Bioenergy, Thermodynamics and Inequalities

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> How much blood there is in my memory …
> Look at the tadpoles of my prodigious ancestry hatched inside me!
> Those who invented neither gunpowder nor compass
> those who tamed neither steam nor electricity …
> *Heia* [praise] for those … who give themselves up to the essence of all things …
> free of the desire to tame but familiar with the play of the world …
> Pity for our conquerors, all-knowing and naïve!
>
> Aimé Césaire (1969 [1939], pp. 63, 72, 75, 76)

> What irony is often hidden in this sign of equality.
>
> Emile Meyerson (2002 [1908], p. 283)

This chapter takes a step back from the empirically-detailed studies of the bioenergy boom in Latin America, Asia and Europe that comprise the bulk of this book in order to focus on some of its underlying historical dynamics. It does so out of the conviction that only an activism that takes account of the exploitation and appropriation common to specific instances of bioenergy development is likely to be effective in the long term against the degradations, threats to survival and inequality-generating mechanisms that it entails.

The chapter concentrates mainly on the contradictions of the thermodynamic energy developed in the 19th century, as a background for sketching how bioenergy perpetuates and accentuates these contradictions, and what the consequences are for biofuel developers, energy transition enthusiasts and bioenergy critics. Interleaved with this exposition are reflections on how social movements might place themselves more strategically in bioenergy struggles.

Thermodynamic Energy as Politics

There's little point in studying bioenergy without some idea of what it is. Clearing away some common confusions, anachronisms and teleologies is crucial at the start.

The biggest confusions are around energy itself, not just bioenergy. These confusions can be found in the writings of many respected contemporary historians such as E. A. Wrigley (2010), Rolf Sieferle (2010), J. R. McNeill (Steffen et al. 2011), Kenneth Pomeranz (2000) and Vaclav Smil (2017). Such writers tend to assume lazily that every society in history has possessed fundamentally the same hunger for greater and greater supplies of an item they call "energy." They seldom define this item or inquire into its history. For example, Wrigley (2010, pp. 42, 44, 191, 205), Sieferle (2010, p. 137) and McNeill (Steffen et al. 2011, p. 848) each write that an energy "bottleneck" in pre-industrial societies frustrated an intrinsic, pan-human desire for growth – a bottleneck that was only broken with the advent of the fossil fuel era in 19th-century Europe.

But there was no such bottleneck (Malm 2016). There was no such energy. The practice and theory of energy, energy stocks and energy sources that we take for granted today did not exist before 1800. It took an immense amount of hard work to create them. At the turn of the 19th century, there existed no extensive industrial energy-conversion and transfer infrastructure capable of uniting and commensurating different kinds of what only later came to be called "energy" into what seemed to be a single, indestructible, abstract force or substance that could be said to "appear in electrical, thermal, dynamical, and many other forms" (Kuhn 1977, p. 78). It was not yet possible to disentangle, or think about disentangling, so many kinds of activity – ranging from muscular exertion to wood burning to falls of water – from the wide multiplicity of social or natural contexts in which they were embedded, re-entangle them into systems of exchangeable "equivalents", and accumulate the transformed result into a single pile. Before then, as historian Joel Mokyr (1999, pp. 20-21) observes, "the notion that a horse pulling a treadmill and a coal fire heating a lime kiln were in some sense doing the same thing would have appeared absurd." Wood was not being used to produce motion; water mills were not being used to produce heat. A charcoal fire or bullock drawing a plough through a field were not instances of characterless, quantifiable "energy consumption". Energy had neither use-values nor exchange value because there was nothing identifiable as such that could be valued. There were no "energy companies." There was no "energy sector." There was no "energy outlook", "energy planning," nor "energy transition," nor any "energy alternatives." Nor could there have been much use for units of measurement like joules, BTUs, kilogramme-metres, ergs, dynes, calories, therms, newtons, or barrels of oil-equivalent, most of which would have been hard to explain to anybody living before the 19th century. Concepts such as "energy return on investment" (EROI) would have been incomprehensible. Although steam engines were already being used early in the 18th century for specialized purposes (indeed there were toy steam engines in ancient Greece), they had not yet begun to convert the latent heat of coal stocks into mechanical energy on a scale sufficient to restructure whole industrial, transport and shipping systems. The electric batteries first described in 1800, which transform chemical energy into electrical energy and back, were as yet only a curiosity. Dynamos for converting mechanical energy into electricity, which were invented around 1830 and achieved industrial significance in the 1870s, did not even exist. Nor did electric motors for converting electricity back into mechanical energy, which appeared only in the 1830s and were embedded into industrial practice only in the 1890s. It was only in the mid-19th century, similarly, that the telegraph began to embed the mutual convertibility of electricity and magnetism into everyday experience worldwide. Solar cells capable of converting sunlight to electricity were not built until 1839. Internal combustion engines for converting chemical to thermal to mechanical energy, although conceived before 1800, began to be marketed only in the 1860s and 1870s.

Correspondingly, it was only between around 1820 and 1850 that today's scientific and technocratic *concept* of energy (if anything that remains so incoherent can be called a concept) began to take shape via thermodynamics. Thermodynamics came principally out of the need of a certain privileged group of male Northern Europeans to theorize industrial heat engines. The First Law of Thermodynamics in particular can be said to have rationalized the organization of frontiers of appropriation for *all* the conversion devices and industrial machines that today figure so prominently in competitive capital accumulation. (See BOX: Thermodynamics: The First and Second Laws.) Thermodynamics helped machines provide business with labour productivity increases, labour discipline, labour concentrations and relative independence from a multitude of ingrained human and more-than-human rhythms, as well as speedier realization of the value of commodities (Malm 2014, Huber 2009). The "regulative idea" of unified energy shaped 19th-century physics partly around the need to map, merge and exploit new and emerging scarce resources as effectively as possible. To adapt the words that Naoki Sakai (1997, p. 41) uses in another context, the emergence of energy science, like that of so many other disciplines, was not "determined by the existence of its object." It would be more accurate to say that the object that emerged was "made possible by the existence of the discipline" – or, to be more exact, the sub-discipline of its social and geographical management and public relations apparatuses. In Cara New Daggett's (2019, p. 37) summary, what we call energy is a "specific concatenation of human-machine experiences in 19th-century industrial Europe," not a "natural fact that was discovered by European men, revealed to adorn a growing pile of human knowledge about the world."

Thermodynamics: The First and Second Laws

In 1865, the great German physicist Rudolf Clausius summarized thermodynamics in two laws:

1. The *energy* of the universe is constant.
2. But the amount of *usable energy* declines (*entropy* tends toward a maximum in a closed system).

The first law encouraged capitalists to try to put the entire universe to work. It conceptualized a monolithic "energy" that was inexhaustible. It was also interconvertible. Whatever capital needed to make machines run – mechanical force, heat, electricity, magnetism, light – could be conjured up from any other form of energy was lying around, given enough ingenuity.

The second law revealed the other side of the story. It showed that the more that capital instrumentalized waterfalls, fire, wind, coal and so forth as being mere aspects of the great pool of abstract energy, the less of that new energy actually became available for capital's own use. That helped linear time became more hegemonic worldwide, in the shape of an arrow indicating a one-way journey toward degradation.

The contradiction between the two laws reflects the contradictions of the capitalist society that gave rise to them. The first law helped capital treat the world as a limitless, fungible resource. The second law exposed the flip side: waste, pollution and disorder that would ultimately cripple industrial capital itself.

Yet even after the First Law began to be formulated, energy was still not treated as a single abstract fluid, universal fuel or strategic resource that could be transferred in large quantities over long distances. The first articulations of the Law set up methodologies for calculating equivalences among previously-separated domains like motion and heat, but did not mention conservation or transformation of a singular energy. For example, James Joule, the brewing capitalist who in the 1840s struggled to fix a mechanical "equivalent" for heat, "never said that all forces are essentially differing manifestations of the same ontological 'thing'" (Mirowski 1989, p. 42). That reification was introduced by Lord Kelvin in 1851. Even at the turn of the 20th century, textbooks were still presenting the First Law more as a "principle of equivalence" than as the "principle of conservation of energy" (Coelho 2009, p. 2651). To be sure, the latter usage – which to some extent encourages the reification of energy – became the popular way of referring to the First Law. As the historian of economics Philip Mirowski (1989, p. 13) observes, the "concept of a conservation principle is practically inseparable from the meaning of 'energy'." Yet the development of "energy" as a fetish-object has continually been undermined by the very sciences that help make the fetish possible. By the 1880s, Hermann von Helmholtz found himself “in cautious retreat from the conception of energy as a mechanistic substance” (Mirowski 1989, p. 47). In 1918, the Göttingen mathematician Emmy Nouther’s Theorem “drove another nail into the coffin of energy as a substance,” cementing a sense among physicists that “energy was not really any one thing, but rather a flexible means of expressing symmetry principles” (Mirowski 1989, p. 72). In 1943, the Harvard physicist P. W. Bridgman argued that energy was just too “hybrid” for it to be possible to set up a “parallelism” between it and “ordinary material things” (Bridgman 1943, p. 115). In the 1960s, the Nobel physicist Richard Feynman was famously careful to remind his audience that the First Law had never actually described “anything concrete”: “it is just a strange fact that we can calculate some number and when we finish watching nature go through her tricks and calculate the number again, it is the same … in physics today we have no knowledge of what energy *is*” (Feynman 2010, 4.1). By 2011, it was possible for one prominent thinker to define energy simply as a “relationship of difference that tends to eliminate itself,” a “gradient across which there is a tendency to even out and dissipate” – that is, as a *form* rather than a *substance* (Deacon 2011, pp. 218-219). Nothing could be further from the technocratic picture of energy as a fuel with sources dotted around the landscape. Yet in a sense, this conception of energy as form rather than substance has been present from the very beginning of thermodynamics. It derives ultimately from the inspired analogy explored by the early 19th-century French thermodynamicist Sadi Carnot between the “falls” (*chutes*) of water that river mills captured and the “falls” from hot to cold that made heat engines work (Carnot 1988 [1824]). Although Carnot himself thought of heat as a substance, his metaphor paved the way for thinking of energy in terms of relations and terrains rather than of magical stuff.

Throughout its early development, energy science was created largely by engineers who shared the interests of business. “An *economic* point of view formed the root of thermodynamics,” historian Theodore Porter (1994, p. 141) emphasizes. “Economic and physical ideas grew up together, sharing a common context.” As historians of science Crosbie Smith and M. Norton Wise (1989, pp. xx-xxi) note, the mathematical physics of Lord Kelvin was “thoroughly permeated” by an industrial capitalist cosmovision. Nor would energy as we know it have come into being without empire. Helping merge and reorganize activities belonging to diverse networks of life into a monolithic, unitary “energy” supporting worldwide deployment of steam engines, vortex turbines and transatlantic cables, the First Law of Thermodynamics is one of the mechanisms of enclosure of commons across Europe, India, Africa and the Americas. AIt is also an integral part of what accompanied enclosure: the mobilization of millions of newly-landless labourers and slaves in centers of mechanization and the increased dominance of commodity exchange in providing the necessities of life. Likewise central in cementing the abstraction that is thermodynamic energy into world politics was the growing industrial importance of the extraction of coal, oil and gas, without whose abundance and density energy could never have “come to signify fuel as an object in need of governance” (Daggett 2019, p. 3). It was not that there had always existed a primordial pan-human need for more and more abstract “energy” that fortunately just happened to be relieved one day by fossil fuels. Rather, the emergence of fossil fuels played a part in creating the very concept of thermodynamic energy that we use today – transportable, accumulable, unbounded by seasons, air and water currents, or the land. Of course, for millions of years, long before *Homo sapiens* came along, processes had been going on that were later described as the transformation of sunlight into thermal energy, thermal and chemical energy into mechanical energy, mechanical energy into electricity, and so forth. None of that began in the 19th century. But without post-1800 imperial restructurings of the political relations among humans and nonhumans across the world, it would never have became possible for dominant classes to believe that they could understand what energy was without first having to try to translate it into non-thermodynamic idioms that would reveal its parochial orientation (Sakai 1997).

But if capital and empire made thermodynamics what it is, thermodynamics fully returned the favour (Daggett 2019). Energy science became an integral part of an imperial narrative featuring an abstract substance capable of making industrial machines mobilize and augment a theoretically unlimited amount of capitalist human "work," or carry out what early 19th-century Cornwall engineers measured as the "duty" done by given quantities of coal (Cardwell 1993, p. 117). This substance was pictured as being available anywhere on earth or off it. It became possible for maps to link and organize interchangeable "sources" of it. Coal seams, oil fields, uranium deposits, rivers with steep drops, peninsulas prone to steady high winds, deserts with high rates of insolation, forests with chippable trees, or stretches of soil suitable for oil palm, jatropha or sugar cane could all be marked (in the same colour, as it were) as locations from which this abstraction could be derived. These locations could easily be made to overlie, overlap or even obliterate more traditional geographical features such as cultivated land, indigenous territories, water sources, grazing grounds, customary property or political boundaries, and so forth. It is through hundreds of thousands of concrete actions like this mapping process that the abstract energy symbolized in the First Law of Thermodynamics has become a real part of the world, entangling itself into the emergent "abstractified" forms of work, society, space, water and nature that to some extent preceded it on the early modern landscape.

Today's thermodynamically-rationalized "biofuel complex," for instance, has engendered a new concept of "marginal land" in the tradition of older colonial notions of "waste" and *terra nullius*. Areas of land identified through remote sensing as "non-competitive" for purposes of industrial food production become acceptable sites for energy extraction on a par with deposits of peat or oil shale. In common with the 20th-century notion of "sacrifice zones" (National Academy of Sciences 1974), this geographic/thermodynamic methodology tends to put into shadow many other features of the land in question (Nalepa and Bauer 2012). These include not only the capacity to supply medicine, provide building materials, and sustain hunting, gathering, grazing and subsistence farming. They also include the plural non-thermodynamic or "little-e" energies (Lohmann and Hildyard 2014) inherent to the territory, maintaining the mutual incommensurability of which is often central to local livelihood strategies and to resistance to the encroachments of big capital and the state.

In addition to augmenting a notion of efficiency that has formed part and parcel of modern racism and colonialism (Daggett 2019, Alexander 2008), the energy abstraction has also significantly expanded the domain of global scarcity. Until firewood from a common woodland becomes "energy," it is not necessarily scarce in an economic sense (Lohmann and Hildyard 2014, pp. 63-64; Illich 1983). Correspondingly, it is only with the emergence of thermodynamic energy that modern waste really comes into its own as a global entity, as well as the types of human labour that are needed to help clean up, reuse, manage, stow, absorb or hide it. In unifying disparate ways of enabling, organizing, aggregating, rejiggering, coordinating, augmenting, accelerating and disciplining a multitude of irreversible Carnotian "falls" or erosions of difference across broad geographies that are both spatial and temporal, human as well as more-than-human, thermodynamic energy unavoidably generates forms and volumes of "waste" energy specific to the age of the Second as well as the First Law of Thermodynamics. This is so whether the "falls" in question are waterfalls driving mill wheels, water sluicing through dam penstocks, air impacting on the blades of windmills, "falls" of electrons through the electrolyte of batteries connected to closed circuits, "falls" of soil fertility into sterility on industrial biomass plantations, or – most crucially of all – "falls" from hot to cold within heat engines (which are in turn made possible by "falls" from the chemical remains of Carboniferous-Era organisms, via reactions producing heat, into ash and carbon dioxide). Water cannot be returned to the height from which it falls using only its own energy, nor ash, heat and CO_2 reassembled into coal. That makes it all the more imperative to find cheap ways of clearing detritus out of the way so that costs can be saved. Any locomotive that is to go on pulling railway coaches has to be provided with a place to vent its smoke and workers to clear it of ash. Every Google translation machine needs dedicated, cheap living human or non-human activity to clean away the debris it generates, whether it be carbon dioxide or inappropriate word sequences. Every watt of commodity electricity that results in a certain amount of diffused boiler heat will result in that heat's becoming "waste" insofar as selling it to keep people's houses warm is unprofitable (Pirani 2020).

But usable energy can become "waste," too, just by being allowed to lie around unused. So can a great deal of unusable energy that has not resulted from industrial processes but still turns out to get in the way of the kinds of landscape reorganization theorized and facilitated by thermodynamics. For example, the "falls" of river systems that are not exploited with hydroelectric dams that "break" the falls become viewed by technocratic organizations such as the Mekong River Commission as "wasted resources," much to the bemusement of communities that have depended on them for generations. Other wastes emerge after the dams are built and the reservoirs behind them silt up, removing the "fall" and necessitating abandonment or dredging that must be powered via the exploitation of further "falls" elsewhere. Even the space that a quiet lake occupies can suddenly start looking like "waste" when the ratio of "usable" to "unusable" energy in it is revealed to be lower than that of a waterfall. The wider the scope and spread of heat engines, batteries and generators, and the greater the length of energy conversion chains (Smil 2017, p. 26), the bigger the complex generating thermodynamic waste. Every leap in labour productivity wrought by the thermodynamic organization of energy engenders a commensurate increase in demand for management and concealment (Daggett 2019) of that waste. Insofar as thermodynamic energy amounts to a running modification of landscapes to organize and break "falls" in pursuit of a good structured as unlimited (Hornborg 2001), it is also a shorthand for the unlimited expansion of the frontiers of degradation. It is not so much that the need for thermodynamic energy necessitates the political re-engineering of territories, including their peoples. In a more elegant formulation, thermodynamic energy *is* the re-engineering of territories.

This "denaturalization" of the history of energy (Bonneiul and Fressoz 2016, p. 64) helps us understand thermodynamic propositions not only as valid science, but also as chunks of political ideology that tend to cover over resistance to the hegemony of modern energy itself. Take, for example, the Second Law of Thermodynamics. (See BOX: Thermodynamics: The First and Second Laws.) In the end, as the literary historian and physicist Barri Gold (2010, p. 9) observes, the Second Law concept of entropy "as a measure of energy beyond our use" cannot escape questions such as: "What use? And who's *we*?" That generically anthropomorphic "we" (Georgescu-Roegen 1975, p. 351) would be very unlikely to include indigenous peoples for whom what physicists would call the "unavailable" or "disordered" energy in a calm lake is far from useless, or peasants who deny strenuously that the kinetic energy in a fast-flowing river is "wasted" unless converted into hydroelectricity. The reality, indeed, is that thermodynamics tends to hide a vast, churning, enduring "underground" of anti-thermodynamic energies. These energies are around us always and everywhere, in cities as well as rural areas, in hospitals and factories as well as irrigation systems. They include – to take a few examples at random – the growth of vegetables in contemporary urban gardens in Milwaukee; the everyday interactions among staff in a power station in Berlin; the burning of commons firewood in Chiang Rai; the "quality of thought" sustaining the integrity and strength of the cosmological components of the water-hill-village systems of Totonac communities in the Sierra Norte de Puebla (Smith 2007); as well as millions of others. The very logic of these energies militates against aggregating them with one another and disentangling them from the limited goods of subsistence in the manner of the First Law of Thermodynamics. It also militates against becoming overly preoccupied with the Second Law, whose barrier to a notional "ideal efficiency" is always more of an object of dread to capitalist technocrats and ecological modernizers than to ordinary people. For millions of individuals virtually all of the time, and for everybody at least some of the time, the refusal of thermodynamic energy's claim to be able to subsume anti-thermodynamic energies into itself is simply a matter of survival and common sense. So, too, just as Cartesian space cannot subsume, but must coexist with, vernacular places, professional management and concealment of ever-exploding volumes of thermodynamic waste is incapable of replacing the myriad, homely ways of working the vernacular wastes of commons – through which, for example, food waste is integrated into animal-raising, animal waste into field care, and plant waste, cleaned up and recycled through fire, into the care of grain, forests, water and humans alike. From a subsistence perspective, such practices are not "renewable energy." They are not energy at all. They do not exemplify efficiency and are not productive of anything except themselves. It is only when the heat source (the frontier of "usable energy") for the industrial engines that thermodynamics has worked to improve becomes a "real abstraction" that the heat sink (the zone of high entropy) becomes a capitalist obsession and global environmental issue. A community striving to take care of a local stream that never runs dry is typically not preoccupied with Wilhelm Ostwald's thermodynamically-inspired "energetic imperative": "do not waste any energy, make it useful" (Ostwald 1912, p. 85) nor Nicholas Georgescu-Roegan's (1971) thermodynamically-inspired Malthusian cautions. For such a community, the Second Law is not necessarily a problem, any more than a perpetual motion machine that ignores the Second Law is a "sublime object of ideology" (Zizek 1989). Nor would there be any point in praising such a community for "efficiency." Efficiency as understood today, riven by some of the same deep contradictions that afflict capital and thermodynamics (Polimeni et al. 2008), derives from a different context, that of industrial machines and their interpolation into societies organized around limitless capital accumulation.

The irony is – and this is an insight that is unfortunately missing from nearly all current global energy and climate debates, including debates over bioenergy and the so-called "energy transition" – that anti-thermodynamic energies are not only ubiquitous, but also, paradoxically, essential to maintaining the precarious status of thermodynamic energy itself. Together, the two form an unstable combination in what David Harvey (2014), following Marx, might call a "contradictory unity" analogous to those that uneasily link living and dead labour, use value and exchange value, unpaid reproductive work and wage labour, commons and capitalist forms of socionatural organization. Unavoidably "inside" the monolith of official energy can always be found a "hidden abode" (Fraser 2014) inhabited by a plurality of vernacular energies that it converts, commensurates, parasitizes, degrades and exhausts, yet which through their very opposition make it possible to accumulate surplus value (Toscano 2018). To capitalist planners, for example, a common woodland may at first sight look like either raw material for thermodynamic energy or an obstacle to be cleared to make way for a hydroelectric dam, oil refinery or wind farm that produces more of it. Yet when economic crises hit and the planners themselves face redundancy, they may suddenly find themselves "recognizing" the woodland's non-thermodynamic energies as a useful zero-cost subsidy that helps maintain local workers while they await re-employment in the service of machines powered by sources of thermodynamic energy. Or the planners may find themselves paradoxically dependent on the creative subversion that commoners exercise by thieving grid electricity to sustain subsistence systems dedicated to thwarting the commensuration of "little-e" energies into thermodynamic energy. In practice, it is only in conjunction with non-energetic, non-entropic or negentropic enclaves in commons and elsewhere that the massively energetic, massively entropic machines reliant on thermodynamic energy become capable of working for capital for any significant length of time.

To put it another way, thermodynamic energy did not emerge once and for all in the 19th century. It *continues* to emerge in tandem with frontiers of implicit or inchoate resistance to its dominance. With a bit of patience, this resistance can be recognized in every kitchen, back garden, slum, factory floor, or social movement fighting mining operations, biofuel plantations or even just local rights of way that highways catering to internal combustion engines threaten to break up. Thermodynamic energy is always under construction, but also always being undone, in millions of locations. Struggles contesting it, far from being based on hypothetical or utopian "alternatives," form one part of continuing, ubiquitous battles against enclosure of all kinds, including the dominance of the concept of resources. Any political struggle whose horizons extend beyond correcting prices, improving efficiency and securing wage work toward confronting patriarchy, racism, coercive capitalist social relations, commodity fetishism, and capitalist work itself is likely eventually to find itself joining in already-existing movements confronting the hegemony of thermodynamic energy (Ediciones Ineditos 2019, Daggett 2019). So will any climate movement that seeks to build solidarity with workers, peasants and indigenous peoples – including those struggling against oil extraction, bioenergy plantations and blockchain developments – instead of just playing around with trying somehow to ally itself with "physics" against a generic class of human carbon dioxide emitters (Davis 2019, Invernizzi-Accetti 2019). As Christophe Bonneuil and Jean-Baptiste Fressoz (2016, p. 63) emphasize, any serious response to the "shock of the anthropocene" will need, in a sense, to "free itself from … the very concept of energy" and the "project that brings every form of work (from brain to blast furnace) into a generalized equivalence."

Like so many other political projects of "masterful" abstraction, thermodynamic energy has a particular gender (Lutz 1995), a particular racial "colour" (Eze 1997, Dabashi 2015), and a particular class. It also has a deep-seated bias defying the practices of many oppressed groups who are accustomed to showing respect for a fire, a stream or a tool as "one of us" (Lenkersdorf 2008, Helmreich 2014). Finally, it sets its face against societies for whom "our history is the future" (Estes 2019) insofar as it superimposes the one-dimensional arrow of time of the Second Law of Thermodynamics on spiral or multidimensional time (Cusicanqui 2015), in which present and past events can be simultaneous (Anderson 2006, pp. 22-36; Martin 1987). Like the frequent white feminist failure to interrogate race, or the common failure of antiracism to interrogate patriarchy (Crenshaw 1989), any failure of liberation movements to interrogate thermodynamic oppression is bound to reinforce in many ways the subordination and unequal status of peasants, workers, women, indigenous peoples and the colonized everywhere.

Bioenergy as Thermodynamic Energy: Deepening the Contradictions

As is obvious from the other chapters in this book, adding the prefix "bio-" to energy changes nothing about its essential ecological and political characteristics. Bioenergy – in the sense used in this volume – is not an uncommensurating of the "little-e energies" referred to above nor a re-embedding of them in diverse commons practices. Nor is it a revalorization of pre-energy relations among human beings and the more-than-human. That path is blocked by the angel with the flaming sword. Instead, bioenergy is thermodynamic energy and remains subject to all its contradictions. Opening a new chapter in the co-evolution of fossil-fuel dependence and thermodynamics, bioenergy marks a continuation of the same anti-colonial and anti-capitalist struggles that were modified so decisively by the Northern European development of energy itself.

Bioenergy's challenge to coal, oil and gas, in short, is purely notional. Bioenergy demands that living biomass supplement and substitute for fossil biomass as precisely the same kind of universal "fuel" that thermodynamics helped make possible. Its claim to be a fossil-free thermodynamic energy is a delusional denial of that energy's very fossil inheritance. Far from confining itself to enlisting living plant matter to round out the low-cost self-provisioning of reserve and other armies of labour, bioenergy policy indeed jams it ever more forcibly down onto the painful Procrustean bed of industrial capital's thermodynamic abstractions. Four hundred times more forcibly, in fact, given that capital has long been committed to appropriating the thermodynamic "equivalent" of at least 400 years of current plant growth in the form of fossil fuels for every year it continues to exploit human labour (Dukes 2003), and is now asking living biomass to help it, *per impossibile*, to strive for the same objective.

Take, for instance, the aviation industry, which is attempting to treat living biomass as if it were fossil fuel in two different ways. First, aviation biofuels are supposed to be able to "substitute" for kerosene, in spite of the fact that an area of land equivalent to that of a medium-sized country would have to be found and permanently set aside to grow plant fuels thermodynamically capable of replacing aviation's share of world petroleum consumption, and in spite of the tremendously entropic follow-on effects. Second, fossil carbon emissions from aviation are supposed to able to be "offset" by yearly plant growth under the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). This would require the annexation of land areas of the same order of magnitude, together with the maximal formal and real subsumption of what is now called the "organism performance" of the most carbon-"productive" plant species and the ecosystems and human communities that are recrafted, degraded and progressively exhausted for the sake of their cultivation. This intensified dynamic of thermodynamic enclosure is likely to have similar outcomes at the grassroots regardless of whether it is impelled by national and international environmental regulation or by efforts to transform biofuels, carbon offsets or biopatents into commodities, assets, claims on rent, or objects for financial speculation – or by all of the above.

Arguably, that places today's battles against bioenergy projects at the very forefront of the two-century-old struggle resisting the rule of thermodynamic energy. The experience of – for example – the Indonesian woman migrant oil palm plantation worker in Malaysia (Puder, this volume) lies at the intersection (Crenshaw 1989) of multiple oppressions: landlessness, subjection to machine discipline, precarization, externalization of reproduction costs, nation, patriarchy, race, class – but now also the expanded hegemony of 19th-century thermodynamic energy, as increasing amounts of biomass are pressed into service as substitutes for energy-dense hydrocarbons. The Indonesian woman migrant cannot be spoken for by the male plantation worker, nor the Indonesian peasant woman, nor the formally-educated Northern critic of thermodynamics, nor a committee of the three. Yet while only she can say "when and where she enters" onto a path of liberation (Crenshaw 1989, p. 160), it is also true that only with her entry along that path that *others* struggling with thermodynamic energy can also enter.

In an important book analyzing what they call the "biofuel delusion," Mario Giampietro and Kozo Mayumi conclude (2009) that

> “we do not need alternative energy sources to keep alive an obsolete pattern of economic growth. What we need is an alternative pattern of development that will make it possible to use alternative energy sources” (pp. 256-7).

This chapter has sought to go a step or two further still, by exposing the contradictions inherent in the very act of treating cane ethanol, wood pellets or aviation biofuel as energy, as well as by asking whether it is worth even talking about an “energy transition” that does not challenge the dominance of thermodynamics itself. A strategically-effective critique of bioenergy developments has to go all the way down into energy itself.

One last way of summarizing the lesson of this chapter is to parse briefly the ways in which bioenergy developments involve what this book calls “global inequalities.” At a time when debates about energy equality are still overwhelmingly concerned only about the *distribution* of energy and of the costs of its production and circulation, it is more important than ever to stress that the prior issue is actually the *constitution* of energy. In a sense, inequalities are what thermodynamic energy is *for*. It should be no surprise that access to electricity, heat and motive power remains so skewed throughout the world, nor that so many have to suffer unjustly to make energy available to privileged classes and nations. From the beginning, thermodynamics itself has been organized in a way that suppresses practices that billions of people depend upon to flourish and subsist. It is an integral part of a political settlement achieved and precariously maintained since the 19th century under which frontiers of appropriation are organized to make it possible for fossil capital to go on getting something for nothing from a commons both human and more than human (Moore 2015). Global inequalities connected with bioenergy development and energy transitions cannot begin to be seriously addressed without addressing energy itself.

Over the last 50 years, the focus of discussions about the international object known as “development” has perceptibly shifted from “equal rights to development” to supposed “egalitarian forms of development,” and then to “development alternatives,” “alternatives *to* development” and, finally, the need to come to terms with the construction of development and its alternatives as itself being at the heart of inequality. In a similar way, the debate over energy to which this book contributes needs to move ever deeper toward recognizing and questioning the very politics of the concept.

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