CHAPTER 1

In the Heat of the Past: Towards a History of the Fossil Economy

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* (1835)

The chemical changes which thus take place are constantly increasing the atmosphere by large quantities of carbonic acid [i.e. carbon dioxide] and other 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* (1835)

Besides, what has your steam engine and your cast iron done for us? Not to mention the gas, whose frequent explosions threaten one day to blow up Babylon itself.

Anonymous worker in *The Metropolitan*, 'Imprisonment for debt' (May 1834)

Global warming is the unintended by-product par excellence. A cotton manufacturer of early nineteenth-century Lancashire who decided

to forgo his old waterwheel and 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 Nile Delta soil, the altitude of the Maldives, the frequency of droughts on the Horn of Africa, the diversity of amphibian species in Central American rain forests, the availability of water in Asian rivers or, for that matter, the risk of flooding along the Thames and the English coastline. 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; his book is considered the first to introduce 'the factory into the realm of economic analysis'.[1] He made his fleeting remark some three decades before John Tyndall explained the greenhouse effect and some six decades before Svante Arrhenius first calculated the rise in surface temperature on the earth following an increase in emissions of carbon dioxide (called 'carbonic acid' by Arrhenius as well).[2]

But the environmentally concerned enquiry of the pioneer economist was instantly truncated, due to sheer lack of knowledge. Babbage was verging on 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'.[3] In that turn of phrase, Babbage articulated a leitmotif of bourgeois thinking corresponding to the operating procedures of manufacturers, who fought the annoying idiosyncrasies of human workers precisely by installing ever more machinery impelled by ever more powerful steam engines, unsuspecting of any particular noxious effects. Those on the receiving end of that machinery had more reason to be afraid.

Now They Know What They Do

By now the science of the by-product is perfectly clear. It has been so, in its basic outlines, for roughly as long as capitalism has been free of really existing adversaries: in 1990, the Intergovernmental Panel on Climate Change (IPCC) submitted its first report on the likely fate of a warming world. The facts and projections served as the basis for the United Nations Framework Convention on Climate Change (UNFCCC), signed at the Earth Summit

in Rio de Janeiro in 1992 and ratified by all UN members, who pledged to 'prevent dangerous anthropogenic interference with the climate system' by *cutting* their emissions of greenhouse gases, chief among them carbon dioxide. Yet in 2012, global CO_2 emissions were 58 percent higher than in 1990.[4] By that time, the IPCC was preparing its fifth report – each edition more certain of the disastrous implications of 'business-as-usual' than the previous one – as a permanent hailstorm of scientific warnings rained down on humanity. A random pick from some leading journals in the years 2012–14: hurricanes in all ocean basins are becoming markedly stronger due to higher temperatures; North American butterfly populations have embarked on a perilous journey north to escape the rising heat; Arctic ecosystems are fast approaching a whole range of tipping points; the threshold beyond which the Greenland ice sheet will plunge into irreversible melting – raising sea levels by six meters – is a warming of 1.6°C rather than 3.1°C as previously thought; the retreat of glaciers in Tien Shan is accelerating, primarily in areas where they are most essential for irrigation in summertime, some rivers having already shrunk to tiny rivulets; since the mid-1980s, the vegetation of Congolese rain forests has browned, dried out and declined; climate change could wipe out the equivalent of the entire present yield of maize, soybeans, wheat and rice in key producing regions by the end of the century; the old target of keeping global warming below 2 degrees – widely regarded as obsolete, due to the already painful impacts of a mere 0.85 degrees – is rapidly slipping out of reach: and on it goes.[5] Everybody knows it. Whether one chooses to ignore, suppress, deny or agonise over the knowledge of what is happening, it is there, in the air, heavier by the year. And yet the descendants of the Lancashire manufacturers, whose dominion now span the globe, are taking decisions on a daily basis to invest in new oil wells, new coal-fired power plants, new airports, new highways, new liquefied natural gas facilities, new machines to replace human workers, so that emissions are not only continuing to grow but doing so at a higher speed. In the 1990s, the annual increase in global CO_2 emissions stood at an average 1 percent; since 2000, the figure has been 3.1 percent – a tripled growth rate, exceeding the worst-case scenarios developed by the IPCC and expressing a trend that still does not show any sign of reversal: the more knowledge there is of the consequences, the more fossil fuels are burnt.[6]

How did we get caught up in this mess?

History under a Heavy Sky

In the first pages of his acclaimed textbook *Political Ecology*, Paul Robbins travels to Yellowstone National Park to observe what lies behind its veneer of pristine wilderness. To an untrained eye, the iconic features of the landscape might appear perfectly natural. In fact they are intensely produced. The native hunters that once roamed the land have been removed by fiat; wolves were first extinguished and then reintroduced. Managing authorities have alternated between culling elk populations and allowing them to explode, suppressing fires and permitting them to rip through the valleys and leave their mark on the biota. At every step, walking through forests and along rivers, sighting some animals and not others, Robbins discerns the effects of power struggles that have raged over the park: between the state and the native population, between hunters and environmentalists, hoteliers and scientists. Out of the raw material at hand, political actors have created the ecology of Yellowstone, often with chains of unintended consequences.[7]

A traveller along the frontiers of climate change today – not to speak of tomorrow – might encounter a landscape even more thoroughly shaped by humans with power. Weather conditions, types of vegetation, entire biomes, even the sea itself might have fallen into place as a fallout of the combustion of fossil fuels. But where Robbins is able to trace a certain property of the Yellowstone landscape to a specific decision made in the past – the absence of natives to their historical removal – the climate change traveller can, by the nature of things, see no such straight lines. A submerged islet has born the full weight of a history lacking differentiation. No single decision, no emission of one tonne of greenhouse gases can be connected to this particular scene: the burning of this barrel of Texas oil cannot be pinned down as the cause of this Levantine drought. Every impact of anthropogenic climate change carries the imprint of every human act with a radiative forcing, such that they are infinitesimal representatives of two moving aggregates – the aftermath and the source – intimately coupled yet strangely disconnected from each other. Eyes gazing on abruptly transformed ecosystems are forced to turn back towards human society to understand what has happened – but where should they look? Only a totality can be the object of interest. We shall call it, provisionally, 'the fossil economy'.

Seen from another angle, global warming is a sun mercilessly projecting a new light onto history. Only now is it becoming apparent what it really

meant to burn coal and send forth smoke from a stack in Manchester in 1842. When natural scientists discovered global warming, they passed on a discovery to historians yet to be made on anything like a comprehensive scale: these things were there for two centuries, invisible up to the present. Now is the time to turn over a thousand stones, to unearth the climatic implications of innumerable actions – not merely because the smallest puff of smoke in Manchester in 1842 released a quantity of CO_2 which then lingered in the atmosphere, playing a microscopic part in the creation of the current climate, but also, and more importantly, because the fossil economy was established, entrenched and expanded in the process. It is as though a novel dimension has been suddenly revealed in modern history. Just think, in this light, of the building of the railway networks, the construction of the Suez Canal, the introduction of electricity, the discovery of oil in the Middle East, the rise of suburbia, the CIA coup against Mohammad Mossadeq, the opening of the Chinese economy by Deng Xiaoping, the American invasion of Iraq … As a series of moments in the historical totality of the fossil economy – deepening its channels, adding ever-greater volumes of fossil fuels to the fire – these events are retroactively suffused with a new significance, calling for a return to history, eyes wide open.

Would such a history be environmental? Most traditional concerns in the field – say, deforestation, air pollution, species extinction through hunting or overfishing, pathogen movement through trade or invasion – exhibit some kind of historical immediacy: the cutting down of a forest *is* deforestation. In his *The Chimney of the World: A History of Smoke Pollution in Victorian and Edwardian Manchester*, Stephen Mosley points out that 'smoke could be easily perceived by four of the five senses: one could see it, smell it, touch it, and it could be tasted.'[8] He is obviously engaging in an environmental history, writing of how the natural world in and around Manchester was transformed through the explosive spread of dense black clouds in the nineteenth century. But the burning of coal in that town also had another ramification, which did not, as it were, touch down in the environment until much later, after a whole series of biogeochemical and social mediations. The writing of that history should be a central task, and yet it is bound to have an odd quality of detachment from environmental repercussions. Insofar as we are interested in the fossil economy as the instigator of climate change, its ecological dimensions must be placed within the brackets of posterity in a way that hardly applies to any other problem of environmental history: even nuclear waste, whose fallout is comparable to global warming in duration, is immediately constituted and

handled as such. Anthropogenic climate change – this is part of its very definition – has its roots *outside* the realm of temperature and precipitation, turtles and polar bears, inside a sphere of human praxis that could be summed up in one word as *labour*.

At the intersection of climate and history, most scholarly traffic has so far moved in the other direction. The search for meteorological causes of past events is currently undergoing a spectacular renaissance: climatic fluctuations are said to have had a finger or two in everything from the collapse of the Mayan civilisation and the conquests of the Vikings to the witch hunts and the French Revolution. Promising analogues for the future, this endeavour uses data on temperature and precipitation to explain crisis, war, persecution, upheaval and other social affairs – explanations well worth pursuing for their own sake (albeit with certain well-known pitfalls) but not particularly appropriate in constructing the historiography of global warming. Here it is a matter of searching not for climate in history, but for *history in climate*. Data on factory legislation or free-trade policy should be brought to bear on rainfall and ice, rather than the other way around; in a warming world, causation runs, at least initially, from company to cloud. It is that leap across ontological divides that calls for reconstruction.

The Revenge of Time

Over the past decades, critical theory has moved towards space, away from time as the long-favoured dimension, the classical vessel of structure, causation, rupture, possibility. Within historical materialism, this 'spatial turn' has generated the meteoric rise of critical geography, now equalling or surpassing the time-honoured discipline of history in innovativeness and influence: the star of David Harvey shines brighter than that of any Marxist historian. Another adept in the field, Neil Smith, hymns the victory of space over time in *Uneven Development: Nature, Capital, and the Production of Space*, quoting approvingly such one-liners as 'we are in the epoch of simultaneity'; 'the present epoch will perhaps be above all the epoch of space'; 'prophecy now involves a geographical rather than historical projection' (whatever that could possibly mean) – even endorsing Francis Fukuyama's infamous thesis of the 'end of history' by asserting that 'indeed historical time would seem to be over'.[9] Global warming should put such fantasies to rest.

Floors below the desk where these words are written, people travel to work in cars, go on visits and vacations in cars, drive their shopping lists and shopping bags back and forth in cars: nowhere is simultaneity to be seen. Cars, to begin with, run on fossil energy, a legacy of photosynthesis originating hundreds of millions of years ago. The vehicles were not invented just now; they spread in the twentieth century. The choice to travel in them rather than in trams or buses or on bicycles is conditioned by a vast infrastructure of oil terminals, petroleum refineries, asphalt plants, road networks, gasoline stations – not to speak of the film industry, the lobbying groups, the billboards – which did not fall from the sky in this moment but was built up *over time*, eventually amassing such weight and inertia that other modes of transportation are now excluded, or at least prevented from rising to predominance. This is what some refer to as 'carbon lock-in': a cementation of fossil fuel–based technologies, deflecting alternatives and obstructing policies of climate change mitigation: a poisoned fruit of history.[10] Furthermore, there is reason to suspect that the heat wave and drought plaguing this part of the country, sending residents to seek relief by leaving the town in cars, has some connection to climate change – signs of a future to come, a state-of-weather-in-the-making – and if that suspicion is at least partly correct, not even the weather belongs fully to the moment. It is a product of past emissions. The emissions produced by the cars running to and fro, meanwhile, will have their greatest impact on generations not yet born: they are so many invisible missiles aimed at the future.

Wherever we look at our changing climate, we find ourselves in the grip of the flow of *time*. The transfer of carbon from geological reserves to fireplaces and thence to the atmosphere, into the running carbon cycle from which it was locked away for ages and eras, sets the process in motion. But the effects are always delayed. It takes time before a certain quantity of CO_2 emissions is realised as a corresponding amount of warming, and before that warming takes its full toll on the ecosystems. For every emission added to past output, the atmospheric concentration of the gas increases, its effect further augmented in accordance with 'the fundamental tenet of climate science: emissions are cumulative'.[11] The release of one tonne of CO_2 would not be so dangerous were it not for the billions of tonnes already out there; it is the total accumulation that pushes temperatures upwards, and the more that has been emitted, the smaller the prospect of limiting the ongoing rise. If humanity wishes to avoid a certain temperature threshold – say, 2 degrees Celsius – only a certain amount can be

emitted – roughly one trillion tons – and for every year emissions continue (not to speak of *increase*) that budget is progressively squandered.[12] If one tonne is emitted in this second, a fourth of it will stay in the atmosphere for hundreds of thousands of years.[13] If we wait some time longer and then demolish the fossil economy in one giant blow, it would still cast a shadow far into the future: emissions slashed to zero, the sea might continue to rise for many hundreds of years, the waters slowly expanding as the heat makes its way deeper and deeper into the oceans. A rising and warming sea could then unhinge ice sheets, thaw permafrost, destabilise methane hydrates or trigger other feedback mechanisms centuries after a complete cessation of emissions – once a certain historical level has been reached – in keeping with 'the long memory of the climate system'.[14] At its core, then, climate change is a messy mix-up of time scales. The fundamental variables of the process – the nature of fossil fuels, the economies based on them, the societies addicted to them, the consequences of their combustion – operate over seemingly unrelated temporal spans, all refracted in the moving, elusive present of a warming world; in an elevated sense of the term, every *conjuncture* now combines relics and arrows, loops and postponements that stretch from the deepest past to the most distant future, via a now that is non-contemporaneous with itself.[15] Ours is, if anything, an epoch of diachronicity.

'The temporal aspect is particularly striking,' writes philosopher Stephen Gardiner, who has done perhaps more than anyone to foreground it, in *A Perfect Moral Storm: The Ethical Tragedy of Climate Change*: it catches us in a bind. Given that global warming is 'seriously backloaded' (every moment experiencing a higher temperature posted from the past) and 'substantially deferred' (the cumulative effects of current emissions arriving in the future), a warped ethical structure arises. The person who harms others by burning fossil fuels cannot even potentially encounter his victims, because they do not yet exist. Living in the here and now, he reaps all the benefits from the combustion but few of the injuries, which will be suffered by people who are not around and cannot voice their opposition. Each generation, reasons Gardiner, thus faces a perverse incentive to 'pass the buck' to the next, which also profits from its own fossil fuel combustion while dodging the pain from it, and so on, in a vicious cycle of infliction of harm.[16]

Rob Nixon would call it 'slow violence'. In *Slow Violence and the Environmentalism of the Poor*, he grapples with a problem closely related to Gardiner's, though coming from the angle of literary theory. 'Violence

is customarily conceived as an event or action that is immediate in time, explosive and spectacular in space, and as erupting into instant sensational visibility', he writes, but there is also a different kind of violence: not rapid but slow motion, not instantaneous but incremental, not body-to-body but playing out over vast stretches of time *through the medium of ecosystems* and therefore far more difficult to capture between book covers or on-screen than the bullets of a sniper. When a company dumps a toxic chemical substance in a poor country, the violence is only being felt gradually, 'decoupled from its original causes by the workings of time', never contemporaneous with the act itself; Nixon places fossil fuel combustion in the same category.[17] He then asks: how can slow violence be represented in narratives that catch our attention? What are its equivalents in the crime novel, the war epic, the action movie? Symptomatically, he finds and reads stories and essays on the slow violence of the Bhopal disaster, oil exploitation in the Arabian Gulf and the Niger Delta, mega-dams in India, natural parks in South Africa, depleted uranium in Iraq *but none on climate change as such*. Here the capacity to imagine violence seems to have reached its limit.

There is more to these temporalities than dilemmas of ethics and representation, however. The longer business-as-usual persists, the harder it becomes to break out of it. Every round of new pipelines and tankers and deep-water drilling rigs encumbers the next decades with an even more ponderous mass of infrastructure into which carbon has been locked: the ruts of path dependency deepen. Every generation presiding over growing emissions adds more than the former to the accumulation of CO_2 in the atmosphere.[18] For every year global warming continues and temperatures soar higher, living conditions on earth will be determined more intensely by the emissions of yore, so that the grip of yesteryear on today intensifies – or, put differently, *the causal power of the past inexorably rises*, all the way up to the point when it is indeed 'too late'. The significance of that terrible destiny, so often warned of in climate change discourse, is the final *falling in of history on the present*.

History does not usually work in this way. The echo of Caesar's march across Rubicon, the fall of the Ming dynasty, the formation of the Sokoto caliphate or the storming of the Bastille can be expected to fade away as time goes by – or at least there is no inbuilt mechanism to amplify it. But in times of global warming, iron laws of economics and geophysics boost the past from behind, so to speak. 'The tradition of the dead generations weighs like a nightmare on the minds of the living,' Karl Marx famously

wrote in *The Eighteenth Brumaire of Louis Bonaparte*: in a warming world, it weighs down heavier and heavier, on the bodies of the living and their surroundings, in a relentless consolidation of the tyranny of the past.[19] This will certainly be more than a gradual progression. Extreme weather events convert the attrition of slow violence into photogenic spectacle: think of a flooding in Pakistan or a wildfire in Colorado. The snap disasters of abrupt climate change – the fatal crossings of tipping points in the earth system – would mark the sudden irruption of the mounting history of the fossil economy onto the stage of the present. Indeed, as unseasonable weather is becoming the new norm, this is already happening: when Julius, the protagonist in Teju Cole's novel *Open City*, roams the streets of New York in the middle of November without yet having had the occasion to wear his coat, he cannot help but suspect, with a sense of 'sudden discomfort', an effect of global warming.[20] Contrary to popular misconceptions in the media (and to Julius's own scepticism), it is now perfectly possible to attribute a particular heat wave or other anomaly to the underlying rise in average temperatures, in whose absence such events would have been utterly improbable.[21] The thermometer can be legitimately suspected as a barometer of the rolling invasion of the past into the present.

There follows, from all of this, a very peculiar temporality of climate change politics. Few if any other issues have such heightening urgency built into them by dint of sheer physical laws: the point of *too late* is coming closer by the day, and the closer it comes, the more swift and comprehensive the emissions cuts must be. The tradition of the dead is breathing down the necks of the living, leaving them with two choices: smash their way out of business-as-usual – and the heavier the breath, the more extreme the measures must be – or succumb to an accumulated, unbearable destiny. As of this writing, both scenarios remain possible. The famed 'window of opportunity' for abolishing the fossil economy and stabilising climate within tolerable bounds – even returning it to safer conditions – is still there; if emissions were reduced to zero, the rise in temperatures would soon taper off.[22] Such an enterprise would have to stage a full-scale onslaught on the structural nightmares bequeathed by the past. It would be a revolution against history, an exodus, an escape from it in the last moment, and it would have to know what it has to struggle against.

None of this is meant to deny that space is a crucial dimension or that geographers have enriched critical theory with an abundance of insights; we shall deal with the former and draw on the latter quite extensively in what follows. But now is a singularly bad time for declaring the demise of

time.[23] The spaces of climate change are relevant only insofar as they are folded within the process: the *change*, the warm*ing*. As the word indicates, this tempest is eminently temporal.

Searching for the Origins of the Fossil Economy

What do we mean by 'the fossil economy'? A simple definition would be: an economy of self-sustaining growth predicated on the growing consumption of fossil fuels, and therefore generating a sustained growth in emissions of carbon dioxide. Roughly synonymous with 'business-as-usual' in the lexicon of climate politics, this, we submit, is the main driver of global warming. It first appeared during the Industrial Revolution, whose great historical feat was to inaugurate an era of 'self-sustaining growth', meaning a process of growth that was not episodic, evanescent, broken off after a brief efflorescence, but persistent and unremitting, a secular progression propelled by its own inner forces.[24] In biophysical or thermodynamic terms, no growth can, of course, feed upon itself: one of the key lessons of ecological economics is that it always relies on the withdrawal and dissipation of natural resources. But through mechanisms to be specified later, the fire of modern growth reproduces an economic gas that necessarily ignites as more growth, the result of the process spurring it to advance further, the loop reinforced anew on a grander scale – and in this and only this sense is it self-sustaining. The fossil economy was born when that fire began to be fed by the material fuel of fossil energy.

Now we immediately see that the fossil economy, under this definition, cannot account for all human influence on the climate. Fossil fuel combustion is only one cause of global warming, just as the sun is only one of the bodies in the solar system and the American president only one in a larger team: the others, puny by comparison, revolve around it. 'Land-use change' – read: deforestation – accounts for a fourth of all CO_2 released since 1870, but its share is secularly diminishing, now standing at around 8 percent of current emissions, fossil fuels taking up virtually all the rest.[25] Then there are the other greenhouse gases – methane, nitrous dioxide, ozone, sulphur hexafluoride… – whose social histories would have to be recounted for a full picture to emerge. But it is safe to say that the burning of fossil fuels is the hard core of the problem, quantitatively dominant and qualitatively determinant. It deserves special focus.

If emissions of carbon dioxide ceased to increase and stayed constant, atmospheric concentrations would still continue to climb: absolute volumes of CO_2 are, in the end, what matters for climate. Then why include their *growth* in the definition of the fossil economy? Because it is the union of economic expansion and fossil energy consumption that has pushed emissions up to the present, utterly unsustainable – and still rising – levels: this is the really existing process, the alloy that has brought us to this warmer place. Three major deviations from the norm are possible. An economy that grows while its emissions flatten out, even if on a high level, can be classified as a *decoupled* fossil economy; it might still be overwhelmingly based on fossil fuels, but only one of the two components remains in motion. One with no trend in either respect may be termed a *steady-state* fossil economy, while one with continuously diminishing emissions – due to spontaneous breakdown, deliberately orchestrated policies or some other factor – is a fossil economy *in decline*. To the extent that these variants have existed at all, they have been exceptions proving the rule, or aberrations from business-as-usual (pretensions to decoupling gainsaid by rising emissions embodied in imports; steady-state situations a transient feature of crisis, such as in 2009; decline – notably in Eastern Europe in the 1990s – followed by rebound).[26] None undermines our definition of the object of historical inquiry.

The fossil economy has the character of a totality, a distinguishable entity: a socio-ecological structure, in which a certain economic process and a certain form of energy are welded together. It has some identity over time; contrary to the axioms of methodological individualism, the embryonic individual is suspended in its fluid. A person born today in Britain or China enters a preexisting fossil economy, which has long since assumed an existence of its own and confronts the newborn as an objective fact. It possesses real causal powers – most notably the power to alter the climatic conditions on planet Earth, but this only as a function of its power to direct human conduct. A factory manager will be pressured to obtain energy by plugging into the current from the nearest coal-fired power plant rather than building her own waterwheel. The company owner will send her commodities to the world market on cargo vessels, rather than sailing ships. A cashier may have little choice but to commute to the supermarket in a car – she certainly won't ride a horse – and if she wants to go on vacation, she will encounter intense advertising for flying as a transportation option. Moreover, none of these emitting actions would be possible without integration into the fossil economy: alone on an island, or living

in a country untouched by this economy, an individual could complete none of them. As such, then, the fossil economy is an altogether *historical* substance. It must have undergone its own birth once upon a time. The causal powers it now exerts are emergent properties: they were not always there. Agents must have created it through events amounting to a moment of construction, much as, once erected, a building's structure is now an enduring feature of the world; entrenched in the environment, it conditions the movements of the people inside. Eventually it appears indistinguishable from life itself: business-as-usual. But the fossil economy was once constructed and has since been reproduced and enlarged, and anything built over time can potentially be torn down (or escaped).[27]

So how did it all begin? Where would the search for a moment of construction lead us? While several countries could lay claim to being the cradle of modernity, capitalism, enlightenment or liberal democracy, the fossil economy has one incontestable birthplace: Britain accounted for 80 percent of global emissions of CO_2 from fossil fuel combustion in 1825 and 62 percent in 1850.[28] There is a margin of error in these figures, but they give us an idea of the proportions and trends, suggesting that Britain lost some of its paramountcy as the consumption of fossil fuels spread to other countries but continued to generate *more than half* of the world's emissions far into the nineteenth century. The origins of our predicament must be located on British soil.

Consequently, there has been a minor flurry of interest in revisiting the British Industrial Revolution for clues as to how all of this happened and, not the least, what to do now. An energy transition – most simply defined as 'a switch from an economic system dependent on one or a series of energy sources and technologies to another' – occurred at that time; we are heading towards another transition; thus, the argument goes, we need to learn from the past to proceed as best we can now.[29] If we think of the fossil economy not as a static building but rather as a train put at a point in the past on the current perilous track, we require knowledge of the switching mechanism to enter a safer course. The British Industrial Revolution here assumes the status of a unique archive of lessons. What do they say? 'First, the transition was slow. Second, it was driven by prices. Third, it required new technology.' Add human capital, scientific discovery, cooperation and narrow self-interest in equal measures and, concludes economic historian Robert Allen, a future transition to sustainable energy will also share these characteristics. Most importantly, 'people respond to price incentives'.[30]

One lesson often taken away from the switch to fossil fuels is precisely

that it was protracted, passing through several phases of stumbling experimentation, the agents slowly learning to master the novel form of energy – and hence the shift *away* from them should follow the same pace and refrain from 'pre-mature scaling up of technologies and industries'.[31] A transition must be given time. Even more critical, as we shall see, is the presumed lesson of prices: fossil fuels won the original race because they were cheapest, and the same advantage will now have to be secured for renewable alternatives if they shall have a chance. Moreover, if the British Industrial Revolution stands as a model for 'the second industrial revolution', or the green or the low-carbon or the sustainable one, yet another lesson seems unavoidable: 'The profit-motive of small and medium-sized enterprises rather than community action might drive innovation. The fact that' the instigators of the switches back then 'were competitive capitalists and became wealthy as a result' counsels us from assuming that 'only communal initiatives can drive radical change.'[32] Capitalists slowly unrolling technologies with lower prices: this is the manual to follow.

But any straight parallelism between the entry into and the exit from the fossil economy is spurious. It comes close to the fallacy of presupposing that the present is essentially the same as the past, allowing for an immediate transfer of precepts, such as when generals have drawn up their strategies from the lessons of ancient battles and suffered grievous defeat, forgetting the Heracleitan rule that you cannot step into the same river twice. As several scholars have pointed out, the transition now impending – if indeed it is – would be motivated by the urgent need to stave off or at least minimise catastrophic climate change, a danger humanity has never before confronted, and one which certainly did not figure in the calculations of early British industrialists. The most highly prized quality of renewable energy would be low or zero emissions of carbon dioxide: a public good, not a private benefit. Time is already characterised by being short. For these and other reasons, the next transition cannot share the canonical features of the British Industrial Revolution; above all, this time it would have to be *collectively planned*.[33] But it would face impediments. Measures necessary for an enforced, rapid, politically driven phaseout of fossil fuels may, as IPCC tersely notes in a 'Summary for Policymakers' from 2007, be 'difficult to implement' due to what the panel labels a 'key constraint': namely '*resistance by vested interests*'.[34] In these few words, a planet of antagonism briefly comes into view. So fossil fuels have to be discarded for human civilisation to endure and thrive – but there are 'vested interests' standing in the way. What are they?

Here might lie a better reason to revisit the Industrial Revolution. If the fossil economy is a train that never stops but always accelerates, even when approaching the precipice, the task is to pull the brakes (or maybe jump off) in time, and if there is a driver who seeks to keep this from happening, she has probably been seated in the locomotive for some time: we need to know who she is and how she works (or perhaps it is an automatic engine, a driverless construction – but the need would be the same). The interests that once put the train in motion may still be driving it. The previous transition, then, would be not so much a template for the next as *a key to understanding and removing the impediments*. We cannot know this for sure: it is a mere suspicion. It is, of course, conceivable that the initial reasons for taking up fossil fuels are entirely unrelated to the interest in clinging to them now, which might have taken over at some point along the journey. But if we want to know more about the propulsive forces of the fossil economy, its laws of motion and the interests invested in it, the beginning seems a good place to start.

Whether we frame this as a search for parables or for enemies, the underlying assumption is that meaningful action can be undertaken: it is not yet too late. But what if it is? 'If there's no action before 2012, that's too late', declared Rajendra Pachauri, chair of the IPCC, in 2007: 'What we do in the next two or three years will determine our future. This is the defining moment.'[35] What if that were no mere rhetoric, but an accurate forecast soon to be fully vindicated – then would there be any point in delving into the annals of the fossil economy? If any historical matters exist that would be of interest under sea levels two metres higher, this might be one of the few. Or, with Gardiner: there is a 'task of *bearing witness* to serious wrongs even when there is little hope of change'.[36] The militant reason for studying the history of the fossil economy has a meditative backup. Both boil down to, in the simplest possible terms, that one burning question: how did we end up in this predicament?

The Moment of Steam

So we return to the Industrial Revolution in the hope that it will divulge its reasons for welding growth to fossil fuels, the first of which was coal. But coal had been burnt in Britain for millennia. From the Bronze Age and the Roman occupation to the Middle Ages, fires of coal were appreciated for their intense heat, used, as we shall see, in the kindling of religious

ceremonies, the heating of homes, the cooking of food and the processing of some materials, notably iron in smitheries. Yet few would argue that the fossil economy emerged around the year 2000 BCE or 50 CE or in the thirteenth century. The union between self-sustaining growth and coal combustion existed at none of these times, because the former had yet to develop and the latter remained limited to heat generation. Britain had to wait for the Industrial Revolution to write out the growth formula *and* initiate a qualitative leap in the manner of coal consumption: the transformation of heat into motion, or the conversion of thermal into mechanical energy, by means of *the steam engine*.

In the first steam engines, coal was burnt in order to force a piston up and down in a vertical motion well suited for the pumping of water, but not much else. Another form of motion was called for: in the words of a mid-nineteenth-century treatise, 'of all sorts of motion, that which is most frequently required in the arts, is one of continued rotation. Mills in factories of every kind are impelled by machinery which receives its motion from a wheel.' It was the earth-shattering exploit of James Watt to connect the coal fire to the wheel. With the device he patented in 1784, Watt finally 'adapted the motion of the piston to produce *continuous circular motion*, and thereby made his engine applicable to all purposes of manufacture', as stated by another tract.[37] With this, the foundations of the fossil economy were laid down.

What could the rotative steam engine accomplish that the hearth and pump of old could not? Most obviously, it could impel a *machine*: the prime fulcrum of self-sustaining growth, increasing output per capita, raising the productivity of labour in a universal speedup that has yet to see its end. As a source of thermal energy, coal was useful for a range of processes requiring that input, but only as a source of mechanical – rotative – energy could it fuel the production of all sorts of commodities. 'Machinery is', explained the *Rees' Cyclopædia*, the most important compilation of technical knowledge in the early decades of the nineteenth century, 'the organs by which motion is altered in its velocity, its period, and direction, and thus adapted to any purpose'; once coal had been made to power it, the fuel could flow into the veins of an economy throbbing with expansion.[38] In this book, we shall study how the fossil fuel of coal was coupled to the machine through the rise of stationary steam power in the mills of Britain.

A rotative engine could also impel a *vehicle*, the second fulcrum of self-sustaining growth, likewise receiving motion from wheels, travelling across sea and land and transporting commodities – raw, finished – to and from

the mills. A sequel to this study entitled *Fossil Empire* will deal with mobile steam power on a global scale. Heat could work on materials with certain chemical properties; pumps could force up liquids. Machines and vehicles alone could fabricate and distribute the widest imaginable range of commodities; driving them with coal, the steam engine first made fossil fuels integral to growth across boundless expanses. Moreover, the combustion of coal in British cottages and smitheries never spurred *other* countries to adopt the fuel. Only the machine and the vehicle had the power to project the fossil economy out from the British Isles, through the pressures of economic competition and military invasion. A country flooded by commodities from steam-powered mills or attacked by the overwhelming force of steamboats would feel the whip of external necessity and perhaps seek to emulate the technology in order to save its industry or survive as a nation; as long as coal was primarily consumed within British households, distant communities had little reason to take notice.

The existence of coal seams in Britain – or indeed on any continent in the world – was evidently not a sufficient condition for the transition. The same goes for the rotative steam engine. Like strata in the rock, that artefact could not, as a mute physical thing, spark off something like a fossil economy by itself. The mere presence of the engine as certified in the legal rights of the inventor tells us nothing about the extent to which it was actually installed, its function in the economy or the propensity to emit carbon dioxide: the atmosphere does not feel the breath from a patent. History is stocked with inventions petrified into objects of exhibitions or fantasies in the style of da Vinci, and so the question of the steam engine is the question of *why it was adopted and diffused* – in Britain and, above all, in the cotton industry. There it supplanted the waterwheel. Before steam, the British cotton industry – the fast lane of the Industrial Revolution, in which self-sustaining growth first appeared – impelled its machines with water. So why did cotton capitalists turn from water to steam? By examining the causes of that original transition, we may come closer to an understanding of the mechanisms that launched, and perhaps still drive, the process now known as business-as-usual.

Seeing Power as Power

The word 'power' in the English language has a dual meaning: 'power' as in a force of nature, a current of energy, a measure of work; 'power' as in

a relation between humans, an authority, a structure of domination. The conjunction is not as close in other major European languages. 'Motive power' and 'absolute power' are 'fuerza motriz' and 'poder absoluto' in Spanish – no apparent connection there – while French distinguishes between 'énergie' and 'courant' on the natural side of things and 'puissance' and 'pouvoir' on the social, roughly equivalent to Kraft/Strom and Macht/Gewalt in German (hence Atomkraft but Weltmacht). Why have the two poles collapsed into one in English? An inquiry into such comparative European etymology is outside the scope of this study: we can only note the intriguing fact.

Do the two meet in reality? In spite of the semantic confluence in the Anglophone world, thermodynamic and social power are nearly always treated as 'distinct phenomena, a habit encouraged by the disciplinary structure of academic research', as observed in one recent attempt to bridge the gap.[39] Two authoritative works in the respective hemispheres exemplify the separation. In *Energy in Nature and Society: General Energetics of Complex Systems*, Vaclav Smil offers an exact definition of power as 'the rate of flow of energy', or 'W = J/s', where *J* is joule, *s* is second and *W* the unit of power: Watt from James.[40] Put differently, power is here understood as the rate at which work is done or energy transformed – and that is all there is to it, apparently, for in spite of the nominally transdisciplinary character of his work, Smil does not so much as notice that there is another meaning to the term, much less any actual movement between the two.

Turn to Steven Lukes's sociological classic *Power: A Radical View* and the other eye is shut. Here the overlap between 'horse power' and 'power struggles' is mentioned merely to indicate the terminological chaos surrounding 'power' in society: the nature of social power can only be distilled if cleansed of all associations with the mechanical phenomenon, in a first, essential act of analytical distinction.[41] In the dozens of dissections of the concept filling Lukes's pages, there is no hint at power being *at once* energetic and interpersonal, nor does he see any potential for plumbing the depths of social power by taking its mechanical base into account. The colloquial drift between the poles – reflexive, unnoticed and perfectly realistic – has its counterpart in a stern intellectual segregation. The English language might contain a basic truth from which scientific research has become estranged; in any case, it permits us to formulate a general hypothesis guiding the rest of this work: *the power derived from fossil fuels was dual in meaning and nature from the very start.* Steam as a form of superior power was just that. The two moments cannot be isolated

from each other, since they *constituted each other* in a unity, the opposites interpenetrating throughout.

It is proven beyond all reasonable doubt that global warming does not have natural causes. Solar radiation, volcanic outgassing, endogenous variations in the carbon cycle, and other similar suspects have been decisively cleared of responsibility for the rise in temperatures, the root causes firmly passed to the social side of the equation. Once we cross that line, we immediately encounter *power* – indeed, this happens as soon as we use the term 'fossil fuels'. They are, by definition, a materialisation of social relations.[42] No piece of coal or drop of oil has yet turned itself into fuel, and no humans have yet engaged in systematic large-scale extraction of either to satisfy subsistence needs: fossil fuels necessitate waged or forced labour – the power of some to direct the labour of others – as conditions of their very existence. If we take the message of climate science seriously, we should direct our attention to power in the dual sense, first of all in the process of labour. That is the point of contact between humans and the rest of nature, where biophysical resources pass into the circuits of social metabolism, where coal and oil and gas are extracted, transported, coupled to machines: burnt. The process is peopled. 'As a primary agent of energy and matter transformation through the labor process,' writes environmental historian Stefania Barca, 'workers are the primary interface between society and nature', wielding and subject to power.[43] *That* is the sphere where the fossil economy must have originated.

Neither environmental nor labour history has, for their own particular reasons, been very keen on connecting the dots of workers and the wider environment, class and climate. The same silence reigns in research on energy in the Industrial Revolution. Indeed, climate change as such remains primarily an object of natural science, recent spurts of interest in the social sciences notwithstanding. We are awash in data on the disastrous effects but comparatively poor on insights into the drivers.[44] Or, to paraphrase Marx: 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. Natural scientists have so far interpreted global warming as a phenomenon in nature; the point, however, is to trace its human origins. Only thus can we retain at least a hypothetical possibility of changing course.

CHAPTER 2

Scarcity, Progress, the Nature of the Human Species? Theories of the Rise of Steam

Steam as Response to Scarcity

Long before global warming crept up on modernity, a quick look sufficed to spot energy at the heart of the Industrial Revolution: in the rear-view mirror of historians, among the most conspicuous facets were novel ways of harnessing the powers of nature for the purposes of production. The doyen of modern research on the role of energy in the Industrial Revolution is E. A. Wrigley. In a pathbreaking article in 1962, he first broached ideas later developed into a grand narrative of the dynamics of change in eighteenth- and nineteenth-century Britain and, more generally, of economic growth.[1] In what he would come to call 'the organic economy', all forms of material production are based on the land: raw materials, thermal energy and motive force – human and animal bodies used to put things in motion – are drawn from the yield of present photosynthesis. That yield is restricted. There is no way to enlarge it beyond the constant supply of land. A growing organic economy will inevitably find itself trapped in fierce competition for scarce resources, making 'a permanent, radical increase of industrial raw material supply' – a necessary condition for self-sustaining growth – 'very difficult to obtain'.[2] Dependency on the land imposes a tight bottleneck on industrial production. Fossil fuels shatter that bottleneck.

Preindustrial Britain was an archetypal organic economy, where the farmers fetched whatever they needed from the land: food, fodder for

the animals – some sheared, some slaughtered, some employed as beasts of burden – furniture, building materials, originally even fuel for the fires: everything came from the fields and the forests. The spinners and weavers, tanners and dyers, sawyers and carpenters, smiths and cabinetmakers worked with fruits of one and the same earth, such as wool, flax, leather, hair, fur, straw, charcoal and, not the least important, wood itself. A growing sector could continue to grow only if it seized a larger slice of the pie from another. Within the tight energy budget of the organic economy, where all activities jostled for access to the same finite area of photosynthetic productivity, the process of growth could not possibly become universal or self-sustaining: sooner rather than later, it would peter out.

This idea Wrigley has borrowed, of course, from David Ricardo, to whom he gives ample credit. According to Ricardo, growth has to lay claim to more fertile land. As long as the economy is young and the country sparsely populated, this will present no problem, but at some point 'land of an inferior quality' will have to be called into cultivation: wetlands, steep slopes, fields in the mountains hitherto left untouched are scoured for more soil on which to expand. More products now have to be wrested from increasingly meagre land with greater inputs of labour. Nature turns from a giver to a taker: 'In proportion as she becomes niggardly in her gifts, she exacts a greater price for her work'; the prices of the foodstuffs extracted from her soil rise. Profits fall, accumulation sags; general descent into economic paralysis sets in, emanating from natural constraints: the stagnation will, Ricardo writes in a formulation repeatedly quoted by Wrigley, 'necessarily be rendered permanent *by the laws of nature, which have limited the productive powers of the land*'.[3] It is this chain of causation that Wrigley applies to the Industrial Revolution. It explains the turn to fossil fuels.

The new system – designated the 'inorganic' or 'mineral-based' economy by Wrigley – finally broke the spell of stagnation. When iron, pottery, bricks, glass, salt and other industries turned to coal, they bypassed the restricted surface area by digging into the stores of *past* photosynthesis, wholly new vistas of expansion opening up beneath the forest and the field. Further down the same subterranean road, cars, ships, trains, planes, all sorts of consumer and capital goods would be made out of fossil fuels, thanks to which a perpetually growing economy could fly past Ricardian constraints. In Wrigley's scheme of things, such constraints explain not merely the preference for fossil fuels, but also, and perhaps more importantly, the very conditions of self-sustaining growth. Only when British

terms: for capitalists to burn fossil fuels, there have to be other capitalists specialised in their production, and for the former to burn more, the latter have to deliver it in greater quantities, the two cycles ever intertwined. In the strict sense of a circuit, primitive accumulation of fossil capital is a *permanent foundation for the fossil economy.* As a *political* process, it has reiterated the ordinances of the Elizabethan leap in countless instances over the past two centuries: from the Arabian peninsula to the Ecuadorian rain forests, expanding extraction of fossil fuels has come about only through expropriation of the land and its riches, annihilation of resistant state structures and customary rights, dispossession of local inhabitants, expulsion into shantytowns – a history very much written 'in letters of blood and fire'.[126] Conditional upon the power of capital, the process cements it at every step, first and foremost by extending *exclusive capitalist control over nature.* If there is a faint trace of Ricardian-Malthusian dynamics in the Elizabethan leap, it disappears completely in the more recent iterations – as is well known, the history of petroleum has until very recently been one of overproduction – entirely different factors driving the rigs and drills into the soil. Shell did not go to the Niger Delta because the British population no longer could subsist on plants.

Capital does not eat because someone is hungry: *capital always eats.* The ecological voracity of this relation-in-process cannot be captured by a model of substitution and relief, precisely because it is not embedded within the natural limits of ecosystems. It operates on a higher level, above that of use-value, in the thin, abstract air of exchange-value, and just as it must pump out surplus labour in perpetuity, so it must pump out material substrata from the ground *whether or not they are scarce.* Capital is supra-ecological, one could say: a flying biophysical omnivore with its own peculiar social DNA. It is not a timeless growth pursuit bumping into walls of shortages and transcending them by moving on to abundant goods, not a universal process unfolding through reaction upon specific constraints. Rather, it is a *specific* process unfolding through a *universal* appropriation of biophysical resources, insatiable in its appetite, starting and ever continuing with energy.

CHAPTER 14

China as Chimney of the World: Fossil Capital Today

An Emissions Explosion

On 12 May 2014, the *New York Times* reported that 'a large section of the mighty West Antarctica ice sheet has begun falling apart and its continued melting now appears to be unstoppable.' That would mean at least three metres of sea level rise in the pipeline. The findings were published by two independent teams in *Geophysical Research Letters* and *Science*: the latest additions to an endless background noise of ringing tocsins. Glaciers running from inner West Antarctica towards the Amundsen Sea have hitherto been held back by ice shelves, functioning like plugs in a bathtub, but the warming oceans are transporting more and more heat towards the continent, melting the shelves and pulling the plugs. The balance of forces overturned, the tub is draining, the glaciers unhinging from the ground, no hills or ridges preventing them from sliding into the sea.[1] 'Today we present observational evidence that a large sector of the West Antarctic ice sheet has gone into irreversible retreat,' one of the lead authors said in a press conference called by NASA: 'It has passed the point of no return.' A couple of centuries would likely be necessary for all of it to reach its destination, but, the *New York Times* noted, even 1.2 metres would suffice to inundate land on which nearly 4 million Americans currently live. What is more, continued emissions of greenhouse gases would initiate the same processes on the even larger ice sheets of East Antarctica and Greenland. 'If we have indeed lit the fuse on West Antarctica, it's very hard to imagine

putting the fuse out,' commented Richard B. Alley, expert in the field – 'but there's a bunch more fuses, and there's a bunch more matches, and we have a decision now: Do we light those?'[2]

On the very same day, the *New York Times* reported that 'Canadian oil companies are proposing many new and expanded pipelines that would connect the oil sands fields with new markets in China and across the world.' Not beaten by the delays in the Keystone XL project, designed to transport oil from the tar sands region of Alberta through the United States all the way down to Houston, the companies were planning pipelines that would snake towards the Canadian coasts, both eastern and western, from whence oil could be ferried to combustion in, above all, China. Oil sands production would climb by more than a fourth in the next decade, even without Keystone XL. Several companies would double or triple their output. Not since the 1950s had so many pipeline projects been on the table. They faced diverse resistance – from First Nations, environmental activists, local communities worried about the spoiling of scenic views – but the vice president for oil sands at Shell Canada stated their compelling rationale: 'For us, for future investment, it's pipeline,' he told the *Times*. 'We want more capacity. Long term, we need to see access to global markets.' The government risked 'violent confrontations' if the most controversial projects were implemented, but the prospects for most of them, the *New York Times* concluded, 'appear bright'.[3]

Counting from 1751 to 2010, half of all CO_2 emissions from the combustion of fossil fuels occurred after 1986, in just twenty-five years, when one of the greatest research efforts in history produced the science of climate change.[4] The turn of the millennium marked another crossing. Widespread awareness of the catastrophic implications of global warming essentially belongs to the twenty-first century, and since the year 2000, the rate of growth in CO_2 emissions has been triple that of the 1990s. Not because of any climate policies, but due to the crash in capital accumulation, emissions shrank – a truly extraordinary event – by a little more than 1 percent in 2009, only to rebound in 2010 with a near 6 percent climb and then stabilise around the annual average of 3 percent. Exceeding the worst-case scenarios developed by the IPCC, that novel clip of business-as-usual puts the world on track to a rise in temperatures of 4 degrees by 2060, far beyond the level to which humans can be expected to adapt with any reasonable sense of civilisation intact.[5] Things are out of hand. We may legitimately speak of a post-2000 *emissions explosion*. A theory of fossil capital should have something to say about it.

Two basic facts about the explosion immediately strike the eye. First, it has been centred on a single country: the People's Republic of China. Between 2000 and 2006, 55 percent of the global growth of CO_2 emissions happened there; by 2007, the figure stood at *two-thirds*. In 2004, China became the world's largest extractor of fossil fuels; two years later, it eclipsed the US as the top emitter.[6] Second, the explosion appears to stand in some relation to globalisation. From the early 1980s up to 2008, world trade grew by 8 percent per year – markedly faster than output – but the true novelty lay in booming foreign direct investment (FDI): from the 1980s onwards, FDI flows increased faster than cross-border trade; from 1990 to 2009, they quintupled, reaching a peak before plummeting during the financial crisis and then rebounding. As it happened, this tendency was also centred on China. The main destination for FDIs, the country's inflow in 2008 was nearly twice those of Russia and India combined; two years later, China deposed Germany as the top exporter of manufactured goods.[7] Beyond those well-known figures, what has been going on here? What combustible mix of China and globalisation has set off the emissions explosion, whose power to light a whole bunch of fuses on earth seems little short of overwhelming?

An Explosion for Export

The baseline of the bourgeois ideology known as eco-modernism is a belief in more affluence as the remedy to ecological woes: if only people were modern, high-tech and sophisticated enough, there wouldn't be so much pollution around. More precisely, countries follow the environmental Kuznets curve (EKC). Poor and underdeveloped, they leave little imprint on the environment; as their incomes begin to grow, so do their impacts – but only up to a turning point, after which increasing wealth *reduces* environmental degradation, pushing it back towards the point of departure. Having passaged from neutral agriculture and dirty industry to clean services, the most advanced economies end up with populations prosperous enough to care about their surroundings, efficient technologies, responsible institutions: all that is needed to tread lighter on earth. Others ought to travel that royal road. The best way to open it is to promote globalisation – or so runs the argument in force since the early 1990s, when the idea of the EKC emerged in debates over NAFTA and economist Wilfred Beckerman summed up its political traction: 'There is clear

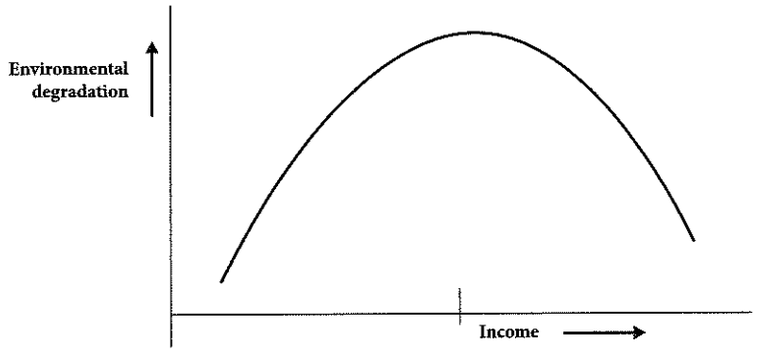

Figure 14.1. The environmental Kuznets curve.

evidence that, although economic growth usually leads to environmental deterioration in the early stages of the process, in the end the best – and probably only – way to attain a decent environment in most countries *is to become rich*.'[8]

Now, decades of research have produced scant evidence for the existence of any EKC in perceptible reality. As for carbon dioxide, there is one variable that seems to follow the curve: the *intensity* of pollution, or the amount of CO_2 released *per unit of production*. But what counts for climate is, of course, *total* emissions, and for that critical measure, there is no downward turn, only a secular rise with income.[9] (Yet intensity might be a central variable in the emissions explosion, and so we shall return to it below.) Moreover, the EKC can be faulted for overlooking precisely the globalised nature of the world economy. The carbon footprint of a smart, tech-savvy, happy-go-lucky art director is not a function of what he produces, but of what he *consumes*, much of which will be imported from other nations still doing the dirty work of manufacturing. There are absolutely no indications that people at the right end of the income axis cease to purchase laptops, smartphones, shoes, jeans, cars and long-haul flights and revert to hermitic asceticism. To the contrary, the ecological burden of their existence grows without fail – only it is being off-loaded to distant producers, to which it then *seems* to belong.[10] The lightness of the MacBook Air crowd is an illusion grounded in myopia.

In the case of CO_2, most emissions associated with a commodity originate in the process of production, not final consumption: a Swede does not emit CO_2 by wearing a T-shirt from Bangladesh. It has already been emitted from the factory where the T-shirt was sewn and the power plant

providing the electricity by the builders and machine-makers and those further back in the supply chain, forming a sequence of emissions – an invisible legacy of the burnt accessories – *embodied* in the commodity. The actual volumes of CO_2 caused by the importing consumers may thus stretch far beyond the borders of their homeland. Indeed, the tendency of late has been for more CO_2 to be discharged in the production of commodities ultimately consumed in a different country: in 1990, 20 percent of all emissions; by 2008, the share had grown to 26 percent.[11] Official statistics, on whose basis climate negotiations are conducted, still allocate emissions to the territorial states where the smoke actually leaves the ground. But why should Bangladesh be held accountable for CO_2 released for the benefit of Swedish T-shirt wearers? Catching up with the growth of 'emissions embodied in trade' (EET), a rising chorus of researchers, activists and politicians from certain countries advocate a reallocation of responsibility, a shift from production-based to consumption-based accounting, which would provide a more realistic picture of '*how* and *why* human actions affect CO_2 emissions'.[12] In plainer language: do not let the well-off Westerners get off that cheaply.

Again, China is at the centre of both the phenomenon of EET and the ensuing pointing of fingers. In the period 1990–2008, fully 75 percent of the growth in emissions imported to Annex B – the developed countries with obligations under the Kyoto protocol – emanated from the People's Republic. In 2001, China entered the WTO, dismantled the remaining barriers to investment, abolished restrictions on foreign ownership, relaxed requirements on local cooperation and, in general, flung the gates wide open: then the real explosion began. While a third of the increase in Chinese CO_2 between 1990 and 2002 could be directly attributed to export, the share rose to *half* in the following three years; moreover, according to one estimate, as much as 48 percent of the country's *total* emissions between 2002 and 2008 were generated in the export sphere.[13] Here was the main source of the plume of smoke shooting up from Chinese territory. Other drivers were comparatively puny: for the years 2002–5, population growth and 'changing lifestyles' contributed 2 percent and 1 percent of the emissions growth respectively, government expenditure and household consumption 7 percent each, in contrast to the roughly 50 percent of export production.[14] No other part of the early twenty-first-century Chinese economy came close to the eruptive dynamism of this sector, and then its indirect stimuli on infrastructure and consumption are not even counted.

The mountains of Chinese commodities mostly ended up in developed nations. While China was the main exporter, the US was the main importer of embodied emissions, swallowing ever-greater volumes, net imports increasing by 250 percent from 1997 to 2007. For the EU, the corresponding figure was 154 percent.[15] Some countries in Western Europe like to believe that they have climbed the summit of the EKC and entered the descending slope, but that self-image is based on production-based deception, for imports have been rising higher and faster. In terminology stemming from debates over the Kyoto protocol, such displacement of emissions is known as 'carbon leakage': at an early stage of climate negotiations, fears arose that if only some countries – those in Annex B – would be covered by mandatory reductions, dirty activities would simply move out. A car manufacturer seeking to emit unlimited amounts of CO_2 could relocate to an unfettered country outside Annex B, such as China; a country wishing to reduce its emissions could import products instead of producing them.

But no carbon leakage of that kind has in fact occurred. No mass flight from Annex B countries could possibly have been triggered by draconian emissions cuts, for no such cuts have been implemented. A distinction is therefore made between 'strong' and 'weak' carbon leakage. The strong variety is the – so far hypothetical – departure of production activities *caused by* stringent climate policies. The weak is the phenomenon of them leaving *for some other unspecified reason.* Here mainstream research into EET suddenly halts. One team notes that 'the likely cause of the large emission transfers we report here are pre-existing policies and socioeconomic factors that are unrelated to climate policy itself,' but stops short of asking the next natural question: then *what are* these causes?[16] If car manufacturers do not move their factories to China to escape climate change mitigation, *why do they do it?* For all its merits, EET research has not been able to identify the causal drivers at work; precisely when it comes to explaining '*how* and *why* human actions affect CO_2 emissions', it limits its field of vision.

There is another, related trouble with the framework. Negating the EKC, it tends to jettison the moment of production and lay all its emphasis on consumption. Thus we may read that the proportion of emissions stemming from exports 'is large and significant, which demonstrates China's position in international trade as a "world factory". Those who *consume* the goods made in China should also share the responsibility.'[17] Now contemplate that statement. China is a world factory, emitting a lot of CO_2, and those who *consume* the goods should assume responsibility for them. Is not someone missing from the picture here? What emerges from the consumption-based accounting approach is a view of the Western consumer as an absolute sovereign who sends CO_2 packing to other parts of the world, presumably by standing in front of shelves and picking cheap Chinese commodities rather than expensive domestic ones, the owners of the means of production being neutral, passive, out of sight.

When consumption is treated as a generic Western activity, the argument has the potential to go seriously astray. Studying the embodied emissions in US–Chinese trade, one group of researchers argues that 'workers making goods in the developed world enjoy comparatively lavish lifestyles versus their counterparts in the developing world, a lifestyle which in many cases *induces substantial environmental impact.*' Chinese emissions are 'dominated by the manufacturing of products consumed *by workers*'.[18] Making up the majority of American consumers, they – the workers – should assume responsibility, and this is indeed implicit in much of the research in the field: CO_2 from China falls on the shoulders of ordinary people in the West. No differentiation is made between rich consumers and others – in a premise about as unrealistic as the original EKC curve – and while it is of course undeniable that workers in advanced economies benefit from cheap Chinese commodities bought at Walmart, Tesco or Ikea, putting the blame on them is not very convincing as a science of *why emissions have relocated to China.* American or other Western workers never made the decision to outsource manufacturing. In fact, if there is anyone who has ever resisted such moves, it is they. Neither the EKC nor its standard negation can make sense of the nexus of emissions and globalisation as it has materialised in China. A negation of the negation might do the job better.

Globalised Fossil Capital

The theory of fossil capital outlined above suggests that the stock is the general lever for surplus-value production. On its basis, we may propose a simple hypothesis for the era of globalised production. *Globally mobile capital will relocate factories to situations where labour power is cheap and disciplined – where the rate of surplus-value promises to be largest – by means of new rounds of massive consumption of fossil energy.* The transition is by now a distant memory; it is all a matter of pursuing the spiral.

What do we mean by 'globally mobile capital'? We mean, first of all, industrial capital free to invest across national borders and capable of carrying production technology to the new locations. Capital from source country A is globally mobile if it may construct factories (greenfield investment) or buy companies (mergers and acquisitions) in host country B, and if it can bring machines, technical expertise, management principles and other key assets from A to B – and, of course, if B is flanked by a range of other, similarly available host countries. As the world economy has developed since the 1970s, these conditions have been progressively realised. They imply that capital can transcend borders with roughly constant levels of productivity – or, put differently, the productivity of a transnational corporation (TNC) is a firm-specific asset, something it owns and can insert into the host country regardless of the average levels of productivity attained there.[19] But this only holds – and as we shall see, the distinction is crucial – for immediate production technology, while not for *infrastructure*.

Mobility of this kind represents a foray deep into abstract space: on a quest for optimal profitability, capital roams the earth more freely than ever before. Labour, on the other hand, remains relatively place-bound. Since it is tied to living human beings, with their own neighbourhoods, dialects, memories, families, habits, friends and bars and political parties and innumerable other life components, the commodity of wage labour cannot become mobile like capital (even if there were no pass controls and walls obstructing migration). As time goes by – as capitalist development unfolds in history – workers develop distinctive features anchored to their places of habitation. In one locality, they build up powerful unions enabling them to push up wages, while in another they remain barely organised; some are highly educated, while others have only basic schooling; some are prone to political militancy while others are under the sway of preachers of patience. Wages, skills, manageability and other properties of labour power vary in space: the inextinguishable autonomy of workers gives rise to a rugged, uneven, never fully stabilised geography of class relations. It follows that 'mobility is not a luxury for capital, but a necessity,' in the words of Storper and Walker. Because working-class communities are 'not as plastic, or are less geographically mobile than capital, labour forces must be sought out, fought with and, on occasion, abandoned by industry in its ceaseless process of evolution and restructuring.'[20] On this view, the production of abstract space is not a capitalist monologue but a way of staying one step ahead in the class relation, bolstering

the freedom to evade, approach and parry labour from an outer rim of circulation.

When capital has secured its liberty to prowl the globe with portable productivity, it chooses between potential host countries on the basis of *their* specific assets. One profoundly nation-specific endowment is precisely labour power: as capital moves around, it will attach great weight to the national characteristics of the labour supply. It will look for cheap labour: places where labourers are easily procured. It will look for workers amenable to discipline, accustomed to high labour intensity and long working days: a population trained to industrious habits. A favourable combination of these factors will sustain a high rate of surplus-value and ceteris paribus entice TNCs to invest; conversely, if labourers become dearer and more rebellious, TNCs will *move out* of such places. The simplest indicators of high rates of surplus-value are low labour costs, commonly and roughly translated into low incomes, and hence it follows that industrial production will *tend* to move from nations with higher average incomes to those with lower ones – not in a complete evacuation from the former, but in a process of relative relocation.[21]

But things are not, of course, that simple. Features of labour power are an independent determinant of FDI flows, but far from the only one. A TNC might, for instance, wish to position itself in the midst of a market, serving customers face-to-face in order to better adapt products to their tastes, inflate the value of a brand or excel competitors in some other way: here it is the consumers of the country, not the workers, who attract investment. But if the TNCs *export* their products from the host country, we have reason to suspect that it is the workers – not the consumers – who have enticed them to set up shop there. Labour might figure in a market-oriented strategy as well – a country offering both moneyed consumers and inexpensive workers is a particularly good choice for production in situ – and foreign affiliates may switch between selling to local and external outlets, but as a general rule, export-oriented FDIs are more strongly determined by the attributes of labour power.[22]

In the abstract space of a globalised economy, customers can be served from practically anywhere; sites of production can be dissociated from sites of consumption; capital may pick and choose between export platforms – and the lever by which it reaches and exploits labour is fossil energy. More precisely, there are three moments by which enhanced mobility draws on the stock. A necessary condition for labour power to be cheap and disciplined is, to begin with, the presence of a reserve army

of labour: full employment dilutes both qualities. From the classic case of Britain, we may surmise that the best place to find a sizable reserve army is an economy in the throes of the passage from agriculture to industry; a whole new labouring population will be released for procurement, as ex-farmers leave their villages en masse and congregate in towns. But a country experiencing this passage also, in all likelihood, undergoes the transition to a *fossil* economy. To the extent that inflowing capital expedites this process, it extends business-as-usual to places where it did not exist before, other than in undeveloped forms: an *expansion* of the fossil economy accompanies the relocation of production. CO_2 will be exhumed from the chimneys of foreign-owned factories – perhaps in surroundings that until recently were rural, even pristine – but more importantly, the arrival of foreign capital will stimulate enlargement of the *infrastructure* of the host country.

No capital would flow to a place where it would have to establish all infrastructure from scratch. After all, the physical presence of propertyless workers can never be a sufficient condition for attracting investment; rather, they will only be de facto accessible for surplus-value extraction if a basic infrastructure is in place prior to arrival – first and foremost, power plants and electricity grids capable of delivering the indispensable *energy*. Cheap and disciplined workers in the darkness and standstill of constant outages would not be of great value. The TNCs must be able to rely on an energy substratum upheld by the host country's state apparatus and count on its capacity to absorb more inflows.[23] Conversely, an item high on the agenda for states wanting to attract FDI – and in the globalised economy, that is the holy grail of development – is construction of infrastructure, and so we should expect a positive feedback loop: operational plants and grids, mines and wires are prerequisites for TNCs to invest; their arrival will encourage further enlargement, which will in turn draw more FDI, and so on. We may identify this moment of the dynamics as *the expansion effect.*

A second moment concerns emissions intensity. In general – and this is the consolation prize for the EKC believers – wealthy nations do have lower carbon intensity than poor ones: more CO_2 is emitted in the production of one T-shirt in Bangladesh than if the same T-shirt were to be produced in Sweden. Between the early 1970s and the early 1980s, a curve really did appear for developed countries, their continuing ascent towards ever greater affluence coevolving with a decline in carbon intensity – that is, a decline in CO_2 emissions per *unit* of production, not in

total amount of emissions.[24] At the end of the day, such 'progress' is of little importance, but now consider a capitalist who is about to reinvest his profit and expand the scale of production. Suppose that he can choose between two countries to invest in: his homeland A and a potential host country B. Suppose, further, that the carbon intensity of production is twice as high in B. We can easily see, then, that if he bets on B, total CO_2 emissions from his expanded business will be twice as high as if he stayed at home: the increase in scale will be compounded by a jump in carbon intensity. If this simple example is stretched out temporally, we may add the assumption that carbon intensity declines simultaneously and equally in both countries, with the gap between the two unchanged; even so, a move from A to B would push up the intensity of production relative to a scenario of staying put. In these cases, the expansionary logic of capital accumulation would not only trump the decline in carbon intensity, as in Jevons's paradox, but rather be realised *through a concomitant relative rise in carbon intensity* – and needless to say, that would be all the worse for the CO_2 concentration in the atmosphere.

There are some intuitively appealing reasons for why carbon intensity should be lower in high-income than in low-income countries. The former will likely possess the most advanced and efficient technologies for power generation and transport; propped up by well-endowed governments, relying on high wages for tax revenues, their infrastructure will generate low amounts of CO_2 per unit of electricity supplied or good delivered. In developing nations, infrastructure will indeed be less sophisticated. Power plants will use suboptimal equipment and the cheapest available fuel. The scramble to expand infrastructure to keep pace with development will induce governments to set considerations other than costs aside; indeed, inward FDI may incite them to embark on crash programmes for augmenting capacity for power generation, with whatever equipment is at hand and the least expensive fuel mix.[25] While TNCs carry along their firm-specific production technologies, they have no choice – and no other interest – but to utilise the infrastructure on offer: here, they will take what they find. Hence there emerges an environmental Kuznets curve *in reverse.*

If we insert the premise of globally mobile capital into the EKC – vastly enhancing its realism – we are led to the prediction that, when a turning point in income levels has been reached, capital will move *back to countries near the peak of carbon intensity.* It will not move to the poorest countries, for there the infrastructure will be inadequate. Neither will it stay in the

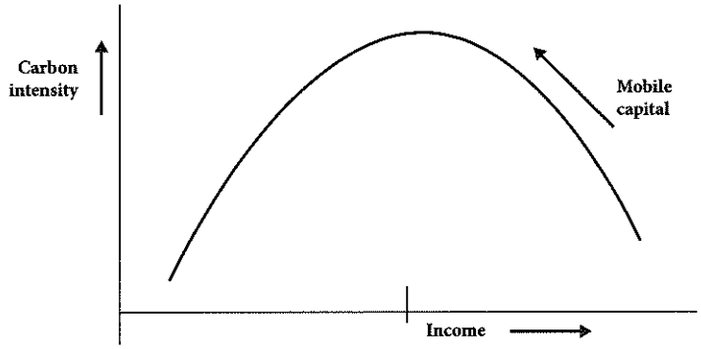

Figure 14.2. The environmental Kuznets curve in reverse.

richest, most carbon-efficient countries, for there rates of surplus-value will be low: instead, it will hover around the apex of the curve, *increasing carbon intensity through relocation.* If high incomes and low carbon intensity form a single package, as they seem to do, and if low incomes and high carbon intensity are their mirror compound, then a rise in incomes – equivalent to a rise in wages – will, given that capital is globally mobile, cause a shift of industrial production to more carbon-intensive countries – not because capital desires such intensity for its own sake, but because it is thrown into the bargain when it scours the globe for maximum surplus-value. We may call this second moment *the intensity effect.*

Thirdly, energy infrastructure is, again, not a sufficient condition for realising the promise of inexpensive, submissive workers. If they are disconnected from major arteries of transport, the commodities will not reach the world market smoothly and perhaps not at all, making their labour power, for all pecuniary purposes, worthless. There have to be rails, highways, containers, warehouses, ports; likewise airports to ferry raw materials, components, finished goods, managers, CEOs between affiliates, markets, factories and headquarters. Since modern transport systems are almost completely reliant on oil, globalised production will translate into larger emissions of CO_2 in this sphere as well: the more fragmented and integrated the circuits, the more extended and dispersed the supply chains, the more petroleum will be burnt on the road, on the sea, in the air. As in the expansion effect, the TNCs will balk at constructing the requisite transport infrastructure and look to the state to ensure it, and needless to say, this imperative will be particularly compelling when the corporations *export* commodities from the host country.[26] This third moment might thus be designated *the integration effect.*

Combining the three moments – expansion, intensity, integration – we arrive at a more precise version of our hypothesis. Here are the dynamics through which globally mobile capital will speed up the consumption of fossil energy *through* its perpetual drive to maximise surplus-value. The environmental Kuznets curve in reverse might stand as a general metaphor: since conditions for accessing cheap and disciplined labour power tend to be bound up with expanding business-as-usual, comparatively high carbon intensity and increased transport, capital will shoot its arrows upwards and backwards, towards the summit of degradation. While not, of course, covering *all* emissions growth, we have here a key to the explosion.

The Chimney of the Workshop

Globalisation is no longer driven primarily by trade. In 2011, the Vale Columbia Center, a leading FDI research institution, declared that 'international investment has become roughly twice as important as trade in delivering goods and services across frontiers.'[27] By the time the financial crisis struck, 'emerging markets' had decisively surpassed developed countries as receivers of FDI; among them, China outshone all others. Where did the capital come from? The circulation of FDI money through Hong Kong and various tax havens – notably the Virgin and Cayman Islands – before touching down on the Chinese mainland made it notoriously difficult to pin down its origins, but a trend manifested itself after the WTO entry: while neighbouring Asian countries had been the preeminent provenances of FDI in the 1990s, flows from the US and the EU now took off. China became the home for factories relocated from all over the globe; according to one study of the years 2001–4, the US was the number one country of origin for immigrating industry, followed by the EU, Japan, Taiwan, the Philippines, Canada, Singapore and Mexico.[28] For the first eleven months of 2010 – when the tax havens had largely succumbed to the effects of the financial crisis – the Chinese Ministry of Commerce reported the following list of top ten FDI sources: Hong Kong, Taiwan, Singapore, Japan, the US, South Korea, the UK, France, Holland and Germany. Industrial capital settling on Chinese soil had a propensity to *export.* Over the years 1998–2005, 19 percent of domestic manufacturing firms were exporters, as against 63 percent of foreign affiliates.[29]

The secret behind this surge in foreign-financed, export-oriented production was never very well kept. In October 2004, *The Economist*

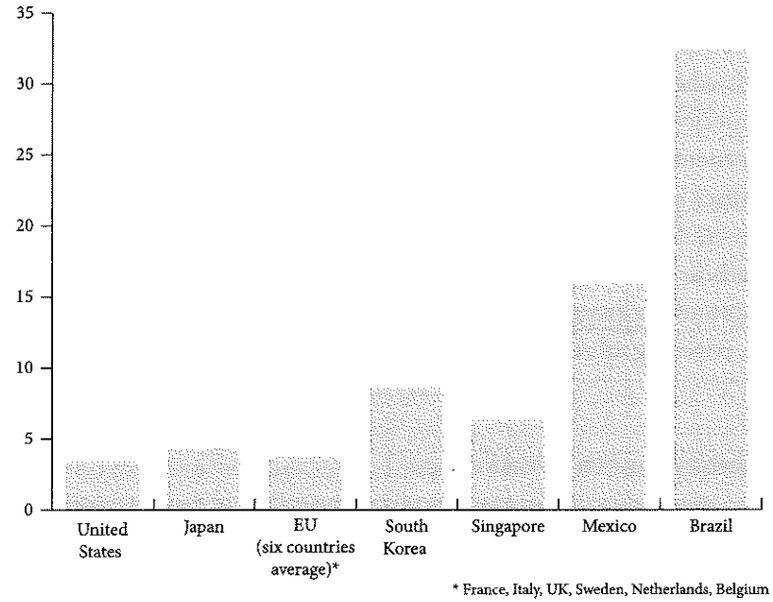

Figure 14.3. Chinese manufacturing wages: average in 2002 as a percentage of the average in selected countries.[30]

affirmed that the ascent of the People's Republic was safeguarded by its 'almost unlimited supply of cheap labour. By some estimates, there are almost 200m under-employed workers in rural areas that could move into industry. This surplus labour may take at least two decades to absorb, helping to hold down wages for low-skilled workers.'[31] Figure 14.3 shows how Chinese manufacturing wages compared to those of some other countries in 2002.

As predicted, the relative wages barely rose at all during the first decade of the century, the cost of labour power remaining a trifle of that in developed countries: in 2008, hourly labour compensation costs in China were 5 percent of those in Japan, 4 percent in the US, 3 percent in the eurozone.[32] It was an immensely powerful magnet. One 2006 survey asserted that 'low-cost skilled labor has long been regarded as China's most important advantage in attracting foreign companies to make goods in China'; furthermore, 'Chinese workers are not only cheap, but diligent, motivated to improve, and good with their hands.' In the words of another study, employers in the early twenty-first century became 'accustomed to having a seemingly unlimited supply of very cheap labor, and being able to insist on certain qualities in their workers', such as 'a compliant and flexible

personality, and the willingness to work very long hours'.[33] Easy to procure, trained to industrious habits.

The force that weighed down on Chinese workers and imposed on them these characteristics was, at the bottom, as explicated by *The Economist*, the gargantuan reserve army of labour. Bent on fast-tracking industrialisation, the post-Maoist state released – to interpret it benevolently – hundreds of millions of young farmers from the countryside into the cities. But the 'floating population' retained one foot in the villages, falling back upon traditional sources of income in need, reducing the reproduction costs of labour power; inside the cities, meanwhile, attempts at independent union organisation were nipped in the bud, the working class subdued and delivered to foreign investors.[34] The Chinese export miracle would not have come about without their presence. In the 1980s, foreign-invested enterprises (FIEs) – that is, either joint ventures or wholly foreign-owned companies – produced a meagre 0.1 percent of the goods exported from China. In 2001, the share exceeded 50 percent for the first time, and it stayed above that mark throughout the decade.[35]

Other methodologies produce even higher figures: foreign affiliates might have accounted for more than 70 percent of total Chinese exports in 2005.[36] From 1990 to 2008, China's industrial output increased by a factor of 26; that of FIEs by a factor of 332. Here was the impellent of capital accumulation in the People's Republic, running on high and rising profits,

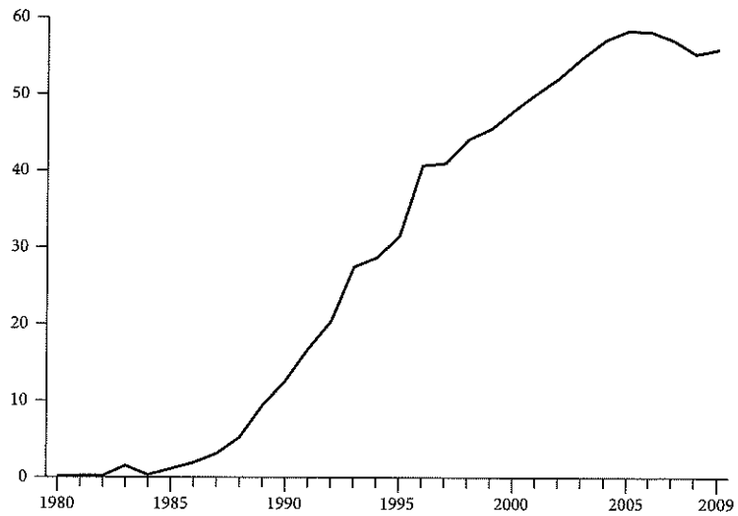

Figure 14.4. Share of foreign-invested companies in exports from China (percentage), 1980–2009.[37]

outshining domestically owned companies in technical prowess as well as in revenues. On the basis of figures similar to the above, *The Economist* argued that the export growth 'has more to do with foreign firms relocating their production to China than with Chinese businesses undercutting other producers'.[38] The conclusion can be extended straight to the atmospheric legacy, inverting the causation implied by the consumption-based approach: the main agents behind EET were not consumers in the West, but *owners of firms relocating their activities*. Decisions on boards of directors preceded and shaped those in front of shelves. Cheap and disciplined labour power was not, of course, the sole attractor in China; the huge domestic market had its own distinctive allure – but for capital moving to China and *exporting* its commodities, the characteristics of labour power must have exerted the stronger pull. Given the role of FIEs in Chinese exports, and that of exports in Chinese emissions, we may thus infer that the quest for maximum surplus-value was indeed a paramount mechanism for igniting the explosion.

More concretely, the three effects – expansion, intensity, integration – appear to have been in full swing. There was a spike in fossil fuel burning after accession to the WTO. Of all the massive growth in Chinese energy consumption between 1987 and 2007, over half occurred in just the final five years, with industry the most voracious sector by far. Having lost some appetite in the last three years of the 1990s, the volumes it took swelled again at the turn of the millennium; accounting for more than two-thirds of total final energy consumption, it was a powerhouse in all senses of the term. The relative contribution of households to energy use *declined*, the absolute magnitude of residential energy *stayed level* between 1987 and 2008 – in spite of a 20 percent increase in population – but then people have never propelled the fossil economy. Agriculture, construction, commerce and other services reduced the role of coal in their fuel mixes, so that in 2002, industry absorbed more than 90 percent of all coal consumed in the Republic, three-fourths of it burnt *in the generation of power and heat*. Coal → electricity → manufacturing of commodities for export – such was the sequence at the centre of the explosion.[39] For all the talk of industry having become *less* central to capitalist development, in this case, whose planetary significance is hard to overstate, it weighed heavier than ever. (In fact, an authoritative study suggests the same trends on a global scale: power generation and industry dominate total CO_2 emissions and drive them ever higher, putting buildings entirely in the shade.[41] Mills, not cottages, pour petrol on the fire.)

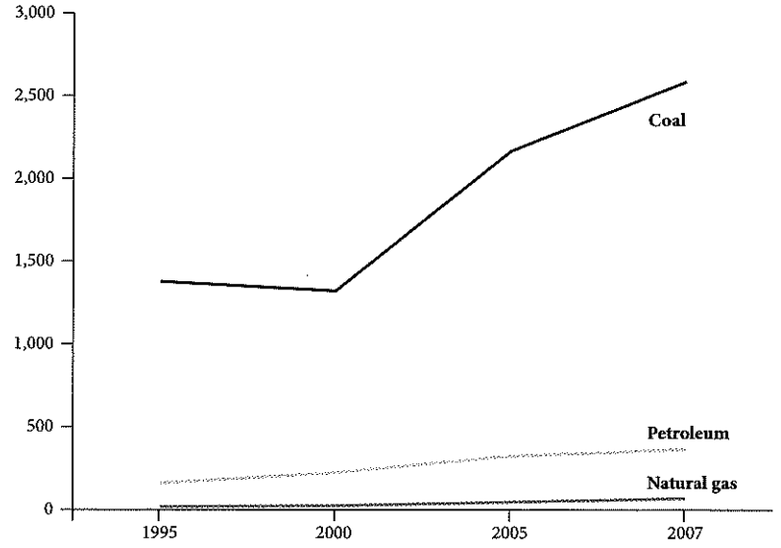

Figure 14.5. Fossil energy consumption in China, 1995–2007. Coal: million tons. Petroleum: million tons. Natural gas: billion cubic meters.[40]

The spike coincided with the coming to fruition of governmental plans to attract foreign capital. Banking on FDI as the recipe for national development in the 1990s, Beijing resolved to expand energy infrastructure to cater to incomers, ratcheting up the efforts as WTO accession approached. A reminder of the needs came in 2002, when a shortage of oil, electricity and even coal struck the nation. To secure a supply capable of keeping up with expanding industry, the government now further deregulated the coal market, allowing a thousand mines of all sizes and efficiencies to bloom and, not the least importantly, undertaking its own investments in transmission lines from inland power plants, railways and highways to the FDI-dense, bloated cities on the coast. More than 80 percent of all coal burnt in China in the first decade of the millennium originated from the two northern provinces of Inner Mongolia and Shanxi, often travelling two or three thousand kilometres – distances as long as from Paris to Moscow or Cairo to Casablanca, though without crossing international borders – before being piled up inside the magazines of labour power.[42] Chimneys rose to the sky on the foundation of the mobile stock. Until recently a negligible fishing hamlet, Shenzhen became the boomtown of the FDI-export miracle, literally sprouting smokestacks, exhaust pipes and cement buildings where none had existed, posting 14 million inhabitants in 2008; the twin town of Dongguan likewise rose from the backwaters

into a conurbation brimming with factories, migrant workers and clouds of CO_2 arising from their combination. It was Lancashire redux, on an unheard-of scale.

But not even the seams of China were enough to feed its bulging industries. The Republic became a net importer of coal in 2007, spurring massive expansion of mines in Australia, Mongolia, the US and a host of other countries; in the first half of 2009, most of the coal imported to the industrial hothouse of Guangdong – the province home to both Shenzhen and Dongguan – came from Vietnam.[43] An oft-noted feature of the early twenty-first century, China's hunt for energy sources extended to the four corners of the world, including, for instance, the oil fields of Angola, where Beijing – honing its skill at producing fossil-abstract space – constructed an entire port city. Alongside the black stone, the Republic thus became progressively more dependent on the black gold. By 2002, only the US consumed more oil; by 2007, more than half of the oil consumed in China was imported, a share projected to reach 77 percent in 2020.[44] Rarely if ever has the formula of placing 'the power amongst the people, wherever it was most wanted' been implemented on such a scale.

The state apparatus of the People's Republic accomplished its mission. In 2010, its Investment Promotion Agency could boast:

> In recent years, the construction of Chinese infrastructure has been improved greatly. The infrastructure in transportation, communication, and the supply of water, electricity and natural gas is almost complete. The ability of supply and quality of energies, raw materials and components has been improved obviously, which provides foreign investors with excellent external conditions in production and operation … The bottleneck effect of infrastructure construction in hardware on the economic development, such as transportation, communication and energies, has been eliminated almost.[45]

Had the state not done its work so dutifully, FIEs would not have arrived in such numbers – and conversely, without the stimulus of FIEs, the imperative to expand infrastructure would have been nowhere as strong. The expansion effect roared through China.

As for the intensity effect, approximately 18 percent of growth in atmospheric CO_2 concentration between 2000 and 2006 stemmed from the 'increasing carbon intensity of the global economy' – increasing, or

deteriorating, by an annual average of 0.3 percent.[46] The homeland of the trend was, of course, China, its already high carbon intensity rising further and hosting a constantly swelling portion of the world's manufacturing. Of the three fossil fuels, coal is the dirtiest, most productive of CO_2; a power plant running on coal emits roughly twice as much per Watt as one fuelled by gas – and in 2003, coal accounted for 97 percent of all fossil-fired power in the People's Republic. There were good reasons to choose coal before the slightly less nasty alternatives. The Republic was rich in coal, poor in oil and lacking in gas; more of the black stone could swiftly be extracted by workers in the mines; its cost stood at a sixth of that of oil. Coal dominance is a major determinant of high carbon intensity, and to make matters worse, levels of efficiency in China's coal plants were spectacularly poor: among the fourteen countries responsible for 65 percent of global power generation in 2003, only India came out worse.[47] When manufacturing relocated to the People's Republic in the early twenty-first century, it was plugged into a relatively satisfactory energy supply, predominantly based on coal, transformed into electricity by highly inefficient technologies. Just as we would expect, wages and carbon intensity were inversely related: compare Figure 14.3 to 14.6.

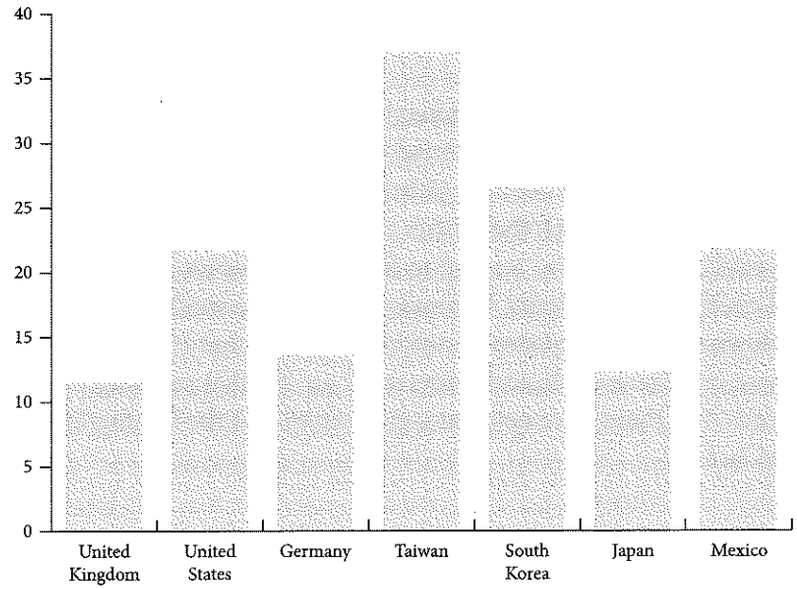

Figure 14.6. Carbon intensity of selected countries as a percentage of China's carbon intensity, 2001–08. National averages for the period.[48]

China had, relatively speaking, low wages and high carbon intensity, certain other countries had high wages and low carbon intensity, and *capital flowed from the latter to the former.* It moved back along the curve towards higher rates of surplus-value *and* higher levels of emissions per unit produced. If all the industry removed to China by, say, 2008 had stayed in the US, South Korea, Japan, Taiwan, Germany – not to speak of concentrated in an extremely carbon-efficient country such as Sweden – things would have looked very different indeed.

Beijing launched a colossal enlargement of transport infrastructure in the 1990s to pave the way for FDIs, most conspicuously along the southeastern littoral, the traditional gateway for incoming capital now rejuvenated with container terminals, port systems, highways, inter-metropolitan networks for commuting businessmen and other nodes sunk into global circuits. While all coastal cities waved the same basic bait – cheap and disciplined labour power from the inland – they sought to outmatch each other in transport facilities, explicitly conceived to lure footloose investors. The shipping of goods from China left growing traces of CO_2 in the sky; for every insertion of export-oriented production, the distances to be travelled were stretched out, emissions per product rising. In the year 2000, inputs – raw materials, parts and components – accounted for a stunning 85 percent of global CO_2 emitted in the cross-border transport of commodities, final goods only taking the remaining 15 percent. Such emissions from within globalised production chains gravitated heavily towards China.[49]

If Manchester was the 'chimney of the world' in the 1840s, the People's Republic of China assumed that position in the early twenty-first century primarily because *globally mobile capital seized upon it as its workshop.* Or, to reach the centres of populous towns, where labourers were easily procured and trained to industrious habits, capital deployed fossil energy in ever greater volumes, pursuing the modus operandi first laid down by the rise of steam: not in its entirety but in its essence, the Chinese emissions explosion represented an epochal carrying of power to hands. But there were never any guarantees that the bonfire of profits would last.

Capitalists Consider Leaving China

On 28 May 2010, the *New York Times* opened a dispatch with the following words: 'After years of being pushed to work twelve-hour days, six days a week on monotonous low-wage assembly line tasks, China's workers are starting to push back.' Eleven days earlier, at a Honda gearbox factory in the Guangdong city of Foshan, two workers had pressed a red button for shutting down the machinery in the event of quality problems. The turnout soon involved the entire workforce of 1,800 and spread to other plants supplying components to the Japanese auto giant, forcing it to halt all production in the People's Republic; in Zhongshan, the strikers added the demand of free trade unions to higher wages and better working conditions and 'developed a sophisticated, democratic organization, in effect electing shop stewards to represent them', the *New York Times* reported, apprehension mixed with admiration.[50] Within another few weeks, the wave had engulfed unprecedented numbers of foreign affiliates: a sewing machine factory belonging to the Japanese Brother Industries, a Taiwanese rubber plant in Shanghai, several Toyota works, a Carlsberg brewery, seventy-three factories in the northern industrial zone of Dalian, a Hyundai establishment in Beijing where the union official had once promised the South Korean owners that no strikes would ever happen under his watchful eye. Analysts cited by *China Daily* 'say workers – particularly those among the new generation of migrant laborers – are becoming more confident about their bargaining power and predict these actions could ultimately bring an end to cheap labor in China'.[51]

And indeed, the strike wave enforced whopping wage increases across the board. At its gearbox factory at Foshan, Honda eventually agreed to pay 32 percent more; in the Dalian zone, the 70,000 striking workers achieved a 34.5 percent hike; at Hyundai's Beijing plant, management conceded a 25 percent rise over two months. Reacting to the turmoil, all but one of China's provinces raised their legal minimum wage, by an average of 24 percent (the first significant increase since the minimum wage system was adopted in 2003). While China was no stranger to mass action, nothing like this – in terms of spontaneous contagion, geographic spread, targeting of FIEs and clear-cut victories – had ever before occurred in the workshop of the world.[52]

The summer of 2010 sent shivers down the spine of bourgeois observers. Contemplating the contours of 'the next China', *The Economist* declared that 'the popular image of the country's workers as docile, diligent and

dirt cheap' had been shattered: 'Recent unrest has put Chinese labour at odds with foreign capital. Firms may have to get used to bolshier workers.' Undergirding the new 'bolshiness' was an unexpected depletion – or withdrawal – of the reserve army of labour, as explained by *Forbes*: 'The size of the workforce peaked in 2010, six years before Beijing's official demographers said it would, and rural residents are increasingly reluctant to move to the cities to work in dreary factories and live in squalid conditions.'[53] Even in the world's most populous nation, supplies were drying up after a decade of breakneck accumulation, boosting the strike forces on the southern coast. How would firms respond to this new situation? In the assessment of *The Economist*, rising wages would erode 'the return on capital', but

> workers are not the only ones who can migrate [sic]. Capitalists can also go to where workers are abundant. First, labour-intensive factories will move inland. Eventually they will depart China altogether, just as they left Japan and Taiwan before it. That, after all, is why Honda and Foxconn opened plants there in the first place.[54]

In the wake of the strikes, reports of investors planning to desert China abounded. Among the countries identified as new havens were Vietnam, Indonesia, India, Malaysia, Cambodia, Bangladesh; Chinese workers now cost five times more than their Vietnamese counterparts, three times more than the Indonesians, thirteen times more than the Burmese. Other low-wage destinations mentioned – some patently in desperation – were Pakistan, Ethiopia, other parts of sub-Saharan Africa, even North Korea.[55] But the predictions may have been premature: there were obstacles to the exodus, one of them particularly telling. In late 2011, the *Financial Times* spoke to Frank Leung, owner of a Hong Kong–based women's footwear company, about his travels in search of new homes for his Dongguan factories: Bangladesh appealed to him, with wages 20 to 30 percent of those in China. But after his visit to the country Mr Leung was 'shell-shocked. "They have crazy traffic congestion and everyone uses a generator in factories (because the power supply is erratic)", he says. "The logistics make it very hard to work efficiently."' The *New York Times* later pointed out that most of the alluring alternatives in Asia 'have other problems, such as overburdened, unreliable electricity grids', and for the same reason, the Vale Columbia Center concluded, sub-Saharan Africa would probably not receive much redirected FDI after all.[56] The substratum was simply too deficient.

As for Vietnam, FDIs had already put pressure on the 'creaky infrastructure (power cuts are still common, even in the capital)'; furthermore, 'lengthy traffic jams slow down shipments and drive up costs'. But the state pledged to accommodate incoming capital – above all, by establishing coal mines and coal-fired power plants of low efficiency. In late 2009, the government unveiled plans to develop the largest deposit in the country, twenty times the size of the biggest mine in operation, meant to 'ensure national energy security by 2025'.[57] A similar situation prevailed in Indonesia, where rampant electricity shortages 'discouraging investment' were combatted by means of 'a "crash program" for expansion of base-load capacity through coal-fired power plants'; some concerns were voiced over the growing dependence on dirty coal, but the great advantage of the fuel was its abundance and low price compared to oil and natural gas, to say nothing of geothermal or nuclear.[58]

For India, one economist drew the lesson that FDI could be attracted if labour power were dressed up like in China: 'quick to learn', 'highly disciplined', low wages. While that description of Chinese workers might have already become outdated, the following lesson had not: the main hurdle for larger inflows 'is the lack of infrastructure such as power, roads, railways, oil and gas, aviation, telecommunications, etc. There is also a need to improve transport between the metro- and port cities.'[59] In February 2014, the Indian *Business Today* discussed the opportunities created by the end of cheap labour in China and relayed the conditions laid down by capital: 'The government, say manufacturers, needs to encourage component suppliers. *It must also fix the country's creaky infrastructure* by building highways, power plants and ports.' And indeed, the Indian government vowed to emulate the Chinese model: in 2010, it approved the construction of a new coal-fired power plant every second day.[60] If arrows were to be shot out from China, they would have to land at new summits.

There were alternatives to leaving the Republic. Factories might be moved away from the boiling cost to rural provinces where wages still belonged to another realm, the chimneys of the littoral replanted or replicated in the Chinese interior. But that strategy raised its own problems, as one manufacturer of knitwear complained: 'We need nimble fingers, but we're worried we find farmers who … can't work my machines.' Treading the inland path or not, companies could also put another time-honoured strategy into effect. 'The giant orange robotic arms that swiftly weld together car frames at the Great Wall Motors factory in Baoding might seem like the perfect answer to China's fast-rising labor costs – they don't

ask for a raise, get injured or go on strike,' *Reuters* began a story about factories on the frontlines of automation.[61]

Leading the charge was Foxconn, the single largest foreign-owned exporter in China, long anonymous but, after 2010, infamous for assembling iPods, iPhones, laptops and other electronic gadgets for American brands. At Foxconn's mega-factory in Shenzhen, housing 400,000 inmates in a sprawling compound, some of the workers chose another method for revolting against unbearable conditions in that year of unrest: jumping from the roofs of dormitories and cutting their wrists. After a dozen suicides, the company offered a massive wage hike – and immediately began to prepare for automation. A robot called 'Foxbot', designed for assembling, moving and polishing things, would be engineered in mass quantities; aiming for 1 million units in 2014, management sped up the substitution of dead for human labour. Technology magazine *The Verge* quoted 'Zhang', a worker in the Shenzhen factory, describing the changes: 'There were about 20 to 30 people on the line before, but after they added the robots it went down to five people, who just pushed buttons and ran the machines.' In a Dongguan town specialising in knitting, firms installed 40,000 computerised knitting machines to rid themselves of 200,000 workers; similar spurts of automation were reported from across the manufacturing spectrum – and not only in China, of course.[62] Robots are on the rise in the world economy. What they mean for energy demand is obvious.

The summer of 2010 really does seem to have constituted an inflection point in the evolution of the workshop of the world. Since then, not only have walkouts hit FIEs on a regular basis and labour shortages cast a pall over expansion plans, but wages have continued to soar, at double-digit rates each year in Guangdong. In 2013, *Focus on Fashion Retail* snivelled over data on the new basic salary in Shenzhen – 'a frightening figure for factory owners' – and an average rise of more than 30 percent in some cities and provinces since 2010 – 'a heart-breaking figure'.[63] Actual relocations were underway. 'Foreign buyers are fleeing China for Bangladesh, Cambodia and Indonesia not just for cheaper labour but also because of rising tensions between the workers and their employers,' the *South China Morning Post* reported in February 2014; citing 'unpredictable movements in the migrant workforce', Swedish garment company H&M redirected manufacturing to Bangladesh; Foxconn eyed Indonesia as a new platform. One survey indicated that 40 percent of US firms considered moving out, with many having already begun; FDI inflows to China stagnated and surged in Asian alternatives; in 2013, Indonesia seized the position as the most popular investment choice for Japanese companies.[64] *All such movements were predicated on fossil fuels as the general lever of surplus-value production.*

Indeed, if the post-2010 insecurity around China and its Asian rivals demonstrated anything, it was precisely how necessary a condition that lever continued to be. Without it – without new mines, plants, grids, ports, roads… – the workers that, for the moment, seemed most easily procured and industrious could not be exploited. But states seemed eager to roll out the black carpet. If massive relocation of capital away from the People's Republic were to transpire, it would undoubtedly unleash new expansion and integration effects, though a rise in carbon intensity would be more uncertain (though ironically, there were signs that China had increased the share of imported natural gas in its fuel mix *just as* incomes for working people reached 'heart-breaking' heights).[65] Spreading factories across more Asian countries to safeguard against bolshiness would translate into more chimneys in more places, more fragmented–integrated production chains, more self-reinforcing spirals of accumulation touched off across the continent, whose exploding emissions have other sources as well, but none as flammable as the quest for maximum surplus-value.

Whether factories actually depart in significant numbers remains to be seen. It depends on levels of working-class militancy in China, stability of the state apparatus, potentials for replenishing the reserve army with fresh supplies from the countryside – IMF has produced a list of refill measures, including accelerated mechanisation of agriculture – the possible attraction of richer consumers, movements in currency rates and parallel developments in all of these variables, and more, in alternative host countries.[66] Perhaps the most likely scenario is a pattern of more widely disbursed FDIs, driven by a dynamic non-equilibrium in which capital leaps from place to place, refuelling the combined effects of the drawn-out relocation of industry from old centres to Asia. A collapse of the manufacturing industry in China inducing an absolute *reduction* of its CO_2 emissions seems out of the question – but then again, capital accumulation is a cumulative process, not a zero-sum redivision. The response to labour revolt may simply be to let another thousand chimneys bloom.

The Law of the Rising Atmospheric Concentration of CO_2

In the first edition of *Long Waves of Capitalist Development*, published in 1980, Ernest Mandel scanned the dismal landscape of yet another structural crisis. One of many contradictions related to all-too-powerful labour. With the postwar expansion having exhausted much of the reserve army in the advanced capitalist countries and lent indispensible workers a high degree of collective self-confidence, rates of profit fell. How could capital regain the initiative? Among the many preconditions for a new upswing, Mandel proposed the following: 'In order to drive up the rate of profit to the extent necessary to change the whole economic climate, under the conditions of capitalism, the capitalists must first *decisively break the organizational strength and militancy* of the working class in the key industrialized countries.'[67] Two decades later, precisely such an epoch-defining victory materialised in China as the workshop and chimney of the world.

The globalisation of production, unfolding since the 1970s and speeding up in the 1990s, caused a tectonic shift in the balance of forces between capital and labour. Endowed with a new ability to remove commodity production to distant countries and *export* from there, capital could twist the arms of unions, their place-bound members now thoroughly substitutable on a global scale. A car assembled in Ghent or Turin for sale on the European market could just as well be manufactured somewhere in Guangdong. China – opened to the world after 1978, but particularly after 2001 – seemed to form a black hole sucking in production, the sound of disappearing factories reverberating across the rest of the globe, echoing in remaining plants from Sweden to Mexico and pushing workers to the wall. In the veiled language of *The Economist*, the flow of Chinese workers 'from farms to factories has held down manufacturing wages – not only in China but also throughout the world'; in effect, the Chinese reserve army became a *global* reserve army, helping to raise rates of surplus-value and widen inequalities throughout the ambit of the dragon.[68]

Chinese workers were themselves harmed by the logic. In late 2010, *Chinese Labour Bulletin* worried that the strikes would yield few long-term results: 'Many low-cost, labour intensive enterprises are currently more likely to respond to workers' wage demands by simply closing down and relocating to a lower cost area, than by actually bothering to negotiate with their workers.' Credible threats of relocation are no less efficient in undermining the bargaining position of Chinese than any other workers caught up in the swirl; indeed, whereas Western labour movements were once

allowed to gather force in relative security – production apparatuses still moored in national economies – their latest Chinese reincarnation walks on a rug that might suddenly be pulled from under its feet.[69] No one has better analysed the immediate class dimension of this dance than Beverly Silver in her *Forces of Labor: Worker's Movements and Globalization since 1870*. Drawing on Harvey, she identifies a recurring 'spatial fix' in the modern history of capital: 'Each time a strong labor movement emerged, capitalists relocated production to sites with cheaper and presumably more docile labor, weakening labor movements in the sites of disinvestment *but* strengthening labor in the new sites of expansion.' Escaping the problem of dear and undisciplined labour, capital ended up creating it anew in what was supposed to be the sanctuary. As a corollary, Silver proposes the theorem '*where capital goes, labor-capital conflict shortly follows*.'[70]

We may now add another: *where capital goes, emissions will immediately follow.* This is the class content of carbon leakage. There is, however, no reason to assume that labour always reemerges in the new sites of expansion with the same strength and vigour as in the old; recent decades of globalisation have rather caused a structural *debilitation* of labour – and in this respect, the historical trajectories of conflicts and emissions diverge. Capital dances around enfeebled labour movements, disempowering the global working class through its relentless spatial fixes and permanent exit points, while CO_2 emissions rise exponentially through the same dynamics. Or, *the stronger global capital has become, the more rampant the growth of CO_2 emissions* – indeed, one might argue that the decisive capitalist victory in the long twentieth-century struggle with labour was crowned by the post-2000 rush towards catastrophic global warming. Counting from 1870 to 2014, a fourth of all cumulative CO_2 emissions were belched out in the last fifteen years of the period. This world of exploding emissions is also the world in which eighty-five individuals own as much wealth as the bottom half of humanity, the *anthropos* becoming *less* of a monolith by the day.[71]

Apart from relocation, Silver emphasises another strategy to sap militant labour: automation. An ecological phenomenon through and through, it is one aspect of the relentless rise of machinery over the *longue durée* of capitalist history, expressing the perpetual increase in productivity under this mode of production. For every unit of human labour, more material substrata are mobilised, processed and dissipated: what Marx calls the *technical composition of capital* goes up. In value terms, constant capital (the part of capital invested in materials) grows in proportion to variable

capital (another term for labour power), so that the *organic* composition of capital – the value reflection of the technical composition – rises as well. Living labour is squeezed out, shouldering an ever heavier mass of machinery and other matter, dead, unable to produce surplus-value: and so the rate of profit inevitably falls.

This, of course, is the basic reasoning behind Marx's 'law of the tendency of the profit to fall' – law of the *tendency*, because there are 'counteracting factors' operating against it. If, for instance, the elements of constant capital become cheaper, their larger share may not cause a growth in the organic composition. Suppose that a worker has to handle two machines instead of one, while those machines have each been produced in half an hour rather than in one, as formerly: then the *value* proportions remain unaltered. A higher productivity in the machinery-producing sector would, in this case, prevent the value of constant capital 'from *growing in the same degree as its material volume*' – and so the rate of profit might not fall after all.[72] It is merely a tendency, held in check, periodically even reversed when capital advances fast enough on its many frontiers.

What is certain in Marx, however – an iron law of accumulation, impossible to bend or stem – is that the *material* volumes grow, that the *technical* composition rises even if the organic does not: and from an ecological perspective, this is what matters.[73] Given that capitalist machinery has been based on the stock since the early nineteenth century, and given that increased productivity will therefore mean that each hour of labour wields a greater amount of appropriated stock, there seems to be a law of a rising *fossil composition of capital*. The struggle to minimise the share of human labour in relation to machinery and other matter – an unceasing substitution missing in the Ricardian-Malthusian paradigm – causes a rise in the fossil composition, which, operating over the span of capitalist history, translates into a law of a *rising concentration of CO_2 in the atmosphere*. Are there counteracting factors here as well?

There is an analogous possibility, not in value but in material terms: the carbon intensity of production might fall, perhaps so rapidly as to offset growth in scale and productivity. Suppose that a worker has to handle two machines instead of one, while those machines each consume half the former amount of fossil fuels: then the *energy* proportions remain unaltered. But unlike in the history of *value* production, such countertendencies have remained scenarios, vain hopes, pipe dreams of eco-modernist thinking; in reality, Jevons's paradox constantly negates them on a global scale, the spirals of accumulation beating the attempts to save fuel. Moreover, globalised production in general and capital migration to China in particular have induced an *opposite* intensity effect, not cancelling but *reinforcing* the underlying rise in fossil composition: the carbon intensity of the world economy as a whole is increasing.[74] The law of the falling rate of profit might be at most a tendency, but the law of the rising concentration of CO_2 is immutable. Realised through both relocation and automation, it represents a *unity* of energy and exploitation, in motion since the original transition to steam and running out of control in the present.

Now, needless to say, far from all of the rise in atmospheric CO_2 can be imputed to fossil capital: there have been states, armies, workers' cooperatives, residential areas, land clearings, plebeian transportation systems and other burners outside its circuits. The claim here is only that it constitutes the *main propulsive force* of the fossil economy. If this is at least somewhat correct, any meaningful action on climate change would one day have to challenge fossil capital, which would require, first of all, a sober acknowledgment of power realities. In some of the literature on EET, one finds pious references to the responsibility we all share, without any particular distinctions: 'Ultimately, our daily consumption and production decisions drive global emissions.'[75] In what sense these decisions are in fact 'ours' is not entirely clear. The danger here is that targeting the Western consumer – or, worse yet, Western workers – as an abstract generality guarantees the failure of climate politics, even if moving beyond production-based accounting; the real culprit would remain an elephant in the room. Indeed, the very thought of limiting emissions attributable to global fossil capital as an amorphous but highly centralised locus of power runs counter to the premises of actually existing international climate politics. The gas is left alone, allowed to continue to expand in the fracture zones.

A Commitment to Inertia

Capital is not a being endowed with a will and mind, a cabal, an almighty conspiracy or a central directory preparing its decisions and foreseeing their consequences: anything but. It is a blind process of self-expansion, but one *personified* in capitalists, whose actions and reactions are – and have to be – animated by the compulsion to valorise value. More often than not, the products are unintended. A putter-out of cotton may adopt the power loom as a protection from embezzlement, only to assemble

weavers in a position to strike inside his premises; a car company might relocate manufacturing from the strong unions of South Korea to several interlinked sites in southern China and one day wake up to the news of a walkout crippling production. Such sequences of displaced, reshuffled contradictions have appeared not only in the textile, auto, semiconductor and other industries, as mapped by Beverly Silver, but just as much inside the circuit of primitive accumulation of fossil capital.

In *Carbon Democracy*, the most important work on the modern history of that circuit, Timothy Mitchell draws attention to what must be considered a great irony of the transition from flow to stock: it empowered some labour. Now the current of energy presupposed colliers. Escaping from the frying pan of the flow, capital jumped straight into the fire of a fossil economy in which human labour 'connected chambers beneath the ground to every factory, office, home or means of transportation that depended on steam or electric power'.[76] With the power of proletarians in mines – alongside those on rails, canals and docks – to switch off all power, the early labour movement could refine the general strike as its weapon of mass paralysis, the intuitions from the Halifax meeting in August 1842 hardening into an effective strategy for maximising the leverage of the class.[77]

How did capital respond? It took up oil. After a series of frightful strikes on the major coalfields in Europe and the US – particularly in the wake of the First and Second World Wars – and with correspondingly emboldened labour movements on the advance, the resolve to acquire oil reserves at a safe distance stiffened. 'An important goal of the conversion to oil', Mitchell argues, 'was to permanently weaken the coal miners, whose ability to interrupt the flow of energy had given organised labour the power to demand the improvements to collective life that had democratised Europe': a more tranquil source of energy would be oil from Middle Eastern deserts.[78] Gushing from the ground, it could be pumped into the landscape by a relatively small workforce – no need for armies of extractors to be sent into the seams – under the permanent supervision of management; thanks to its liquidity, the transport required less labour. From the mid-twentieth century, the fossil economy turned towards the Middle East as its new centre of gravity, in another buoyant spatial fix.

And then the problem reemerged in novel guises: Palestinian guerrillas blowing up pipelines, populist regimes nationalising oil, workers gathering strength enough to disrupt the world economy in general strikes – most notably on the Iranian oil fields in 1978–9 – wars, terror attacks…

which in turn spurred the search for 'energy security' in the form of wells far from the Middle Eastern quicksand. In no case, however, did the shift from one fossil fuel to another, or from one region to another, lead to any *absolute decline* in consumption of the troublesome source. Coal never disappeared from the calculus. Today, it is again responsible for more CO_2 emissions than any other fossil fuel.[79] Just as in the circuit of fossil capital, the reappearing autonomy of labour has provided one incentive for the diversification, multiplication and *expansion* of the circuit of primitive accumulation: and wherever capital has gone, more fuels to burn have been uncovered.

But the fundamental incentive has remained the demand for fossil fuels from the rest of the economy. In China, the explosion fed on material from northwestern mines and thus precipitated a boom in extraction, with all the usual repercussions. Known for their biodiversity, the grasslands of Inner Mongolia are the ancestral homelands of nomadic herders, who have never used coal in their daily life – and still do not – but who happen to live upon some of the best deposits in the Republic. Since the turn of the millennium, intensified exploration and processing have contaminated water, dried out streams, released toxic chemicals into the air, reduced vegetation, occupied landscapes, opened invisible shafts into which herdsmen and animals have stumbled. Seeing their traditional way of life under threat, impoverished and displaced, the herders of Inner Mongolia have frequently resorted to blocking coal transports, with the predictable outcome: greater armed presence.[80]

In May 2011, herders from Xilingol raised a roadblock in the path of 100 trucks; on the midnight between 10 and 11 May, some drivers decided to force their way through the barricade, hit a herder known by the name of Mergen, dragged his body for 150 metres and then drove over it several times. The killing put a match to the grasslands. Over the coming weeks, out of sight of world media, the Chinese state stamped out the anti-coal revolt by blanketing Inner Mongolia with police, blocking Internet and telephone connections, sealing off schools, declaring curfews, imposing de facto martial law. A human rights activist spelled out the seething frustration: 'This land has become a lawless zone in which the companies can do what they like, completely disregarding the indigenous people.'[81] As in the English countryside in the Elizabethan leap, the Middle East in the early oil era and countless other places and periods, the primitive accumulation of fossil capital inside China has proceeded through violent expropriation of the direct producers, sinking the hooks of capitalist power into 'the

earth, the source of all production and of all being', with Marx; once it has taken hold of that source, it is exceedingly difficult to unseat.[82]

As a strictly economic circuit, investment in mines, derricks, rigs, refineries, pipelines and similar structures conform to some well-known laws. These are expensive goods. They are also durable: an oil platform is not consumed over a lunch. In November 1982, a Norwegian platform consisting of nearly 1 million tonnes of concrete became the heaviest object ever moved by people. The money sunk into such installations will return with an increment only after a long time has passed; it might take a couple of years to recover the outlays on a self-actor or a Foxbot, but several decades for a tar sands mine or a trans-Canadian pipeline. As shown by David Harvey in *Limits to Capital*, the result is inertia. 'When capitalists purchase fixed capital, they are *obliged to use it* until its value (however calculated) is fully retrieved': if the platform were to be scrapped one day after inauguration, the loss would be horrendous.[83] The search for flexibility and mobility, which has guided capital since it turned fossil, ends up *fixing it* in ultra-heavy means of production and transportation; for every article of freedom the stock has handed it, the more of it has been locked underground for the long haul.

Immeasurably larger and thicker than in the days of Leifchild, a second crust now girdles the globe: 'Oil and gas fields, coal trains, pipelines, coal-carrying vessels, oil and LNG tankers, coal treatment plants, refineries, LNG terminals' – counting in the tens of thousands, covering millions of kilometres – 'constitute the world's most extensive, and most costly, web of infrastructures', in the words of Smil. This is a very precious thing for some. Capital, observes critical geographer Wim Carton, 'has a vested interest in the endurance of the fossil fuel landscape', antithetical to the interest others might have in terminating use of the stock.[84] This is not, however, a matter merely of recuperating expenses: once a power plant has paid back, the owning firm will be wise not to knock it down, but rather to keep it in operation for as long as possible. Already paid for, it can now be treated as costless fixed capital and used as a base for capturing larger market shares; decommissioning the complex and constructing another would be to start all over again. Two-thirds of American power plants built since the 1890s still remain in use. Beyond solid physics and long turnover times, companies will resist the retirement of such assets for as long as these can be maintained and repaired to a reasonable cost – particularly if the product in question is electricity, which the consumer receives in exactly the same shape and form no matter how old the plant

is.[85] (Something like a coal-fired power plant may seem to straddle the line between the circuit of fossil capital proper and that of primitive accumulation, but here we shall treat such infrastructure as part of the latter, since it delivers F as an output, even if in converted form.)

We might want to dismantle the fossil fuel landscape as quickly as science tells us we should. For the involved capital, that would be tantamount to an asteroid impact obliterating a whole planet of value, still awaiting its first harvest or ripe for a second or third. The same type of commitment extends to the fossil economy in toto – fixed capital in energy end use might have been triple that on the supply side as of 2005 – but an industrial zone can, at least potentially, be retrofitted for renewable energy.[86] A coal mine cannot. Neither can a coal-fired power plant be fed with wind turbines: it would have to be torn down. Early expiry of that kind is now a necessity. 'If global warming is to be limited to 2°C in 2100', one study concludes, 'huge quantities of installed coal capacity will need to be prematurely retired between 2030 and 2050. *Such a vast global write-off of capital would be unprecedented in scale*': talk of a transitional demand.[87] Capital has been destroyed before in history, of course – in wars, crises, waves of deindustrialisation – but this time it would, rather uniquely, be publicly *sentenced* to an untimely death.

Here, then, is one impediment to the transition: capital in the circuit delivering F to consumers. It grows higher by the day. For every moment emissions cuts are postponed, the fixed capital operating as a block against them amasses more weight. Since investments in new and expanded facilities continue right up to the moment when mitigation begins – if indeed it ever does – more astronomic amounts of capital will have to be liquidated on that day than if the work had begun a decade or two earlier: inertia builds inertia, each generation in the fossil economy passing on a heavier nightmare to the next. What needs to be done, of course, is to take off infrastructure for the delivery of F more quickly than it is built – but exactly the opposite is happening. In the first decade of the millennium, more coal-fired power plants were constructed than in any previous decade. The acceleration is quite breathtaking: in the three years from 2010 to 2012, upwards of 2.5 times more coal capacity was added than in the entire decade of the 1990s. A dark cloud of 'committed emissions' is hung over the future. Assuming that they remain operational for forty years, the coal-fired power plants built in the world in 2012 alone will emit 19 billion tons of CO_2 over their lifetimes, to be compared with the 14 billion actually emitted by all operating fossil-fuelled power plants in

2012; currently committed emissions are growing by 4 percent per year, or faster than actual emissions. Such is the war on the future waged by business-as-usual. Nearly two centuries after the rise of steam, the prime ammunition remains coal.[88]

No wonder EURACOAL, the lobby of the European coal industry, in 2014 released a manifesto entitled 'Why Less Climate Ambition Would Deliver More for the EU'. But it is the emissions explosion in the chimney of the world that casts the longest shadow. In the first eight years of the millennium, China added a fresh capacity to generate electricity from coal larger than the entire combined capacity of the five largest EU economies; some thirty to thirty-five years would have to pass before investors could make a profit on these plants. In late 2012, another 1,200 such plants were planned in the world, hundreds of them in Europe but the majority in China and India.[89] By that time, coal suppliers suffered from overproduction, their profit rates declining – but representatives of the industry expected brighter days soon: 'China has exceeded its projections on coal use every time,' said Brendan Pearson, CEO of the Minerals Council of Australia, with confidence. And indeed, by 2010, the People's Republic alone had contributed 37 percent to committed future emissions. But 'committed' should be taken to mean *economically preordained*, not physically predetermined.[90] There is, after all, nothing impossible per se about closing a coal mine. There are just some people standing in the way, infinitely more powerful than a band of herders.

It is imperative to try to grasp the forces any transition would run up against: in 2013, *Fortune*'s list of the 500 largest corporations of the world had Royal Dutch Shell in the lead, Exxon Mobil as number three, Sinopec as four, China National Petroleum five, BP six, State Grid Corporation of China – supplying 80 percent of the country's electricity – seven, Total ten. Only three of the ten largest – Walmart, Toyota Motor, Volkswagen – had their core business outside the circuit of primitive accumulation of fossil capital. But diverse sources flow through that circuit. Financial injections from banks are critical for activating modern coal extraction: from 2005 to 2010 – the years covering Al Gore, the Stern Report, IPCC's Nobel Peace Prize and COP-15: probably the half-decade when awareness of climate change has stood highest on the political agenda – the investment from banks in coal-fired electricity and mining *doubled*. JPMorgan Chase, Citigroup, Bank of America, Morgan Stanley and Barclays threw most money into the circuit, inextricably entwined with those of financial capital.[91]

Not only structures for extraction that have actually been built, however, but *reserves* of fossil fuels are glittering gold to their owners. Contrary to all talk of impending scarcities, there is enough oil, gas and, above all, coal in the ground to raise the average temperature on earth by between 16 and 25 degrees. That will not happen, of course: every investor would be charred long before it could. But the circuit of primitive accumulation of fossil capital is hell-bent on *moving in that direction*, for here capital subsists directly on delivering the stock to the fires. Corporations are valued on the basis of the deposits they control, display them to shareholders and count on their future exploitation, and if only one-fifth of their assets would in fact be taken above ground and burnt before mid-century, the two degrees target would go up in smoke.[92] A plain demand – a minimum of rationality in the current situation – would be to impose an open-ended moratorium on the development of *new* coal mines, oil wells and gas fields. Against it stands an interest expressed with exemplary clarity by Rex Tillerson, president and CEO of ExxonMobil, in March 2013: 'My philosophy is to make money. If I can drill and make money, then that's what I want to do.'[93]

The Fire Looks at Us So Cheerily

Even if the analysis sketched here is broadly correct, it would still leave one – perhaps *the* – paramount question unresolved: why do not people rebel? Why is it that fossil capital persists, if not unchallenged then safely ensconced in the driver's seat? How is it possible that the passengers do not overwhelm and throw it out, or just wreck the train? Given the gravity of the situation, this might be the greatest mystery of all. Dozens of pieces – the distances between victim and perpetrator, the abstract character of climate science, the convenience of turning a blind eye to disturbing facts and thinking about the brighter things in life, all the creative ways in which societies organise collective denial – would be needed for a satisfactory explanation, but here we shall draw attention to only one.[94] It takes us outside the circuits we have dealt with hitherto and into the sphere of *fossil consumption*, where no capital is accumulated, but where the great mass of humanity integrated into the fossil economy resides.

Mysterious as it may seem, the puzzle is, at closer sight, only a sharpened version of the problem Marxist theorists of ideology have struggled with since Gramsci: why do subaltern classes resign themselves to their

fate or even consent to it explicitly? Or, how are the predominant relations of production reproduced? In this tradition, the referent of 'ideology' has undergone a slippage, from a system of ideas proclaimed by meetings and monuments to a structure so deeply ingrained in the very materiality of bourgeois society as to be invisible, inaudible, crushingly efficient because it is unstated and taken for granted. One theory with which to approach the problem might be that of Althusser. For him, ideology is not so much a set of doctrines as a state of existence, in which the subject comes to be enmeshed in the relations; something not thought and said, but *done* and *felt*. More precisely, bourgeois ideology materialises in 'Ideological State Apparatuses' or simply 'ISAs', an ensemble of institutions with their own distinctive practices.[95]

A person holding a political ideology in the ordinary sense of the term might join a demonstration or attend an assembly to express her convictions, but in the Ideological State Apparatus, it is the practical act that *generates* the ideological affiliation. A Catholic does not go to mass because she is a believing Catholic; rather, the acts of going to mass, moving her lips in prayer, kneeling down and confessing her sins *constitute* her as a Catholic: material rituals summon the ideological subject into being. The apparatus recruits its subjects, or transforms individuals into subjects, by an operation which Althusser famously calls

> *interpellation* or hailing, and which can be imagined along the lines of the most commonplace everyday police (or other) hailing: 'Hey, you there!' Assuming that the theoretical scene I have imagined takes place in the street, the hailed individual will turn around. By this mere 180-degree physical conversion, he becomes a *subject*,

Althusser here playing with the dual sense of the term: 'subject' as in a freely acting individual, 'subject' as in a subordinate. In the classroom, the teacher interpellates the student when calling on her to respond to a question; on a TV show, the host hails the viewer by welcoming him or inviting him to text his comments, and so on. Althusser again and again stresses that an ideology 'always exists in an apparatus, and its practice, or practices. *This existence is material.*'[96]

Now if we take this hyper-materialist theory of ideology one step further, we can conceive of the sphere of fossil consumption as an Ideological State Apparatus. In *Chimney of the World*, Mosley shows how late Victorian England developed a popular cult of the domestic coal fire, the archetypal

site of fossil consumption, where coal itself was the use-value. He quotes *Live Coals; or, Faces from the Fire*, an 1867 book by one L. M. Budgen:

> The dear familiar fire, that lights up our hearth, and faces round it! … The fire which looks at us so cheerily from the bars is the companion of the solitary, the comforter of the sad, the enlivener of the dull, the magnet of social attraction, the pivot and cherisher of tender recollections; in a word, the sun (when the summer sun is wanting) of every domestic system: hence its very *life*, not forgetting its vulgar but particularly *vital* uses, as roaster of the joint, and boiler of the kettle.[97]

The conspicuously fetishistic language of this accolade did in fact, Mosley argues, reflect a widespread experience in the working-class homes of Victorian England: feelings of communion and convenience in the gathering around the coal fire. Here it would have been not a priest, teacher, merchant or any other person *but the material commodity itself* performing the magnetic interpellation. In the commonplace homestead scene described by Budgen, the fire called out a 'Hey, you there!' to the members of the family, who turned their faces towards it. By this mere physical inclination, they became parties to the fossil economy, recipients of its blessings, subjects to – and of – the act of consuming the stock. The material ritual fostered an allegiance so deeply felt as to be unconscious, although sometimes spelled out by authorities of the ISA: 'And to all of us the sitting around [the coal fire] is one of the most cherished features of our home-life. In abolishing it we might save coal, *but we should lose England*,' in the words of a professor in the Department of Fuel Technology at the Royal College of Science, speaking in 1912.[98] So inextricably bound up with the fire had the English subject become that its extinction would have deprived her of her being.

Now consider the equivalents of sitting around the coal fire in the modern sphere of fossil consumption: filling up a car at the petrol station, purchasing a ticket for a flight to some distant beach (or academic conference, or activist gathering), enjoying exotic fruits shipped in from some antipode, buying an iPad produced in China or simply paying the utility bill.[99] The interpellations would be *everywhere*, performed by the objects of use-value in all inflections. But this would seem to signify a step beyond Althusser. In his ISAs – the church, the family, the parties, the media, the unions, the school – it is invariably people who hail people: the priest the congregation, the teacher the students. The voice is clear and public,

anchored in material practices but always louder than their sheer physicality. Can the commodity speak *by itself*? Another possibility might be to view the exhortations to engage in fossil consumption as interpellations: not the flight to the Bahamas, but the advertisement of it on TV and all the similar 'constant chatter', to speak with Marx. 'In current consumerist societies we are *actively encouraged* to express our sense of identity through our material possessions, and losing these can therefore mean losing our sense of identity,' in the words of psychoanalyst Sally Weintrobe, who proposes this as a critical factor behind popular inaction on climate change.[100]

But the gist of Althusser's theory is hyper-materialism, or perhaps rather a Spinozist dissolution of the dichotomy between spirit and matter, allowing for no separation between body and symbol. 'Men "live" their ideologies,' Althusser writes, '*not at all as a form of consciousness, but as an object of their "world"* – as their "*world*" itself.'[101] The ideology is immanent in the very act of looking at the fire. If we add to Althusser some insights from the opposite corner of Marxist theories of ideology – the reification school founded by Lukács – we may well locate interpellation in the very act of consumption, after the purchase. The commodity masks the relation between people; it parades, invigorates, swaggers and chatters as though there were a human voice inside it. Such reification tends 'to cover the whole surface of phenomena', since the production of relative surplus-value – synonymous with the perpetual increase in productivity – 'requires the production of new consumption; requires that *the consuming circle within circulation expands*'.[102] Subjects are drawn into spiralling consumption because the sphere of production has to dump its growing mountains of goods onto buyers.

The historical tendency of fossil capital is to spew out *more* products with an F in them for *more* people. In an advanced fossil economy – the one that has to be abolished – the transactions containing the formula C – M – C(F) are so innumerable as to permeate 'every expression of life', with Lukács. Hardly any subject can be formed without material ingestion of the F. Invisible and silent, the stock is present in the most mundane errand and the most exclusive teaser, in the most concrete existence of people, 'in their work, daily lives, acts, commitments, hesitations, doubts, and sense of what is most self-evident', with Althusser.[103] Whether a party animal or a progressive academic, you need to take that flight to maintain your subjectivity and be the person you are. While sitting in the plane, the window, the seat, the attendant and the view of the clouds below hail you without uttering a word: 'Hey, you there!' – you are a subject of the fossil

economy, and since you repeat the act frequently – ISAs are always built on reiterations – you cannot imagine *not* flying: the F has constituted the subject, who cannot see himself outside of it and who rarely reflects upon, let alone articulates, the ideological affiliation. It is just there, in the veins of material life.

So why would the fossil subject rise up to slake the fire? He could lose himself in the process. The fire looks at him so cheerily from the bars. We have here a provisional explanation for why resignation to the fate of global warming deepens with its acceleration: 'Just as the capitalist system continuously produces and reproduces itself economically on higher and higher levels, the structure of reification progressively sinks more deeply, more fatefully and more definitively into the consciousness of man.'[104] But the circles are concentric. On the outer rings of the fossil economy, the bonds to the fire are looser. Indeed, it follows from all of the above that *the subjects most thoroughly constituted by fossil use-values and therefore resistant to climate change mitigation are the richest consumers*. Someone poor, who might pay her utility bill but never flies to the beach, would have far less of her subjectivity invested in the stock and little if anything to lose from a transition. Insofar as class divides are deepening in fossil economies, the differences are widening. The explanatory power of a theory of fossil consumption as an ISA correlates with affluence; it might have some bearing on middle strata, the intelligentsia and certain privileged segments of the working class, but not on the truly subaltern classes in a warming world.

Much of climate politics is preoccupied with hailing consumers: Hey, you there!, buy something different!, something with a green label or lower footprint, something locally produced or, even better, nothing at all. While this seems to match the ideological weight of fossil consumption, we can see clearly why the focus constitutes a double strategic mistake. First, it speaks to the well-off; the efficacy of such counter-interpellation stands in direct proportion to purchasing power. Second, it deflects attention away from production, the active moment determining business-as-usual as a whole *including* the widening circle of consumption. Any progressive climate politics must, to be sure, confront the magnetism of the fire and come up with alternative interpellations, but as a general compass, the targeting of the consumer leads into the classical blind alley of Western environmentalism. In *Reason in a Dark Time: Why the Struggle against Climate Change Failed and What It Means for Our Future*, moral philosopher Dale Jamieson unknowingly begins with an exact rendition of the

human fate under reification, as theorised by Lukács: 'Human action is the driver, but it seems that things, not people, are in control. Our corporations, governments, technologies, institutions, and economic systems seem to have lives of their own.'[105] Only if people were to break out of the stupor of consumption and start acting on *this* level could any real change come about.

CHAPTER 15

A Return to the Flow? Obstacles to the Transition

Woes of the *Gratisnaturkraft*

Our best hope now is an immediate return to the flow. CO_2 emissions have to be brought close to zero: some sources that do not produce any emissions bathe the earth in an untapped glow. The sun strikes the planet with more energy in a single hour than humans consume in a year. Put differently, the rate at which the earth intercepts sunlight is nearly 10,000 times greater than the entire energy flux humans currently muster – a purely theoretical potential, of course, but even if unsuitable locations – oceans, wetlands, steep mountains – are excluded, there remains a flow of solar energy a thousand times larger than the annual consumption of the stock.[1] Wind alone can also power the world. It has nothing like the overwhelming capacity of direct solar radiation, but estimates of the technically available supply range from one to twenty-four times total current energy demand. Pessimists have warned that a massive deployment of turbines would slow down the wind itself to the point where one more wind farm would add no more electricity, but such Ricardian concerns have been put to rest by recent research: it is physically impossible to exhaust the currents of the air.[2] Other renewable sources – geothermal, tidal, wave, water – can make significant contributions, but fall short of the promises of solar and wind. If running water constituted the main stream of the flow before the fossil economy, light and air may do so after it. Fuel scarcity is not the issue this time around either.

what of the scientists who are clearly genuinely concerned about where business-as-usual is taking us? Had it not been for their involvement, geoengineering would not have come anywhere near its current position as a centrally placed emergency brake.

Crutzen ended his article with a frank admission: 'The very best would be if emissions of the greenhouse gases could be reduced so much that the stratospheric sulphur release experiment would not need to take place. Currently, this looks like a pious wish.'[68] Keith bases his entire argument on the premise of 'economic inertia. We suffer from the persistent illusion that we can rapidly accomplish the deep structural changes necessary to decarbonize our economy' – some might have wild ideas about intervening in capitalism, but instead we should treasure that system, which has, by the way, made 'enormous progress in managing environmental problems over the last half century' (proof: the US Clean Air Act).[69] Keith would obviously break out in a rash if someone proposed a planned economy for power, but he is more than willing to countenance a biosphere run by 'central planners' who regulate the thermostat, optimise conditions for agriculture, fine-tune the climate for every living being.[70] And here we have the red-hot engine of geoengineering. Analogies with wartime mobilisation appear every now and then in the literature but evoke none of the buzz surrounding the Pinatubo parallel. Planning the economy is the ultimate taboo; planning the climate is worthy of close consideration, an idea cognate with genetic engineering, GPS systems, smart devices, in vitro meat, drone warfare and other natural elements of late capitalist hypermodernity. Fossil capital would die in a transition; geoengineering may give it a new lease on life; what began as real subsumption of labour must end as real subsumption of the biosphere. There is that nagging feeling that a fleet of airplanes packed with sulphur are far more likely to show up than a special Ministry for a Transition to a Low-Carbon Future. It has become easier to imagine deliberate, large-scale intervention in the climate system than in capitalism.

CHAPTER 16

Time to Pull the Plugs: On CO_2 as an Effluent of Power

The Name of the Epoch

In *The God Species*, Mark Lynas builds his narrative around a familiar villain: we, us. 'God's power is now increasingly being exercised by us. We are the creators of life, but we are also its destroyers,' and 'our collective power already threatens or overwhelms most of the major forces of nature,' and 'our detritus gets everywhere,' and 'we are altering the characteristics of the atmosphere in unanticipated ways,' and on and on ad nauseam.[1] This must be one of the most common tropes in climate change discourse. We, all of us, you and I have created this mess together and make it worse each day – and with such an indiscriminate apportioning of blame, no end to the ordeal is in sight. It is perhaps not a coincidence that Paul Crutzen is the spiritual father of both the Anthropocene narrative and the geoengineering solution, or that Lynas embraces the environmental Kuznets curve, sulphate aerosol injection – 'for me this is a reason for optimism' – and the American view of China as the saboteur of climate politics.[2] If humanity as a whole drives the locomotive, there is no one to depose. A revolt against business-as-usual becomes inconceivable.

Enter Naomi Klein, who bases her call to revolt on the proposition that 'we are stuck because the actions that would give us the best chance of averting catastrophe – and would benefit the vast majority – are extremely threatening to an elite minority.'[3] Upon release of the call, defendants of the mainstream discourse frowned on her. In his review for *The Observer*,

philosopher John Gray stated that 'Klein describes the climate crisis as a confrontation between capitalism and the planet. It would be more accurate to describe the crisis as a clash between the expanding demands of *humankind* and a finite world'; in the *London Review of Books*, Paul Kingsnorth, ex-environmentalist and longtime purveyor of the view that collapse is inevitable, argued that 'climate change isn't something that a small group of baddies has foisted on us … In the end, *we are all implicated*.'[4] After denialism, this is emerging as the great divide in the debate on global warming.

Building a sophisticated case for the *we*-view demands a lot of imagination. In two high-profile essays, noted post-colonialist Dipesh Chakrabarty has questioned the utility of historical materialism for understanding climate change and come down squarely on the side of the Anthropocene narrative: 'Imagine', he writes,

> the counterfactual reality of a more evenly prosperous and just world made up of the same number of people and based on exploitation of cheap energy sourced from fossil fuel. Such a world would undoubtedly be more egalitarian and just – at least in terms of distribution of income and wealth – but the climate crisis would be worse!

Yes, imagine a planet Earth inhabited by 9 billion human beings, every one of whom owned five houses, three SUVs and a private airplane. Wouldn't we all burn! Indeed, such a world would be physically impossible. From his sci-fi scenario Chakrabarty draws the conclusion that 'the climate crisis is not *inherently* a result of economic inequalities,' when in fact it only reminds us of a stark reality: climate change has come about because a fortunate few have appropriated the bulk of the atmospheric carbon sink through massive emissions *which by definition cannot be extended to humanity as a whole*.[5] If everyone lived like a rich American, guzzling cheap fossil energy, we would be at 6 degrees tomorrow and then no one would live. Logically *and* historically, in the actually existing world, from the rays of steam to the twilight of globalisation, the crisis is inherently a result of some having more than – nay, taking from – others, the accumulation of fossil capital a very negation of universal species-being.

But Chakrabarty insists: 'The poor participate in that shared history of human evolution just as much as the rich do.' Frankly speaking, 'the lurch into the Anthropocene has also been globally the story of some long anticipated social justice, at least in the sphere of consumption. This

justice among humans, however, comes at a price.'[6] With this argument, Chakrabarty manages to mistake his invented planet for the one he lives on – truly an impressive feat of the human imagination. Driving it further, he maintains that humanity is unified not only as the source but also as the victim of this crisis. 'Unlike in the crises of capitalism, there are no lifeboats here for the rich and the privileged (witness the drought in Australia or recent fires in the wealthy neighborhoods of California)'; the human species is 'a universal that arises from a shared sense of catastrophe'.[7] But exit Chakrabarty's world of ideas and witness Katrina in black and in white neighbourhoods of New Orleans, Sandy in Haiti and in Manhattan, sea level rise in Bangladesh and in the Netherlands, all the realities of differentiated vulnerability in any impact of climate change, direct or indirect. For the foreseeable future – indeed, as long as there are class societies on earth – there *will* be lifeboats for the rich and privileged, and there will *not* be any shared sense of catastrophe. More than ever, class divisions will become matters of life and death: who gets to drive out of the city when the hurricane approaches; who can pay for seawalls or homes solid enough to withstand the coming flood. The capitalist class is evidently not very worried. Quite a few fractions of it are rather gearing up for some sweet profits from newly available oil resources in the Arctic, desalination plants and floating cities, ownership of ever more precious land, the construction of walls, fire insurances, genetically modified crops to withstand the heat, geoengineering.[8] As in all crises of capitalism, this one presents a welter of opportunities for those in clover, and *après moi, le déluge*.

If 'the Anthropocene' is an indefensible abstraction at the point of departure as well as the end of the line, might there be a more adequate term for the new geological epoch? Our suspicion that the interests once entering the locomotive are still inside it seems to have been confirmed: accumulation of capital through abstract space, abstract time and anarchic competition runs ever faster away from the flow, demanding a fuel of matching qualities in constantly growing quantities. Unlikely to gather anything like a consensus behind it, a more scientifically accurate designation, then, would be 'the Capitalocene'. This is the geology not of mankind, but of capital accumulation. To paraphrase Althusser, capitalist time, biochemical time, meteorological time, geological time are being articulated in a novel whole, determined in the last instance by the age of capital, even though it will come to an end long before this epoch does. The long tail of CO_2 from the stock will stretch out for hundreds of thousands of years; a new glacial period might not form for half a million.[9] Little did a cotton

master switching to steam in Lancashire or a car manufacturer moving to China suspect that this would be his one gift to eternity. The Capitalocene will outlive them all, like oxygen the stromatolites.

There is, then, another way to measure CO_2: as an effluent of power, of *our* defeats and *their* victories. But this requires a conception of history very different from that established in climate change discourse.

In the State of Emergency

> Where the deep, dark drive of the animal (as countless stories tell) finds a way to avoid the approaching danger, seemingly before it can be seen, this society … stumbles as a blind mass into every danger, even the one lying just around the corner, and the variety of individual goals counts for nothing against the identity of forces dictating developments. Over and over again it has been shown that the way society clings to normal (but already long lost) life is so fierce as to frustrate the truly human use of intellect and foresight, even in the face of drastic danger. The upshot is that society today presents a perfect picture of stupidity: uncertainty, indeed perversion of the instincts so essential to life and importance, not to say decay of the intellect. This is the mood of the bourgeoisie as a whole,

except Walter Benjamin did not write 'the bourgeoisie' but 'Germany's middle class', and the year was 1928.[10]

The trope of the undifferentiated *we* does violence to the historical record. For E. A. Wrigley, the 'inorganic economy' was always a blessing, up until the very moment when the news of climate change broke: then it suddenly morphed into a curse. 'The benefits which have flowed in the wake of the industrial revolution are great *and universal*,' but now we must ask if the pursuit of 'prosperity for all' has too high a price – the fantasy world, again. This is an act of exoneration. It idealises the history of the fossil economy. A more accurate philosophy of it would depart from Thesis VIII in Benjamin's *On the Concept of History:* 'The tradition of the oppressed teaches us that the "state of emergency" in which we live is not the exception but the rule.'[11] The tradition of the handloom weavers, the cotton spinners, the calico printers, the wool combers and all the other workers trampled underfoot by the steam demon and its iron men teaches us that the state of emergency arrived at dawn, in the land of Britain itself – and then we have not even glanced at the inhabitants of the distant shores

where British steam power landed. For them, the losses were of another order of magnitude.

In *The Condition of the Working Class in England*, Engels walks among the ecological ruins of the Industrial Revolution, with particular attentiveness to – not to say obsession with – the atmosphere. 'The atmosphere of the factories is, as a rule, at once damp and warm'; workers 'are drawn into the large cities where they breathe a poorer atmosphere than in the country', in streets poisoned by 'carbonic acid gas, engendered by respiration and fire', while the bourgeoisie flees the vitiated air. In the coal mines, CO_2 and CH_4 trigger 'the most terrifying calamities, and these come directly from the selfishness of the bourgeoisie'. At one point, Engels meets a member of that class in a Manchester street and confronts him with the ubiquitous catastrophes, whereupon the man curtly responds: 'And yet there is a great deal of money made here; good morning, sir.'[12] If I can drill and make money…

From this historical standpoint, climate change is not so much a surprising reversal of fortunes as a *lifting of the veil* on two centuries of fossil capital – which is, of course, the literal meaning of the Greek word *apokalyptein*.[13] The truth has been hidden from view; the present moment reveals the meaning of what has been going on for a long time. Benjamin's angel of history 'sees one single catastrophe, which keeps piling wreckage upon wreckage and hurls it at its feet'; Theodor Adorno concurs – 'normality is death' – but emphasises that the eternity of horror 'manifests itself in the fact that each of its new forms outdoes the old. What is constant is not an invariable quantity of suffering, but its progress towards hell: *that is the meaning of the thesis of the intensification of antagonisms.*'[14] From the very start, at the very smallest scale – in the hot factory, the smoky street, the mine laden with explosives – there emerged a pattern – some swept away by the storm we call progress, others sailing to their fortunes – subsequently magnified and iterated on progressively larger scales, until climate scientists discovered it in the biosphere as a whole, where the self-similar storm now spirals on. Every impact of climate change unfolds a fraction of that hitherto folded past.

Why engage in a lost cause?, sceptics might ask of the struggle against climate change, and not without reason. But fighting from a position of defeat is nothing new: global warming is itself a sum of lost causes. Commoners and Luddites and plug drawers and innumerable other vanquished challengers counsel us to rethink 'the moment of the danger' as extreme and unprecedented *by dint of* being the latest manifestation of

the past. Or, in Benjamin's supremely visionary words: 'The only historian capable of fanning the spark of hope in the past is the one who is firmly convinced that *even the dead* will not be safe from the enemy if he is victorious. And this enemy has never ceased to be victorious.'[15] Benjamin's conception of history – his voluntaristic messianism, organised pessimism, revolutionary melancholia – draws its inspiration from the heritage of the oppressed in order to derail the ultimate disaster of the present. And what is needed today, if not some global edition of the Plug Plot Riots? Go and stop the smoke! That might seem like an exceedingly improbable event, but political action can never be based on probability calculations – that would be swimming with the tide or sailing with the storm. At the time of this writing, a global climate movement is gathering momentum.[16] It should be the movement of movements, at the top of the food chain, on a mission to protect the very existence of the terrain on which all others operate, but the question is – as so many have pointed out – whether it can attain that status and amass a social power larger than the enemy's *in the little time that is left.*

But then again, every truly revolutionary movement has faced a similar predicament, as understood by Benjamin. 'Marx says that revolutions are the locomotive of world history. But perhaps it is quite otherwise. Perhaps revolutions are an attempt by the passengers on this train – namely, the human race – to activate the emergency brake.' The prospects are dismal: hence the need to spring into action. As in previous emergencies, but now more than ever, as we soar above 400 ppm, we must 'accept symptoms of collapse as the quintessence of stability and see salvation alone as something so extraordinary as to pass understanding and verge on the miraculous'.[17] The only ones with at least a hypothetical ability to conjure up that miracle are humans.

Acknowledgements

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Alf Hornborg is my sheikh. More than anyone else, he made me see how thoroughly power and nature have become interfused, how accelerating degradation of the environment must be understood in relation to escalating injustices, how progressive scholars and activists ignore that nexus at their peril. I owe him an immense debt. He supervised my thesis; Stefan Anderberg was my co-supervisor; the LUCID PhD students were my colleagues: I thank them all. Also, many thanks to the Human

LT – Leeds Times
MC – Morning Chronicle
MECW – Marx Engels Collected Works
MG – Manchester Guardian
MM – Mechanics' Magazine
NCC – Nature Climate Change
NG – Nature Geoscience
NLR – New Left Review
NS – Northern Star
NSAS – The New Statistical Account of Scotland
NYT – New York Times
PC – Preston Chronicle
PIVRSB – Papers on Irwell Valley Reservoir Schemes (Bolton)
PIVRSP – Papers on Irwell Valley Reservoir Schemes (Preston)
PNAS – Proceedings of the National Academy of Science
PP – Parliamentary Papers (House of Commons)
PTERC – Papers of Turton and Entwistle Reservoir Commissioners
PTRSA – Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences
RFIHYE – 'Report of the Factory Inspectors for the Half-Year Ending…'
RHO/OPBCE – Records of the House of Commons, Opposed Private Bill Committee Evidence
SPCK – Society for Promoting Christian Knowledge
TBNHS – Transactions of the Buteshire Natural History Society
TE – The Economist
TT – The Times
UNCTAD – United Nations Conference on Trade and Development
WR – Westminster Review

Notes

1. In the Heat of the Past

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5 G. Holland and C. Bruyère, 'Recent Intense Hurricane Response to Global Climate Change', *Climate Dynamics* 42 (2014), 617–27; A. Robinson, C. Reinhard and A. Ganopalski, 'Multistability and Critical Thresholds of the Greenland Ice Sheet', *NCC* 2 (2012), 429–32; C. Duarte, T. Lenton, P. Wadhams and P. Wassmann, 'Abrupt Climate Change in the Arctic', *NCC* 2 (2012), 60–2; G. Breed, S. Stichter and E. Crone, 'Climate-Driven Changes in Northeastern US Butterfly Communities', *NCC* 3 (2013), 142–5; A. Sorg, T. Bolch, M. Stoffel et al., 'Climate Change Impacts on Glaciers and Runoff in Tien Shan (Central Asia)', *NCC* 2 (2012), 725–31; L. Zhou, Y. Tian, R. Myneni et al., 'Widespread Decline of Congo Rainforest Greenness in the Past Decade', *Nature* 509 (2014), 86–90; J. Elliott, D. Deryng, C. Müller et al., 'Constraints and Potentials of Future Irrigation Water Availability on Agricultural Production under Climate Change', *Proceedings of the National Academy of Science* [hereafter *PNAS*] (2013), online first; G. Luderer, R. Pietzcker, C. Bertram et al., 'Economic Mitigation Challenges: How Further

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7 P. Robbins, *Political Ecology: A Critical Introduction*, Malden, 2004, xv–xvii.

8 S. Mosley, *The Chimney of the World: A History of Smoke Pollution in Victorian and Edwardian Manchester*, Cambridge, 2001, 20.

9 N. Smith, *Uneven Development: Nature, Capital, and the Production of Space*, Athens GA, 2008 [1984], 220–1 (quotations from Ed Soja, Michel Foucault, John Berger), 233–4.

10 G. Unruh, 'Understanding Carbon Lock-in', *Energy Policy* [hereafter *EP*] 28 (2000), 817–30.

11 K. Anderson and A. Bows, 'A New Paradigm for Climate Change', *NCC* 2 (2012), 639.

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14 Quotation from M. Schaeffer, W. Hare, S. Rahmstorf and M. Vermeer, 'Long-Term Sea-Level Rise Implied by 1.5°C and 2°C Warming Levels', *NCC* 2 (2012), 869. See further N. Gillett, V. Arora, K. Zickfeld et al., 'Ongoing

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16 S. Gardiner, *A Perfect Moral Storm: The Ethical Tragedy of Climate Change*, Oxford, 2011, 8, 33–4; for the full argument, see chs. 5–6.

17 R. Nixon, *Slow Violence and the Environmentalism of the Poor*, Cambridge MA, 2011, 2, 11.

18 P. Friedlingstein and S. Solomon, 'Contributions of Past and Present Human Generations to Committed Warming Caused by Carbon Dioxide', *PNAS* 102 (2005), 10832–6.

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20 T. Cole, *Open City*, London, 2011, 28.

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16. A Time to Pull the Plugs

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15 Benjamin in Löwy, *Fire*, 42. Emphasis in original.

16 See Klein, *This*, part 3.

17 Benjamin in Löwy, *Fire*, 66–7; Benjamin, *One-Way*, 57.

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