to fuse the spaces of production and reproduction, providing for all the needs of their workers – accommodation, access to staple goods, religious institutions, schooling – rather than letting them get by on an infrastructure

145. Engels 2009, p. 34.
146. Storper and Walker 1989, pp. 140–5; Smith 2008, p. 116; Harvey 1999, pp. 381–4.

already in place.[147] It would have been different had the abundance of cheap water been located in a hole in the ground, in a trunk around which the town could bush out, or in some other vertical configuration – but then water would not have been water. As water, it flowed on the surface of the British landscape, fully available but incongruous with the emergent spatial dynamic.

The contradiction was present from the start, but it was long hidden under the super-profits of the first generations of cotton capitalists. Only after the mid-1820s was it brought to a head. Resolving the contradiction, the cotton capitalists then cut off the tether of water power, gained a fundamental mobility to seek out – and discard – workers, broke loose from what Henri Lefebvre called 'absolute space' and moved into its 'abstract' counter-dimension. Absolute space is 'made up of fragments of nature located at sites which were chosen for their intrinsic qualities (cave, mountaintop, spring, river). . . . Then the forces of history smashed naturalness forever and upon its ruins established the space of accumulation'.[148] There emerged *abstract space*. Instead of going reverently to the mountaintops and rivers and establishing its businesses there, capital produced a matrix of nodes and arteries through *its own* circuits. Absolute, natural space 'juxtaposes – and thus disperses'. Abstract, social space 'implies actual or potential assembly at a single point', and thereby also 'the possibility of accumulation'.[149]

But even abstract space ultimately has to rest on nature. Fossil fuels alone have the characteristics that allowed for its formation. They are not diffused on the surface of the natural landscape, not weaved into its qualitative properties but concentrated in deposits beneath the ground, outside the realm of human habitation and visible variety. Their most concrete property is their abstractness. While bound to specific, irreproducible places – seams, in this case – coal is buried at a remove from the space of humans, as the relic of a landscape long dead and gone.[150] It was the optimal raw material for the initial break-out into spatial abstraction. By virtue of being concentrated in subterranean sites of no other use or meaning, coal could be brought into the world of earthlings as loose fragments, passing from hand to hand, circulating freely inside the commodity circuits and releasing the forces of accumulation.

The temporality of capitalist property relations is homologous. Pre-capitalist modes of production were structured by what Moishe Postone calls 'concrete time': time as dependent variable, the function of an occasion, process, or

147. Compare Lefebvre 1991, p. 319; Harvey 1999, pp. 398–405; Smith 2008, pp. 166, 182.
148. Lefebvre 1991, p. 49.
149. Lefebvre 1991, p. 101.
150. Compare the argument made in Mitchell 2011, especially Chapter 1.

sensuous rhythm. Above all, concrete time is *embedded in natural cycles*.[151] The pre-capitalist fisher attended to the tides, while the artisan downed his tools when darkness fell. In peasant households the grain must be harvested before the rains arrive, the cows must be milked in the morning, and the firewood must be at hand when autumn comes – in short, 'hours and task must fluctuate with the weather.'[152]

But capitalist property relations generate a radically different, indeed antithetical temporality: when a capitalist purchases the right to dispose of labour power, that right is restricted and specified in time (otherwise there would be slavery). His objective is to make sure that the worker *performs as much labour as possible within the given time-frame*, be it six or twelve hours, for one week or as long as the parties agree. The labour has to occur precisely within that time – not when the weather is right, or when the sun has risen, or when the worker happens to be in the mood for hard labour, for then the right to dispose of labour power might have already expired, and the purchase would come to nought. Moreover, the capitalist must see to it that his workers produce the commodities at least as fast as those of his competitors, and so he becomes intensely preoccupied with productivity: labour output as measured against a fixed time unit.[153] With the rise of capitalist property relations, there emerged, in Postone's terms, *abstract time*. This is time as independent variable, a mathematical vessel, an incorporeal repository of events which heeds no seasons, weather or other concrete appearances in nature. It serves as a measure *of* activity, beginning with labour.[154]

Water power was a legacy from the era of concrete time. It was eminently commensurate with modes of production attuned to the ups and downs of natural fluctuations, the ebbs and flows, the floods and dry spells, the freezing cold in wintertime. But abstract time inhered in capitalist property relations. A contradiction was inevitable, though it did not make itself felt until a certain juncture in the history of capitalist development: as long as absolute surplus-value was dominant – as long as manufacturers could extend the working day at will – water was still a perfectly viable energy source. It could be used to produce surplus-value, even as labour-time had to be adjusted to the power supply. But with the Factory Acts of 1833 and 1847, not only was the lengthening of the working day for the first time brought to a mandated halt, but the day was *shortened*. How did capital respond to this challenge? It 'threw itself with all its might, and in full awareness of the situation, into the production of

151. Postone 1993, pp. 201–2.
152. Thompson 1967, p. 78. Compare Ingold 1995.
153. Postone 1993, pp. 210–12; Thompson 1967, pp. 61, 90–1.
154. Postone 1993, pp. 202, 214–15.

relative surplus-value', by increasing the productivity and intensity of labour, so that more commodities were produced in the remaining given time units.[155]

The struggle for a shorter working day – *Urform* of working-class self-defence – provoked capital to counterattack with a further abstraction of time. 'The pores of time are so to speak shrunk through the compression of labour.'[156] Abstract time became ever more sovereign and supreme in its claims on labour – and consequently on nature. If labour was to proceed faster and more intensely, so must the prime mover; all bulging pores of interruption had to be banished. In the 1830s and 1840s, as absolute surplus-value was overtaken by its relative twin, the increased expenditure of labour had to be placed on the solid footing of the steam engine, utterly malleable to the temporal needs of capital – turned on, turned off, speeded up at will. Such virtues were mere corollaries of the essence of fossil fuels: *their ejection from perceptible natural rhythms through burial underground.* Frozen in time, coal was congenial to the abstract time of capitalist property relations, and, under the duress of factory legislation, it became a prerequisite for its continued abstraction.

Abstract space and abstract time together form what Noel Castree calls the 'distinctive *spatio-temporality*' of the capitalist mode of production.[157] Capital does not circulate *in* space and *through* time, as if the two were fixed axes along which it develops; rather, it produces its *own* abstract space-time. The one dimension is inseparable from the other. They constitute a single spatio-temporality, which emanates straight from the fundamentals of capitalist property relations. A primordial rift in the relation between humans and between them and the rest of nature – the separation between direct producers and means of production – is propagated in space and time, severing human beings from the qualitative properties of both dimensions. Labour is relocated to particular places and moments set aside strictly for the purpose.

The necessary material substratum for this spatio-temporality – long hidden from the view of most Marxists, however sharp their eyes have otherwise been – is fossil fuels.[158] They represent the geological compression of the time and space required for photosynthesis hundreds of millions of years ago, when no humans roamed the planet; *sui generis*, their dense energy permits capital to produce its own abstract spatio-temporality for the production of surplus-value. They are incorporated into capital *as its own motive force*.

155. Marx 1990, p. 534; emphasis added.

156. Marx 1991b, p. 335.

157. Castree 2009, p. 27; emphasis in original.

158. Some Marxists who have argued in this direction are Altvater 1994; Altvater 2006; Clark and York 2005; Huber 2009.

Marx comes close to capturing this logic in the third volume of *Capital*, at the beginning of his treatment of ground-rent, devoted to an extraordinary discussion of the relative benefits of water and steam. 'Assume', Marx opens his excursion, 'that the factories in a country are powered predominantly by steam-engines, but a certain minority by natural waterfalls instead.' Water is far cheaper, Marx further assumes – this is written in London in the mid-1860s – and provides the proprietors of water mills with 'exceptionally favourable conditions'. Labour applied in the water mill has greater productivity than in the steam mill, expressed 'in the way that it needs a smaller quantity of constant capital to produce the same amount of commodities, a smaller quantity of objectified labour than the others; and a smaller quantity of living labour as well, since the water-wheel does not need to be heated.'[159] However, water is

> a natural force that is not available to all capital in the same sphere of production, as is for example the elasticity of steam. . . . *It is in no way just up to the capital to call into being this natural condition* of greater labour productivity, in the way that any capital can transform water into steam. The condition is to be found in nature only at certain places, and where it is not found it cannot be produced by a particular capital outlay. *It is not bound up with products that labour can produce such as machines, coal, etc., but rather with particular natural conditions on particular pieces of land*.[160]

Water, Marx reiterates, 'cannot be produced by capital's own production process': capital 'cannot create a water-fall from its own resources'.[161] This is in stark contrast to fossil fuels. Their power is 'just what we choose to make it', in the words of Senior; their 'mighty services are always at our command', with Alderson. Needless to say, capital is unable to literally manufacture coal seams or any other fossil fuel reserves, but it can call them into being as energy deposits by mobilising its own resources: labour power and means of production. Indeed, fossil fuels are not a natural force like water, running through forests and meadows prior to capital's arrival, dispensing its energy merely by existing: fossil fuels *must be called into existence*. The appearance of fossil energy *qua* energy is not autonomous, but contingent upon capital itself. It assumes the guise of a power in motion internal to capital, lending it a physical life of its own.

Precisely because it is so abstract, and founded on the power of the capitalist class, the spatio-temporality of capitalism is *more* deeply rooted in a *particular*

159. Marx 1991a, pp. 779–81; emphasis added.
160. Marx 1991a, p. 784; emphases added.
161. Marx 1991a, pp. 784–5.

form of nature than other spatialities and temporalities in history. Arago neatly laid out the principles in his hagiography of Watt: 'The great mechanical powers which had formerly to be sought for in mountainous districts, at the foot of rapid cascades, will, thanks to Watt's invention, readily and easily arise, in the midst of towns, on any story of a house. The extent of these powers will vary at the will of the mechanician; it will no longer depend, as heretofore, on the most inconstant of natural causes, – on atmospheric influences.'[162] Instead, capitalist spatio-temporality came to influence the atmosphere. The depth of its dependency on nature is fully disclosed when carbon dioxide from the combustion of fossil fuels, with a transformative power unlike any other anthropogenic substance, rearranges the qualitative properties of space and jumbles historical and geological time in ways never previously seen. Abstracting itself from nature, capital ended up making it less and less liveable, in very concrete terms.

The persistence of business-as-usual

Fossil capital has proved fantastically profitable for almost two centuries. Up to this day, its rotation continues to propel business-as-usual, in complete disregard of the scientific knowledge of the noxious effects of increasing the atmosphere by large quantities of carbon dioxide. How do we approach this all-time social wreck? The favoured Ricardian-Malthusian explanation for the transition to a fossil economy – the liberation from land constraint – can only be a one-off driver, at the very best. This becomes obvious if we revisit the mathematical conversions from fossil fuels to acres of woodland so highly regarded as explanatory exercises by Wrigley and his followers. When Wrigley calculates that all coal in 1800 equalled 35% of the British land surface, rising to 150% in 1850, this is, of course, a hypothetical, counterfactual thought-experiment. Can it tell us anything about the causal forces operating in the expansion of coal consumption in the period? For that to be the case, Wrigley would have to present evidence that land scarcity pushed up prices for alternative fuels in the first half of the nineteenth century, that the rising costs of these other fuels impelled consumers to shift to coal, and that such cost-motivated consumption made up the bulk of all coal-burning. Wrigley does not, however, provide anything of the sort, and it would be difficult to do so. Then can the exercise tell us anything about the causal forces operating later in the history of business-as-usual?

162. Arago 1839, p. 150.

Consider Malanima's conclusion that a Europe bereft of fossil fuels would have needed 2.7 times its continental surface in 1900 and more than 20 times a century later: can it tell us anything about the driving force of this tremendous pyre? Logically it cannot, because if Europe was liberated from the land constraint – even before the onset of the twentieth century – it could no longer have operated as a causal factor. The supposed breaking of the Ricardian curse is a one-off event, evaporating as soon as it transpires. The same applies to the iron industry, the best case for the paradigm: the liberation from land provided by the conversion from charcoal to coke can explain the initial spike in coal consumption, but once that liberation had actually occurred, other drivers must have taken over. As for the Malthusian component, there is precious little evidence that population growth has been behind subsequent waves of expanding fossil fuel consumption.[163]

Adherents of the Ricardian-Malthusian paradigm are, of course, right in identifying fossil fuels as a necessary precondition for the kind of growth the world has seen in the past two centuries. But the only clue they can offer for an analysis of business-as-usual after the industrial revolution is a vague reference to growth as an innately human pursuit, common to all eras and modes of production, permanently throbbing if sometimes held back. It begs the question of *what is special with the fossil economy.* Nothing new has emerged; the old has merely been realised. The theory of fossil capital, on the other hand, appears to have explanatory power for the transition to a fossil economy *and for its continued development.* Consider only the case of China. The twenty-first century explosion in CO_2 emissions is centred on China, largely caused by the relocation of industrial production from advanced capitalist countries. This process obviously has nothing to do with land constraints or population growth in those same countries. But it has, as argued elsewhere, very much to do with the removal of factories to other situations, where labourers are easily procured and trained to industrious habits.[164]

This points towards a radical rethinking of the drivers of ecological destruction in our time. They should not be conceived as archaic yearnings of the human species, as a timeless growth pursuit bumping into walls of scarcity and transcending them by substituting abundant goods for scarce ones: a *universal* process unfolding through reaction upon *specific* constraints. The reverse appears more appropriate. Capital is a *specific* process that unfolds through a *universal* appropriation of biophysical resources, because capital itself possesses a unique, insatiable appetite for surplus-value extracted from

163. For a debunkning of the myth that population growth drives carbon emissions, see Satterthwaite 2009.

164. Malm 2012b.

human labour by means of material substrata. Capital, one could say, is super-ecological, a biophysical omnivore with its own peculiar social DNA.

Such a theory might, furthermore, provide insights into the stalled shift to renewable energy sources. It has recently been demonstrated that *all* energy consumed in the world could be provided from wind, water and solar power, without any noticeable share of coal, oil or natural gas, within a few decades, at little or no extra total cost – if relevant actors only decided to harvest the abundance of energy surrounding us.[165] But there are hurdles in the way. In a major survey in 2010, *Science* noted that 'building solar or wind farms is a land-hungry process, and the energy they deliver is often intermittent and hard to store.' Quoting an ecological economist specialising in the field, it drew attention to the fact that '"many of the windiest and sunniest regions in the world are virtually uninhabited"'.[166] Now these inherent properties of wind and sun – absolute space, concrete time – would perhaps not constitute such serious handicaps if it were not for the particular form of spatio-temporality that governs the world.

The problem is not new. One day in the late 1860s, as he sat preparing a lecture on the economics of coal, William Stanley Jevons's eyes fell upon a newspaper report about the Swedish-American inventor John Ericsson, who 'undertakes to supply a new fuel in the place of coal, and a new motive power instead of steam. For several years he has been experimenting with a view of collecting and concentrating the radiating heat of the sun' in a 'solar engine'.[167] Jevons saved the clip and scribbled down his excitement. It was the 'most sound' of all suggested solutions to what he perceived to be an impending coal shortage,

> and for my part I really do not look upon it as an unlikely notion to be carried out into practice some day. But if it be carried out, what will be the result for us – simply that we shall be replaced, and the seats of industry will be removed to the sunny parts of the earth. In Manchester at any rate we have little sun that we have to manipulate for light. . . . The tendency of things is such that we are likely to find coal a source of sunlight [rather] than sunlight a competitor of coal.[168]

This 'tendency of things', Jevons thus intimated, did not inhere in the sun or the earth themselves, but in the ongoing concentration of industrial commodity production to the galaxy gravitating around Manchester.

165. Jacobson and Delucchi 2011a; Jacobson and Delucchi 2011b; Leggett and Ball 2012.
166. Kerr 2010 (Cutler Cleveland). Compare the points raised by Trainer 2012.
167. Jevons archive: JA6/9/168, 'Fuel from the sun', undated clip from *Express*.
168. Jevons archive: JA6/9/168, note on the *Express* clip.

Today, the divergence between the potentials of renewable energy and the tendency of things – each advancing in their own direction – is, of course, far wider. Manchester and its twins in the advanced capitalist countries have lost their lustre, because capital has become *even more* bent on removing to locations where the supplies of labour power offer the highest rates of surplus-value, regardless of any intrinsic qualities of places. Here is a question rarely asked: is that tendency compatible with a complete cessation of fossil fuel use, the kind of change climate science tells us is our only chance to avoid a general breakdown of the ecological foundations of human existence? Even if a project such as Desertec – filling the Sahara with solar panels and sending the electricity to Europe – were to be implemented, it would still be impossible to export that solar energy to, say, the Yangzi Delta, or any other distant place capital currently might favour for commodity production.[169] But oil can be pumped out of the ground in Alaska or Angola and shipped to any site of accumulation, from Guangzhou to Ghent. A similar question pertains to the dimension of time. Are the principles of just-in-time and lean production at all reconcilable with renewable energy?

Globalisation may be conceived as a process in which the spatio-temporality of capital is extricated from and made to dominate all other aspects of human and natural life: a most unpropitious moment, it would seem, for embedding the world's energy system in the spatial and temporal matrix of wind, water and sun. It might well be the case that renewable energy can become as reliable and all-encompassing as fossil energy – if scaled up massively and assisted by super-grids, surplus capacity, intercontinental transmission, electricity storage systems and all the rest – but in the meantime, we may do well to wonder if the inaction on the most critical issue in the history of humanity is rooted in the compulsions of self-expanding value.[170] For two centuries, it has craved constantly increasing quantities of energy, whose qualities correspond to its own mode of existence, both of which moments seem to perpetuate business-as-usual and deflect alternatives. Will this fire have to be extinguished? What would that require, given that we have so precious little time to stave off the worst-case scenarios? Further research on fossil capital may throw light on the – literally – social nature of this challenge.

169. On Desertec, see for example Clery 2010.

170. Elaborate arguments for such potentials of renewable energy are made in Jacobson and Delucchi 2011a; Jacobson and Delucchi 2011b.

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Research Note: The Resources of Fiction

GRAEME MACDONALD

> "I should have thought of it before, it's too late now."
> Italo Calvino, *The Petrol Pump*

The opening sentence of Italo Calvino's 1974 story "The Petrol Pump" expresses a regret wearily familiar to 21st century energy-angst. Published in the backdraft of the 1973 global oil crisis, the ethical thrust of the tale is galvanised by a narrator reproaching himself for not fuelling his car when filling stations are closing. Initial indecision whether to make a dash for gas to enable a "necessary" car journey out of town mutates into anguished reflection on an inability to resist the systemic conditions of modern petrolia. The narrator's dismay at the discovery of his gasoline junkiedom is deepened by self-castigation for insufficient consideration to intensifying resource-pressure:

> The gauge has been warning me for quite a while that the tank is in reserve. They have been warning us for quite a while that underground global reserves can't last more than twenty years or so. I've had plenty of time to think about it, as usual I've been irresponsible. (170)

Nonetheless, an open station is located and the tank duly filled. The tale ends with the vehicle exiting the forecourt, leaving the reader to consider the consequences of such conscientious inaction. For the present-day reader, the ironic emissions of Calvino's story linger: what to do, when the car has long bolted from the station? From an age of extended (yet always already depleting) "global reserves" this prediction is wayward at best; formed by familiar combinations of alacrity, wishful thinking and ingenuousness. In retrospect, as fossil-fuelled automobility discovers vast new markets across the globe, that "or so" stings the probability concerns of peak-oil with a waspish irony in its seemingly casual projection. In spite of Dr Hubbert and despite its fundamentally non-renewable "nature", petroleum has continued to find a means and a relatively undisturbed way.

From an environmental perspective, of course, the sentiments expressed above, disconcertingly remain salient. Calvino's slight narrative of the necessity of energy reflects, like only fiction can, on the fiction of energy's necessity. Like most politically

effective literature, "The Petrol Pump" utilises speculation and supposition in subtle yet provocative ways. The conflict between the imagined ecological and economic consequences of Calvino's narrator's sorry actions, for example, is underscored by the shifting pronouns in the above excerpt; emphasizing the extent to which the individual regards his nascent petro-conscience as both privately compromising and publicly ineffectual, and therefore somehow excusable. Here, in short, is a prescient example of the ingeniousness of the privatisations and privations of oil-based modernity, where the sheer pervasiveness of oil in contemporary social infrastructures works as hard as ever to create a general structure of feeling surrounding its *inevitable* use (and misuse). The focalization also exemplifies what is now recognized as the privatization of energy guilt, resting the primary burden of ecological response to the problems s/he sees as causing in the individual, in both their "choice" of energy consumption and their "green" ethical behaviour.[1]

Such irony should be instantly recognizable to contemporary scholars exploring correlations between culture and energy resources, from a perspective platformed by the ramifications the '73 oil shocks continue to provide for the world energy-system and its geopolitics. It is conveyed by the provocative sleight of that "as usual" in the above cited paragraph, and driven by the essential paradox imaginative scenarios of energy's limits continues to generate. These are accentuated within a post-peak, "ecologically modern" environment of "abundant" unconventional and "alternative" energy, amid technologically and geographically expanded resource frontiers.[2] It is an irony punctuated by the politics of an incipient environmental movement that backdropped "The Petrol Pump" in the early 1970s, a politics that remains crucial to interpretations of the present energy competitive world system. In 2013, export and demand for fossils continue to increase, despite widely verified evidentiary warnings that at least two-thirds of *known* carbon reserves must remain in the ground to control global warming (IEA Outlook). This, it is generally agreed, is simply not going to happen. Despite a high degree of "official" international consensus about this intensifying planetary process, implementation of radical de-carbonizing agendas has not generally transpired in the actions and policies of states and listed companies preoccupied by maintaining – and indeed increasing – supplies of oil, coal and gas. Duncan Clark and Mike-Berners Lee describe a stupefying duplicity enacted across

[1] Of course, neo-sustainability arguments pressed into service by corporate and political agencies worldwide maintain that environmental "crisis" is a future-deferred event, however relative the dispute over its temporality and inevitability. A counter-argument insists we are already experiencing that crisis in the present.

[2] That "alternative" signifies "not oil, gas or coal" reveals the definitive dominance of fossils in the world energy matrix.

the globe, where "green" but "nervous" (41) governmental administrations, remain "more concerned about what they have to lose" (85) from carbon restriction proposals and continue to encourage and enable the extraction of fossil fuels, maintaining (and indeed accelerating) the century long upward trend of the carbon curve and initiating what has been termed the "carbon-bubble": where numerous monetary schemes and mechanisms, especially the stock market – perhaps the most threatening ecological system of our times – remain critically invested in fossil futures, to the likely detriment of a sustainable planetary future.[3] Calvino's story, it appears, retains its sardonic bite.

Such a situation is characteristic of what Frederick Buell describes as the "exuberant-catastrophic" oil society we inhabit (291). The short-lived era where oil was almost universally celebrated as an emancipating, "good" substance has long receded. Whereas the appreciation of oil's benefits has not disappeared, it is perpetually haunted by degradation and disaster, forcing extensive contemplation of ways and means of moving beyond its threatening horizon. What, if any, is cultural theory's role here? Decrying the renowned energy expert Vaclav Smil's lament, in his 1994 book, *Energy in World History*, for what he regarded as a "huge conceptual gulf between energy and culture", Buell argues that "energy history is significantly entwined with cultural history", but in so doing notes "no effective response" has, to date, been made to try to bridge this gulf (274). The recent emergence of "Petroculture" as an increasingly prominent international sub-field of academic study and cultural practice bears promise the gap should and can be reduced.[4] Its aim: to claim a space for critical, literary and artistic engagements with what has largely been a geological, political-economic and corporate substance, measured and valued by petrodollars and combustion power rather than (or indeed alongside) aesthetic modes of representation, image and narrative. By asking questions about oil within the entire energy landscape, the burgeoning work now emerging in this field is helping to recast the fundamental orientation and relationship of cultural forms to a material life sustained and underpinned by hegemonic forms of energy extraction, production and consumption. It is still in an early enough theoretical phase to generate reflexive queries such as Andrew Pendakis's: "is there an aesthetics of oil or are its cultural manifestations too diverse and localized to be usefully generalized?" (8). The affirmative answer to this question relies, in part, on the way one elicits and frames the examples of what constitutes petrocultural production,

[3] As Bill McKibben notes, in 2012 oil company assets and share values, as well as the financial futures system relied on approximately $27 trillion priced unextracted carbon (2,795 gigatons) to be used eventually, much of it to be burnt.

[4] See in particular the international research cluster at www.petrocultures.com. The inaugural conference took place in Edmonton, Alberta in September 2012.

of which more below. What *is* certain is that the alacrity of the concerns over energy and its constituent forms has endowed this field of study with a salient cultural relevance to be broadcast and more fully theorized.

Extracting Culture

I want to propose in this inquisitorial essay that a significant area of "effective response" lies in attempts to energize interpretations of cultural production, specifically literary fiction. Fiction, in its various modes, genres, and histories, offers a significant (and relatively untapped) repository for the energy aware scholar to demonstrate how, through successive epochs, particularly embedded kinds of energy create a predominant (and oftentimes alternative) culture of being and imagining in the world; organizing and enabling a prevalent mode of living, thinking, moving, dwelling and working. In industrial modernity this has been largely reliant on the extraction of fossil fuels. The extent to which this energy regime has both fostered and been reliant upon a culture of extraction is of increasing interest. Yet what is recognized as extractive cultural production remains questionable. As I will point out later in this essay fictional awareness offers more than stories about energy types and systems. It establishes a means to contemplate – and possibly to deconstruct – energy capital's formidable representative skills, notably its narrativization of the "natural" necessity of oil to our functioning social systems. Oil's sophisticated signifying-systems have been central to maintaining its position as the fetishized ur-commodity of modern globalized capitalism. While we can easily identify the ways in which certain formal and thematic concerns ensure Calvino's succinct story's recuperation into the evolving subgenre of world petrofiction, we must also understand how this also a tale explicitly driven – like all storytelling – by the formalized essentialism of energy in culture and society in general, albeit in a variety of abstracted forms.

In establishing the character of the relation between the global regime of energy extraction and production, and its fictional abstractions, cultural theory has its work cut out. One way for it to begin is by considering how and why the ironic entanglements of ecological modernity can be simultaneously sustained and exposed by the fictions that circulate around energy, not only by the fanciful projections and stories created to reveal or counter energy crisis, but also in a reaffirmation of fiction's formal requirements and stylistic capabilities: its narrative energetics; its psycho-social dynamics; its requirements for causality, impetus and productivity in plot and character development and its chronotopic ability to straddle and traverse multiple times and spaces. Narrative requires power to become powerful. It can change speed, alter force, utilise digression, and in so doing proves a forum to reflect on matters of efficiency and the rationale for certain modes of energy and power. This is supplemented by fiction's degrees of reflexivity: its awareness of its speculative (and often antagonistic

and inverse) relationship to time and the Real. A five-page story of one man standing at a petrol pump contemplating his compulsive selfishness can thus stir examination of humanity's current entrapments within and exacerbation of the deleterious effects of the phenomenal opportunities afforded by oil and gas in the petro-privatised culture of late globalized capitalism. Along the way, it can find time to muse not only on the development of the service economy and its relation to flexible labour regimes, but also the nature of its connection to the birth, life, death and resurrection of all forms of organic life on a planet thousands of years before and after the relatively short and explosive oil-era. These are expertly hinged by a twin-engine irony generated by relative levels of short termism (the use of dramatic suspense) and long-termism (imagined, "off-page" inevitabilities), in addition to deliberate register shifts and genre switches. We ask: will the narrator be able to fill his car in time to make his journey? But we also ask: will that journey, made feasible by the undoubted liberating opportunities of petrolic life, exacerbate the seemingly intractable dread problems surrounding energy (ab)use in the contemporary world system? The story ensures we answer yes on both counts.

In the protagonist's fears for the running of his car (and thus his way of life) "The Petrol Pump" also reveals fiction's basic reliance on propulsive devices; elementary units of charge that power action, event and consciousness, calibrated by laws of narrative motion and impressions of kinetic and potential energy transference. (These need not necessarily involve constant or *actual* motion or much, if any, movement – think of Beckett's minimalism, or the generic predicates for entropy in Naturalist writing). Like the laws of thermodynamics, fiction relies on momentum and transference; absorbing and exuding, circulating, conserving and converting energy and resources, not only on the level of narrative, metaphor and content but also in formation, production, dissemination and reception. (Is it churlish to point out that you are, after all, reading this on once-oil or once-wood?) The question, however, of how the remarkable energy *of* fiction is inextricably connected to the (often entirely unremarked and unremarkable) energy *in* fiction – the stuff that makes things *go* and happen in literary worlds – goes mostly unstated. This despite the spectacular products and results of primary and secondary energy conversions being visible throughout literature's modern history: imagine, say, *Anna Karenina*, *Things Fall Apart* or *One Hundred Years of Solitude* without coal-powered locomotives! Contemplate Conrad's novels without wind or steam. Consider the sprawling fiction of twentieth century suburbia – relating psyches, bodies and worlds saturated in oil-based products – suddenly shorn of plastics, deprived of automobility or domestic electric power, bereft of pharmaceuticals, denied the cheap food supplies of prime-moved fertilizer!

Necessary if inconspicuous, forms of energy may have remained a latent feature of literary fiction had contemporary culture's promulgation of sustainability as a pre-

dominant and debatable concern not intensified. This has challenged literary criticism to take a deeper and sharper discerning of the physical and aesthetic forms and variants of energy resources, fuelling and powering actions, events, storylines and textual structures throughout the history of fiction (and by extension, throughout culture and material history more generally). Emergent modes of energy research and criticism seem to disavow assertions such as Smil's that "timeless artistic expressions show no correlation with levels or kinds of energy consumption" ("World History and Energy" 559). They reach instead for a "fuller analysis" sought by Edward Cassedy and Peter Grossman, involving "a sense of the social and philosophic context in which energy technology and resources are used, and a keen appreciation of what energy issues mean to the way we live and to the world we live in" (8). The questions asked in emergent modes of energy research and criticism are thus fundamental to the constitution, categories, methodologies and demographics of the literary field: does literature shape and shift in accordance with the dominant energy forms of the era it registers? Might it somehow play a role in *reproducing* (or, indeed, *resisting*) – perhaps inadvertently or unconsciously – a predominant energy culture? How does literature *use* energy and vice versa? Are literary modes – like social formations – brought about by developments in fuel or resource use to a far greater extent than we have previously considered? "What happens", as Patricia Yaeger asks, "if we sort texts according to the energy sources that made them possible . . . what happens if we re-chart literary periods and make energy sources a matter of urgency to literary criticism?" (306). Can we think, for example, of modernism outside an oil-electric context? Of Realism without steam or coal? Romanticism without wind or water?

To begin to answer these questions we have to become more adept at divining the specific fuel(s) literary modes run on. This does not necessarily entail following *only* work explicitly concerned with energy resources (though this might be a start!), despite the number of particular texts from world literature that can be considered "energy classics", such as Émile Zola's *Germinal* (coal, 1885), Fyodor Gladkov's *Energy* (hydroelectricity, 1932-38), Miguel Ángel Asturias's *Hombres de maíz* (1949) and *Banana Trilogy* (food, 1950-60), Henri Queffélec's *Combat contre l'invisible* (nuclear, 1969) or Gene Wolf's *Book of the New Sun* quartet (solar, 1980-83), Abdelrahman Munif's *Cities of Salt* quintet (oil, 1984-89), to name a few. To these (where, frustratingly, the topic and concept of energy remains rather incidental to established critical inquiry) we could add numerous others, in addition to myriad literary registrations of wood, wind, whale oil, paraffin, electricity, tidal water, biofuel, GM foods, etc.

Such work would be substantially supplemented by an interpretive strategy that considers ways literature can reveal energy's "hidden" ubiquity. A strongly developed strain of petrocultural theory focuses on the way in which the means and effects of oil are structurally occluded from its mass of consumers, making it less apparent as

an *explicit* object in social life and thus a specific topic in and for cultural production. For Peter Hitchcock, oil produces the most "violent" logic of all energy forms and in doing so militates against alternative imaginative forms of representation. Oil's powerful "symbolic order" works influentially to present an inviolable discourse as to its prerequisite role in real life, its "omnipresence" creating a sheen of dependency "that paradoxically has placed a significant bar on its cultural representation." In this view, oil's "real" fictive power is such that literary fiction cannot hope to articulate it in realistic terms:

> In general, oil dependency is not just an economic attachment but appears as a kind of cognitive compulsion that mightily prohibits alternatives to its utility as a commodity and as an array of cultural signifiers. …I view the problem as primarily dialectical in the broadest sense, rather than as one of cultural expression by itself. ("Oil in an American Imaginary" 81-82)

Considering appropriate means of culturally expressing oil's domain, the editors of a special oil-related issue of the journal *Imaginations* somewhat echo Hitchcock in viewing the problem as one of pervasive mystification. This is a result of the collusion of corporate secrecy and consumer repression typical of late capitalism, however "ecologically responsible" it declares itself:

> the problem of visualization, of the proliferation of determinate, useful maps of our economic lives, is not specific to oil, but one politically structural to a system that is at once spectacularly consumerist and fully globalized on the level of production. However, it could be argued that oil is a uniquely occluded substance: not only does its exchange value engender an enormous corporate project of hiding, an explicit machinery of deception and spin, its pervasiveness, its presence, everywhere, perhaps singularly christens its position as "hidden in plain sight." (Wilson and Pendakis 5; qtn from Szeman and Whiteman 55)

There is room for counter-argument here that would note two basic points: 1) that such an "everywhere-felt-but-nowhere-seen" condition is geo-culturally uneven; symptomatic of the uneven international division of labour, regulation, and ownership of oil capital; 2) that we *are* in fact extremely aware of oil issues, most especially in the over-consuming Global North, where environmental membership and activism is relatively high and influential. As I and others such as Michael T. Walonen have argued, these points are somewhat qualified by a comparison of international petrofiction (and other cultural work, such as documentary photography) from the various spaces of the world oil-system, notably that registering the experiences of those living and working in those "concealed" or peripheral zones of extraction. Subject to varying regulation, oil's local presence and visibility is fairly explicit here and, some would

argue, openly "taken" rather than "secreted" away. Nonetheless, in the general, world-systemic terms in which oil and climate must, ultimately be framed, the oil-occlusion argument is compelling. It maintains the peripheral geography of fossil-fuel extraction on land and water, combined with what Rob Nixon has called the "slow" or "invisible" violence of its atmospheric and environmental effects, has always effectively "offshored" features of its transacting, refining, transmission and emission across the "advanced" productive economies of the Global North in particular (2, my emphasis). In this sense oil perfectly illustrates ecologically challenged modernity's Janus-face. What could be eulogized by the road-tripping narrator of Nabokov's *Lolita* as the "honest brightness of the gasoline paraphernalia" (153) of post-war America has darkened into a petro-reliant world persistently disturbed by what Buell describes as "a large portfolio of dread problems" (274). Despite these being increasingly difficult to ignore, Imre Szeman notes an obdurate "foundational gap" preventing public action on dirty energy's predilection for crisis, a gap created by:

> the apparent epistemic inability or unwillingness to name our energy ontologies, one consequence of which is the yawning space between belief and action, knowledge and agency: we know where we stand with respect to energy, but we do nothing about it. ("Literature and Energy Futures" 324)

We might heed this as a challenge for cultural theorists to take up: how can achieving meaningful action over the problems (and opportunities) of oil entail *knowing* oil better? The overwhelming majority of climate scientists now acknowledge that solving the problem of human-caused climate change must place less emphasis over the exactitude of the science than its communication and awareness. Most certainly this involves rethinking how to discern and locate the cultural life of emissions and their representative properties within a larger social/energy matrix. But once we discern the 500MW reactor in the corner of the parlour or the derrick in the drawing room, what then?

To reiterate: if we are to realize that historical events, economic relations and political formations are created and sustained by energy resources available and accessible at any particular time, and that such events and formations in turn, create *and are in part reproduced* by a specific energy culture, then reframing fiction as a crucial cultural resource historically suffused with energy, in form and substance, might require an altogether bolder and more ambitious interpretive approach. This would not only insist upon the crucial significance of energy awareness as key to discerning fundamental relations between cultural structures, energy use and predominant modes of production, but also posit the daunting yet exciting assertion that *all* (or perhaps *any*) fictional work is a veritable reservoir for the energy-aware scholar. We might see this as following Said's theory of contrapuntal reading. If we all "live" an extractive

culture, regardless of our cognitive connections or geographic proximity to refineries, mineshafts and drill-zones, then our cultural production should reflect that, regardless of how abstract or distorted the projection. How this can be critically extracted and subsequently refined becomes the point of focus, meeting the challenge Hitchcock issues concerning energy's peculiar "cultural logic": how to interpret it as "a very mode of referentiality, a texture in the way stories get told." ("Oil in an American Imaginary 87)

In spite of legitimate concerns it may be unworkably elastic or over-determined, a "deep-energy" methodological perspective is, in fact, already underway in some subfields. Thermodynamic readings of the narrative and social concerns of the nineteenth and early twentieth century novel, for example, are well established.[5] Electromagnetic expressions of force and speed, and a consciousness of newly mechanized motion, find their way into textual understanding of the technical and topical dynamics of the late realist novel and subsequent modernist movements from Vorticism to Futurism. Enda Duffy, writing on the importance of mass electrification to early twentieth-century life and consciousness can legitimately claim that "the shock of modernism . . . also relates to the shock of electric-shock therapy" (410). Where, then, are analogous pronouncements on later cultural moments and movements? Despite being stock full of fossil fuel's refinements, most fiction set in oil-gas-nuclear–renewables era modernity awaits similar energy-based elicitations. The accelerated mobility and intensified compressions of space and time enabled by carbon-driven capitalism, and petro-technology in particular, have altered the shape and geography of literary plot, not to mention the available global constituencies of character, custom and style, as they have massively altered global spatial, media and economic orders. Oil, like coal, clearly has form, but to what extent has this been fully recognized? How can we appropriately interpret its discretion, in order to connect it to the larger frameworks of energy I have discussed above?

As a newly recognized subfield, petrocultural criticism tentatively has sought to explore what Yaeger (summoning Macherey and Jameson) calls an "energy unconscious" (309). If, despite being up to our eyeballs "in oil", we fail to register the level of its insinuation across social and political life – and thus across the spectrum of aesthetic production, then the type of lesson presented in Calvino's story's remains environmentally critical. This is punctuated by the setting: the most repressed and forgiving arena in most of our regular dealings with petroleum is the gas station; a space of wilful forgetting, aided by ever-quickened transaction strategies. Its multiple consumption opportunities do not stand in the way of a hasty exit. Here, we come into our closest contact with the substance we rely upon most for transport and mo-

[5] See for example the work of Tina Young Choi or Allen MacDuffie.

bility, yet everything is in place to keep it out of sight, to protect our bodies from its touch and smell – and keep our eco-conscience in abeyance.

From the gas station experience upwards the principal definition of the "cost" of oil has been domestically economic, a point that needs understood partly as a *cultural* phenomenon produced by a specific mode of neoliberal political economy. Neoliberalism is an oil system, ironically enabled and sustained by on-stream petro-revenues and dramatic falls in post 1970s barrel prices (from the early '80s switch to monetarism in Reaganism/Thatcherism, to the rise of the Oil and Gas Tsars of the post-communist Soviet Union) and heavily invested in both technological and commodity capacities with the fictive capital structures of electronic financial modelling systems. Finding the energy in cultural production, especially in a service-led context is partly imbricated in understanding the *social* and *economic* fictions of energy created, inhabited and reproduced within any petroculture, but particularly acute in the sphere of neoliberalism. These sediment and systematise prevalent conceptions of the necessity of various forms of exhaustible resource and work to maintain and often intensify the levels of investment placed upon them.

Part of the point in theorizing energy as cultural is, therefore, to expose and determine reasons for our acculturation to its hierarchy of material (and, increasingly, immaterial) forms and the manner in which they dictate fundamental aspects of social life and organization. If, as is often remarked, in an age of consumer sovereignty, we don't really think *enough* about how we expect and trust the lights to go on when we flick the switch, then how is this related to what Owen Logan calls a "supply-side aesthetic": the manner in which the consumer identity we inhabit reproduces the way we (fail to) perceive and portray our predominant energy infrastructures (105)? How we think conceptually of waste, expenditure, and remaining amounts has also, according to Logan, become "undialectical", a point exemplified by the tendency for developed oil societies to offshore or export or make limited ethical claims on the associated pollution and waste, excising it geographically or temporally, as a problem of *elsewhere*, of the future, or by governmentalizing ineffective recycling programmes. Clearly how we "consume" rather than "use" and, crucially, *extract* fossil fuels makes us act and think about it in an uncritical, deflective way.[6] This is aided by the effective brand-management of the oil and gas corporate over the last twenty years or so. This suffered some relapse in the difficulties of BP, which, prior to the Deepwater Horizon

[6] Duncan Clark, for example, argues that despite a fall in US emissions, partly due to shale gas fracking, a consequent increase in US coal exports have led to a rise in its carbon extraction and burning. His argument is that carbon measures should automatically be globally based, and on *extraction* rather than national emission rates ("The Rise and Rise").

disaster was oil's most PR-savvy representative, but has, like big oil generally, rediscovered its mojo. In all these scenarios, an energy imaginary *beyond fiction* underpins fossils as epitomizing a future of security, efficiency, and, even "sustainability." "Unconventional" fossil fuel is represented as technologically innovative and thus largely positive, a "solution" to projected needs. Cheap or thin oil and gas is, thus, heavily mediatized in favour of on-going enclosures and expanded realms of extraction, legitimizing extended regimes of fossil accumulation. In this scenario the very concept of modernity as founded upon and reliant on depletion-based resources is ignored for a holding-pattern vision of a bountiful future.

Oil's emancipatory role in habitual experience is repeatedly vaunted in this incorporating system of petro-acculturation: how *could* we live without it? This has often been presented more as overwhelming threat than earnest challenge, particularly by those interested in retaining oil's dominance, who consistently remind us of the deep spread of oil products – and their socio-economic benefits – across modern life. Mathew Huber also confirms this mixture of fatalism and faux-pragmatism as a logical form of "petro-privatism" consonant with neoliberalism, a political-economic ideology oil and gas companies have thrived within ("Refined Politics" 306). This is underscored by Peter Hitchcock's "Everything's Gone Green: The Environment of BP's Narrative", which argues "BP's desire to move 'beyond petroleum' means more rather than less oil exploitation (104). Hitchcock's penetrating account of how oil companies have attempted to environmentally modernize by utilizing the power of narrative in corporate rebranding exercises.[7] "Going Green" is perceived here as an exploitable extension to energy generation, rather than a replacement for (in)exhaustible carbon chasing. Perhaps only the petroleum industry could work so profitably to turn the perceived end of a crisis-bound substance as a crisis in itself, transformed into market opportunity.

Petrofiction and Beyond

Aided by the subtending practices of culture-project sponsorship, oil's representative conversions of "polluting" energy into "productive" or "good" energy are a prime example of the challenge, but also the opportunity, facing dialectical interpretive responses. We might, on some level, expect the wide scale naturalisation of non-renewable or "dirty" energy in carbon-anxious modernity to present a formidable

[7] A number of cultural activist pressure groups campaign against the ingratiation of big oil in cultural institutions. In the UK, Platform London (www.http://platformlondon.org) and Art Not Oil (www.artnotoil.org.uk) have been increasingly prominent in their objections to oil sponsorship of the Tate Gallery, the 2012 Cultural Olympiad, the Royal Shakespeare Company and the Edinburgh Arts Festival, among many other cultural events.

blockage to "alternative" energy's cultural perception and representation, yet petrofiction's emergence as a truly "global" subgenre demonstrates literature's capacity to energise purviews; confronting and repositioning the potent social and economic signifiers "naturalising" energy and contemporary petrolic living in general. It has conjoined with powerful modes of anti-resource-colonialism and eco-criticism (the bass notes of petrofiction) in seeking to heighten our planetary energy consciousness.

Introducing a volume of reviews of petrotexts, Imre Szeman argues these works

> highlight the important role played by oil in contemporary society and the importance, too, of narrative in shaping the ways we understand, respond to, and engage with our oil ontologies … there is, finally, a move afoot to puzzle out the implications of our dependency, as much metaphysical as material, on a slippery substance that connects technological futures with prehistorical pasts in ways that cannot but be difficult to conceptualize. ("Introduction" 3)

Certainly, our time of environmental dread has brought the critical momentum to elicit the long and deep significance of various forms of energy to literature and vice versa. The identification of fiction concerning and concerned about energy – not only with its limits and secure supply but also with concomitant themes of exploration and (over)production, capacity and consumption, and subthemes of conversion, distribution, and commodification – has also grown, albeit incrementally, in the period since Calvino's story. An energetic form of criticism has also begun to construct a solid platform for the elaboration (and in many ways the re-categorisation) of a whole history of literature concerned with the history and future of the planet, amidst the geopolitical and biophysical machinations of global warming and the contemporary world carbon-nexus. The degree to which this work can exert traction on the established manner in which rising gas or domestic heating prices shake general volumes of energy indifference is interesting for students of the impact of cultural forms. Nevertheless, if, as Szeman and others emphasize, an energy awareness has *finally* begun to spread through the Arts, Humanities and cultural analysis generally, key questions arise: to what degree are conventional modes, not only of ecological literature ("the environmental novel", the "ecopoetic imagination", "ecocriticism") but of literature in general limited in both style, approach, and purview? Have they enough sources and resources to deal with the size and scale of the "urgency" Yaeger (see above) emphasizes? Finally, how and why is the *form* of our dependency a critical matter?

As the most recognizable strain of "energy art", petrofiction has its specific subconcentrations in exuberant (and damning) extraction narratives, local and transnational stories of oil's development and its dramatic transformation of space, place and lifestyle. To these we can add tales of corporate corruption and petro-despotism; spill

and disaster; the conflict between oil capital and labor and even the "drama" of barrel prices and fictive petro-capital enacted across international territories. But in what ways might the fiction of drill-bits, mineral rights and gushers relating the *process* of oil fail to reflect its wider material and ontological spread, as well as Hitchcock's "primary" dialectical form? Should not "petrofiction" be seen as much a fiction of "alternatives" or replacements to oil, both past and future, as it is about the super-commodity oil has become? Is not oil-based culture, by virtue of the (un)certainty of supply and ecological limits, (however much they may be continually shifting or postponed), always already a *post-oil* culture? Alternatives to oil dwell within and alongside oil culture, albeit in a rather spectral fashion, as absent presences demanding attention to their inevitable – or belated – appearance. Cultural production has configured these in various manifestations and interpretive manoeuvres, although by no means are alternative energy sources as explicitly acknowledged as oil. This is changing. As the prime energy form governing contemporary social forms drains away, we might expect new forms of resource fiction to become increasingly insistent. Whither hydrofiction? Windpoetics? Nuclear drama?

Petroleum culture is consistently haunted by its eventual depletion. A post-oil element is detectable in oil texts from the nineteenth century onwards, but since the 1960s a recognizable form of petrofiction has been driven primarily by depletion-anxiety. Here, contemporary fears about resource-wars and climate collapse (among many others) are reprocessed in apocalyptic narratives of floods, population wipeout, continental starvation, solar exhaustion, and bioenvironmental degradation. Scratch the surface of most dystopian narratives and types of resource cataclysm appear.[8] Much of this work ponders the momentous eventuality of a world without large quantities of flowing oil – gasoline in particular. The zombified afterlife of petroleum in numerous post-apocalyptic, carbon-fretful narratives emphasizes how hard it is to let go. Constituencies remain hooked on its scant (and thus unevenly distributed) deposits. Think, for example, of the petro-desperation of the barbarian motorcyclists encircling the embattled renegade oil refinery in George Miller's film *Mad Max 2* (1981), or the allure of the bitumen-shattered highway, navigated by a tattered oil-company map in Cormac McCarthy's *The Road* (2006), or the corpses strewn around gas pumps in Justin Cronin's vampire-apocalypse novel, *The Twelve* (2012).

As post-oil culture mourns the passing of cheap and easy oil it speculates on the elevation of its potential alternatives. Oil is limited but not *totally* missing in novels

[8] Conversely, no one seems to question the seemingly abundant (and presumably "clean") levels of post-fossil energy powering the vast spaceships and megacities of utopian fiction, especially the multiverse energy worlds of Space Opera. These can be safely consigned as "idealist" by petro-realists.

like Sarah Hall's *The Carhullan Army* (2007) or Paolo Bacigalupi's *The Wind-Up Girl* (2009), for example, but their respective relation of a neo-communalist, new-diggers England and a flooded future Bangkok exemplifies an emergent multi-resource novel. This renders a world of mixed old and emergent new fuel and energy "choices" created from necessity-bound relations of anticipated fossil depletion and generalised resource shortage. Concentrations of food, wind, hydro, dung, wood and muscle (animal and human) – natural and biogenetically engineered – show how a imagined future projection of *less* doesn't necessarily imply a scarcity of energy, but emphasizes its control and expenditure as a capitalised resource throughout the modernity it helps establish, yoked to the surplus logic of powerful interests, pressed into the service of capital and (neo)empire. Capacity becomes relative, as opposed to absolute. The persistence of uneven access and private distribution networks ensure that regardless of its non-polluting properties, wind or sprocket-borne power remains, rather like future-Bangkok's illegally burnt animal dung, a "shit" form of "filthy" energy when tied to forms of conflict, corruption and oppression.

Consciously or otherwise, it is significant that the fictions of future energy-scarce scenarios contain salient caution about an almost-post-carbon future of "alternatives" that does not necessarily herald a renewables utopia. In doing so they reveal the *nature* of any society as bound-up with a specific energy mode and particular system of social power. This opens up a vista towards the long view of energy's commodification within the capitalist world-system, where, regardless of its degrees of "cleanliness", it has always been tarnished by powerful systemic organization, controlling price, access, distribution, and consumption. The predominating spectre of supply-anxiety in late-capitalism has ensured that it is rare to see an imagined future where *less* energy is automatically "good". Though the logic and chronology of speculative fiction's energy scenarios may be future-set, its contemporary cognition is as energy-conscious challenge, via either allegorical interpretation or verisimilar credibility, as a world of the possible; a shape of things to come (or as they *are* for the billions of fuel-poor on the planet) under the irrepressible logic of contemporary petro-finance and on-going carbonisation. So much (or, perhaps, so *less*) for the future.

Undoubtedly, speculative fictions of future energy landscapes present uncomfortable contemporary questions. At the very least, in visions of a world with less oil, it offers glimmers of what transition might entail. A problem, however, may lie in potentially unexpected consequences of their progressive eco-cynical vision and generic familiarity; bolstering a fossil-politics opposite to what might be intended. "Look", an oil-company spokesperson can claim, "at the barbarous, chaotic world without oil"; the perfect riposte to any radical imagining of a non-polluting replacement. It could be argued that our preoccupations with scarcity have perpetuated a present situation where abundance remains desirable. The literary fiction of inevitable fossil depletion

nonetheless provides the means for its critics to confront the fictions – social, literary, geological – of on-going abundance we face in the present. Why is it, for example, that imaginary futures of less always seem to run – implicitly or explicitly – on the drama of "more"? Involving the objective of regaining or recovering maximal (usually "dirty") energy systems we critique as unworkable in the present? As I remarked above, the historical examples of most petrofiction reminds us that themes and issues as depletion anxiety are embedded within the enthusiastic pursuit of expanded extraction. A dialectical relation has always configured cultural, political and economic notions of energy's limits within patterns of development and desire generated by perceptions of its (real and imagined) limitlessness. In fact, the social fiction of unhindered and waste-free energy flow – always already a degraded notion in a systemic culture of non-renewables – unconsciously pervades most, if not all cultural production from the coal age onwards.

Oil Fantasies…

A point that cannot go unmentioned here: given the available extent of under-nuanced depictions and professions of oil's dispersed ubiquity, amid perpetual supply-anxiety animating environmentalists, governments, oil corporations and private consumers alike, petroculturalists perhaps haven't paid much attention to the constructive story where such a superlative mode of energy *has been and remains* a "necessary", essential and ameliorative force in modern human history. Looking back at "The Petrol Pump" now, from the century long and continuing "success" of oil, a question arises: has contemporary eco-culture's default setting of the condemnatory registering of "dirty" energy been one-dimensional? Has it not realised fully why hydrocarbons have been "celebrated", or adequately qualified their powerful attractions? To get beyond "dirty-oil" we have to better comprehend and distinguish its powerful, emancipatory attractions.[9] To reiterate: imagine a hospital without pharmaceuticals or plastics, a food supply without fertilizers. What would an oil-free utopia that would dispense with these look like?

[9] This pertains, again, to reappraising cultural perceptions and the acculturation of particular energy forms. Consider, for example, a sport such as Formula One Racing, a pursuit I personally find objectionable on many grounds, not least its contribution of a massive carbon footprint. I recognize, however, its seductive, enthralling aspects: speed, danger, competition, design and technology – and how the copious and economic burning of fossil-energy contributes to these as appealing elements to a large amount of people. Does, therefore, the task of theorizing energy not require rethinking what constitutes and defines speed, force, power, competitiveness, etc.? And, following this, how automobility is socially organized, culturally generated, historically contextualized?

However oil's "usefulness" is perceived, it is clear that much of the culture-world is hooked on relating its devastating qualities at the expense of its evident material and infrastructural qualities. Can cultural and theoretical work help to evolve distinctive replacements for these? To this degree our criticism, like our technology and terminology, might not be sufficiently refined. But interpretively skilled cultural practitioners prove crucial – not solely in decoding and countering the signifying prowess of oil capital, but in framing the social and planetary "story" of oil and narrativizing alternative energy signatures and structures in a form and space outside orthodox or vested representations.

I have argued that in order to detect energy's cultural properties, fictional resources could be read more energetically. One way of managing this involves considering how to rethink why certain texts are deemed *literally* "about" oil, electricity, coal, etc., and others less so. Most fiction dealing explicitly with energy, whether as problematic or enabling force, typically involves a coming-to-energy-consciousness, often in the context of plots about energy rights or fuel discovery and resource deprivation. The "lightbulb" moment in Calvino's story occurs in the forecourt of a new type of "self-service" filling station. In retrospect, it is instructive that its narrator's petro-anxiety is paralleled (and somewhat mitigated) by the enthralling promises of an incipient age of consumerism. This is packed into a moment of false consolation where he considers how it is that the burden of oil consumption and its excision fall on him as he performs – with all the consumer "choice" of an addict – the final labour of the energy company that profits from his purchase: pathetically, he "works" the pump and injects the hi-octane "poison" into his thirsted vehicle. He sublimates his shame and resentment by resorting to an overtly sexualised populist road-fantasy – the ultimate fiction of an oil-based cultural life. The genre morphing is deliberate, recalling Ryszard Kapuscinski's much cited statement, in his *Shah of Shahs* (1980) concerning the "illusion of a completely changed life" that the "anaesthetizing" effects of oil offers. "Oil" writes Kapuscinski, "is a fairy tale, and, like every fairy tale, is a bit of a lie" (35). This famous observation remains ever relevant, and inhabits Stefanie LeMenager's recently expressed concern, that if relations between cultural work and oil might enable a way to realise the transition to another energy order, they must confront the deeply embedded aesthetics of petroleum in our lifeworlds. A major part of this is "the larger emotional geography of automobility": the manner in which car culture reproduces an "affective context" manifest in the way we organize and navigate our material worlds, from our built environments to our work timetables, consumer goods, leisure choices, etc. "In brief", claims LeMenager, "we have to consider the consequences of loving sprawl" (60-61).

In its oblique registration of a post-supply-side ontology, "The Petrol Pump" is a rare example of a way to expand the established parameters of what we can define as

"petrofiction" in the way LeMenager describes. Some petro-stories are driven by reflection on what characters do not know (or indeed care) about the life and designs of oil: relating the corporate secrecy of oil companies, or occasionally questioning how (and from where) energy forms "magic" their way to engine or household. Tortured by his inability to overcome the ramifications of his fuelled-up hypocrisy, Calvino's narrator at least acknowledges the contradictions punctuating relations between energy, capital accumulation, and environmentalism in modern service culture. These relations an energy-conscious fiction and criticism might seek to further extrapolate and represent in all manner and modes of fiction where energy supply is either *not* recognized or simply taken for granted. There comes a time, however, when this ignorance is unsustainable:

> All of a sudden I'm seized by a craving to get out of here; but to go where? I don't know, it doesn't matter; perhaps I just want to burn up what little energy is left and finish off the cycle. I've dug out a last thousand lire to siphon off one more shot of fuel. (174)

As the urge to leave the scene of the crime transmutes into a cathexis to Hollywood/car ad fantasy, the story relies on its reader to see through a recognizably poor attempt to deflect guilt. This hollow agency – acknowledged by the protagonist –is ultimately intended to instil recognition of oil's duplicitous character, and very much aimed at the environmentally aware reader's (relative) ethical sensibility. Here, fiction's constructed ambivalence and advantageous access to consciousness and speculative scenario highlights duplicity in the romantic engineering of energy's illusions. Once we exit the shameful (fictional) realm of the forecourt – the intimate space of our oil encounter – are we who occupy the real free to forget "bad" energy and continue the mundane fantasy of its "special" effects across modern life? At a rhetorical stroke, fiction exposes the fictive life of oil. But how does it engineer a properly energized response? To imagine a world where oil use "doesn't matter" is to live literally in another world. Calvino's story wryly parodies the absurdity of desiring a limited, destructive resource, but doesn't know how or where to go without it. The ironic use of a carefree, cheap metaphor of driving off into the sunset self-reflexively exposes what Szeman has called the "fiction of surplus" that both literary *and* material life seem stuck within; unable to countenance a world of less or "easy" energy, despite impending lack ("Literature and Energy Futures" 323).

The fantasies of oil culture continue in part because, as I have noted, oil *is* fantastic. That it is often misrecognised (or indeed mis-used and abused) as such is part of the problem. The surplus imaginary continues in "environmentally-responsible" late capitalist culture, often in the earnest acknowledgement of the "problem" of energy. Mass-market fictions offer potential here, to consider an alternative energy-imaginary

even if only by revealing its dominant and residual forms. Hollywood, for example, enthusiastically embraces "dirty" energy's pay dirt. The greenwashed plots of recent fantasy blockbusters, from *Avatar* (2009) to *Avengers Assemble* (2012) to *Batman: The Dark Night Rises* (2012) revolve around the miraculous technological discovery of cheap, limitless but *clean* and "ecological" forms of energy. Such films present inevitable conflict over its production and acquisition by either state or private interests. They even query the dubious (super)heroic efforts required to realize them. The question of why a quantitative (or even free) replacement for "bad energy", offering similar power and capacity is required isn't really on the agenda. For why would mass entertainment forego the virtualised drama of crisis for a more philosophically nuanced approach to energy's value, or even offer a more revolutionary concept or utopian suggestion about an alternative system of use and distribution? The spectacle of flat environmentalism is now a preset-stance in the circulation of global cultural commodities, where a liberal-humanism *in fiction* can be espoused by corporate culture-producers, who, regardless of the degree to which they see themselves as somewhat apart from the "bad" energy corporate remain heavily co-opted into the cultural and economic hegemonies of petrolife. "Less" can only appear dramatically sustainable for a finite amount of time within the actual world-system, where energy's cultural capital is remarkably aligned to culture's energy capital.

Conclusion: where's the alternative?

The consolidation of petroculture as a critical means of reconceptualising energy enables reflection on the usefulness of *all* kinds of fiction – from across genres and literary history – for pressing political questions and eco-philosophical reflection in an energy-challenged present. The subtext of Calvino's story questioned the supremacy of fossil fuel in the 1974 context where "is there any other choice?" was a legitimate but rather novel query. It returns in the warming era where unconventional energy, oil, coal and gas are resurgent, and large areas of the earth await pockmarking by new drilling projects. How does this cast the warnings and anxieties of depletion expressed in most petrofiction? Does not fracked gas or thin oil mark Calvino's piece as a product of an *outdated* era of high "peak" anxiety? Might the deferral of "peak" oil culture hinder the development of new subgenres in the literature of energy?

However we choose to meet these conundrums, late energy criticism must make it apparent that it can't all be about petrol. Literary history has a considerable stockpile of energetic potential. Fiction has circulated and conveyed resources of heat, light, relative speed, force and motion long before *Don Quixote* registered wind-power in 1605. From its rise to cultural prominence in modernity, the Novel is replete with moments where its great theme of transition reflects developments in energy and fuel provision. Consider, for example, the moment – recoverable in numerous novels – in

Giuseppe de Lampedusa's archetypally modern novel of tradition and revolution, *The Leopard* (1958) where the death of the aristocrat Don Fabrizio is framed by the phenomenal change Italy has experienced in his lifetime, a transition measured by the accelerated *story* shift from the age of horse-driven power to the jet engine. *The Leopard's* temporal narrative jolts characterise the co-existent elements of most energy transitions but critical readings of the novel's expressions of the intersections between historico-political progression, shifting political culture and transnational geography leave energy provision subsumed. In these and countless novels before and after the age of petroleum, energy makes history and it has form in so doing; but despite providing the engine-room of plot, story, and context, the aesthetics and opportunities created by fuel power are not sufficiently registered, surfacing only periodically, during times of high resource-angst. In an unprecedented time of permanent conflict over supply, availability and destructive toxicity this critical blindness is unsustainable. The corrective involves new angles of methodological perspective and conceptual debates that have begun in the petrocriticism noted above. It certainly means consistently unveiling the banalized acculturation to prodigious uses of "natural" non-renewable energy in growth-obsessed polities and economies. The task is truly formidable, given the intensifying spread of oil-based development across the globe.

The challenge is thus made to critics across the genres of fiction making, from literature to cinema: if *all* fiction is potentially energetic, valorizing energy use, then how do we kinetically assert our claims and configure our readings to make it more apparent? The bedrock of this question is not only formed by the simple fact that the formal conditions for all narrative – even the most minimalist or "slo-fiction" – require a degree of forward momentum for events, space, mobility and development: as a basic unit of charge, but also by recognizing that if literary form is always to some extent an abstraction of the social, then interpretive issues and critical formations of capacity, power and supply determine *all* worlds. This requires we stretch our definitions and reconsider historical sedimentations of genre and period. "Petrofiction" in this frame is certainly stories about platforms, drill-bits, combustible transport, deadly spills and exploration-rights. But it's also about the world a specific fuel creates and maintains; about the relation between the oblique and surface world of fuel; a world of electronic gadgets, imported goods and financial transactions reliant on oil consumption but abstracted from the backstage forms of its conversion, extraction, refining and delivery, from sequestered pipelines and petro-guerrillas to compromised forms of democracy.

How trite or redundant, then, in this view, is the claim that given the global cultural reach of an oil and gas dominated world energy system, *all* fiction is petro-fiction to various removes? That all fiction, pre and post-oil, can be measured by its relationship to the transformed aesthetic and material world that oil created and threatens

to revolutionize again, by either its absence or its carbonizing essence? Is fuel *that* fundamental to culture and cultural production? If a future of eventual diminishment or unworkable or unwanted energy types is certain, and we resort to a world of reduced force, even one of post-prime moving, then work published prior to oil (or outside the carbon-complex) becomes re-energised by the examples it offers of a world constituted via alternative energy sources.

LeMenager argues that

> the petroleum infrastructure has become embodied memory and habitus for modern humans, insofar as everyday events such as driving or feeling the summer heat or asphalt on the soles of one's feet are incorporating practices…decoupling human corporeal memory from the infrastructures that have sustained it may be the primary challenge for ecological narrative in the service of human species survival beyond the twenty-first century. (26)

What would a non-hydrocarbon imaginary resemble, after humanity's experience of oil? Reading fiction in this light offers eco-chronological backflips. A bounty of refuelled scenes from metropolitan core to oil-deprived periphery of literary history offer a means to "re-couple" our pre-oil energy memories to consider their usefulness for a post-oil world. Reading pre-oil texts from a post-oil perspective becomes particularly instructive. Did people really *walk* "sixty miles each way" on errands and business, as Mr Earnshaw does in matter-of-fact fashion, near the beginning of Emily Brontë's *Wuthering Heights* (1847)? Will literature after oil become more pedestrian? Certainly post-automobilic narratives of on-foot struggle, such as *The Road* or Joshua Ferris's *The Unnamed* (2010) seem to suggest we re-attune ourselves to an embodied aesthetic with a rich literary history, from Rousseau to Baudelaire, Beckett and Sebald. Stendhal's famous aphorism from *Le Rouge et Le Noir* (1830), that "a novel is a mirror on a highway walked" – somewhat eclipsed by an age in which the mirror is more likely to reflect a highway burned up by an SUV – comes back into focus here. LeMenager speculates on what might be considered as a "post-petrol style", to challenge the autoerotic, affective concentrations of mass car culture, and asks if, in a world attracted to low growth and reduced output there might be an "erotics of post-sustainability" on a par close to the "affective intensity" oil living provides (61). An entire corpus of ambulatory fiction awaits this type of analysis, but it is wholly naïve to think of the end, however prolonged, of petroleum as automatically ushering in a new, "older" era of slower movement and localized distance. It might require, as Allan Stoekl has argued, a wholly refurbished theory of energy, involving a redefinition of its utility, necessity, and use-value, as well as its physical and philosophical "qualities", to challenge modernity's love of gasoline speed and combustion prowess; it's continual pursuit of maximum output and its captured definitions of energy efficiency and

economy. For Stoekl, "we have no choice but (miming Bataille) to elaborate a theory of excess in an era of radical shortage, a practice of human-powered velocity in an era of gas lines" (193). He insists this cannot involve a simple return to a romanticized past, as a "good duality" to carbon-made modernity, without recognising the importance of energy excess and burn as crucial – but non-polluting – features of human, bodily expenditure.

The extent to which such terms are placed within and against their understanding and operations in the closed global economy of petro-capitalist time and space, presently running out of gas, is crucial. For Stoekl, the solution is to fundamentally rethink animate power, joy and labor, within a radically re-localized spatiality:

> The radical finitude of fossil fuel — the Nature that refuses to die, even when it gives itself up and runs out (and its running out is its reaffirmation of its singular autonomy) — is the opening of muscle expenditure, the squandering of excited organs. (202)

Such a view, in conjunction with the findings of modern bioenergetics, presents an interesting platform to reconsider the way we re-energize scenes from literary history. Think, for example, of Konstantin Levin's appreciation of a "sea of cheerful common human labor" scything crops in part 3 of Tolstoy's *Anna Karenina* (1877). In a novel where the development of steam-driven motive power engages with massive transformations in agro-class development, this renowned scene reminds us of the most primal and fundamental energy form: organic muscular exertion. But it also underlines the long connection between energy "production", resource ownership and labor exploitation. Similar attention to "alternative" energy sources in the anticipated future-without-oil present opportunities for historical re-reading. The giant log pile behind Mr Knightley as he converses with his eventual wife in Jane Austen's *Emma* might have long appeared incidental. Now, in petroleum's deferred wake, it denotes not only an age of wood but also the invested power and prestige in the ownership of stockpiles of energy throughout history.[10] Consider the transformative hydro-active power of a water wheel that runs the nail factory at the commencement of Stendhal's *Le Rouge et Le Noir*. These countless scenes become more than incidental or isolate scenes of the historical entanglement of fuel power, resource-based capitalism and the class control of extractive production: they become critical fuel for fiction's effective recuperation and recycling of the energy forms made peripheral by the oil age and the cultural forms associated with it. Calvino's narrator's day wasn't, after all, to be about fuel levels, but in the end, in order to move forward, it had to be. However we

[10] Emma Woodhouse's name takes on a different hue in a biomass attentive reading!

interpret it, this has to be construed as a problem. If anything, "The Petrol Pump" reminds us that the warning light set in 1973 continues to blink. To properly energize culture in petromodernity's wake requires huge theoretical resolve to jumpstart the practical effort: nothing less than wholesale critical transformation and renewability.

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