

The Belly of the Revolution: Agriculture, Energy, and the Future of Communism

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In the days when man's members did not all agree amongst themselves, as is now the case, but had each its own ideas and a voice of its own, the other parts thought it unfair that they should have the worry and the trouble and the labour of providing everything for the belly, while the belly remained quietly in their midst with nothing to do but to enjoy the good things which they bestowed upon it; they therefore conspired together that the hands should carry no food to the mouth, nor the mouth accept anything that was given it, nor the teeth grind up what they received. While they sought in this angry spirit to starve the belly into submission, the members themselves and the whole body were reduced to the utmost weakness. Hence it had become clear that even the belly had no idle task to perform, and was no more nourished than it nourished the rest, by giving out to all parts of the body that by which we live and thrive, when it has been divided equally amongst the veins and is enriched with digested food — that is, the blood.¹

Many on the left still subscribe to a view of technology that G.A. Cohen, in his reconstruction of Marx's thought, called "the fettering thesis."² From this perspective, the technological forces that capitalism employs in its quest for productivity-driven profit are the foundation upon

which an emancipated humanity will erect its new dwelling. Humane cultivation of these forces is, however, “fettered” by capitalist social relations. Capitalism is pregnant with *what could be*, a deployment in the conditional tense of given productive forces. In a resonant moment of triumphal phrasing at the end of the first volume of *Capital*, Marx describes capitalism as tending toward a moment of crisis, its property relations an “integument... burst asunder” by the maturation of increasingly centralized and concentrated productive forces. The consequences, for Marx, are clear: “The knell of capitalist property sounds. The expropriators are expropriated.”³ At a critical point in the development of capitalism, the fragmented, unplanned allocation of wealth that characterizes production for profit in competitive markets no longer conforms with the complex, industrialized labor process of modern workplaces: only socialist planning and the supervision of the direct producers themselves can make effective use of the technology whose adolescence the bourgeoisie oversaw. Today, many will advance these arguments only with significant caveats, avoiding some of its more embarrassing iterations. Few would argue, for instance, that the deskilled, socialized labor of the factory system contains the germ of a new world in the making. They will not hesitate, however, to pour new wine into old bottles and say much the same thing about 3-D printers and self-driving cars.

The fettering thesis appears throughout Marx’s mature writings, especially in those rare, speculative moments when he considers the transition to communism. It sits uneasily, however, with a view developed most pointedly in his writing on large-scale machinery, in which the factory system actualizes capital’s control over labor, confiscating “every atom of freedom, both in bodily and in intellectual activity.”⁴ For much of the twentieth century, the fettering thesis dominated Left thinking about technology. Beginning in the postwar period, however, numerous Marxists set to work developing a critical theory of technology. Herbert Marcuse, Raniero Panzieri, and Harry Braverman, as exponents of the critical insights offered by the Frankfurt School, *operaismo*, and labor process theory, respectively,

revealed the many ways in which the productive forces of capitalism were saturated with the political imperatives of capitalism.⁵ Today, few people can fully ignore this critical legacy. Even the “accelerationist” authors of *Inventing the Future* (2015), whose primary hypothesis consists of a hyperbolic deployment of the fettering thesis, acknowledge that contemporary technology is sometimes inextricable from capitalist function at the level of design.⁶ Their solution seems to be a sort of mix-and-match theory of transition, in which we discard unusable technologies (nuclear weapons: bad) and cultivate useful ones (antibiotics: good). Such a view is possible, however, only if one thinks of technology as a series of discrete tools, rather than an ensemble of interconnected systems. I have attempted elsewhere to intervene in this discussion by providing a different way of looking at the problem.⁷ Rather than assume the Olympian point of view and ask ourselves what we would do with given technologies if we were allowed to rearrange things as we wish from one end of the earth to the other, we need to start with a much more difficult question: how do revolutionary struggles beginning in the here and now find a way to meet their needs, survive, and grow, while producing communism? Looked at from this perspective, there may indeed be arrangements of given productive means that are impossible because there is no way for them to unfold as the result of class struggle. History is, in this sense, like a board game in which there are appealing configurations of pieces that the rules render impossible. These arrangements can never result from a sequence of play.⁸

The standard assumption among Marxists and many others is that, despite its toxic excretions, the more developed technology becomes, the easier it will be to produce communism. But what if these technologies actually make it harder? What if they are also fetters, blocking attempts to break free from class society? This is obvious when it comes to the technologies for repression, surveillance and warfare, which have effectively removed certain revolutionary strategies from play. But consider, for example, the energy system upon which industrial and postindustrial capitalism is built. Few

people doubt that fossil energy use drives climate change by packing the air with greenhouse gases, and that these effects will massively constrain human and extra-human life over the course of the twenty-first century and beyond. The problem is that the energy system and the technology it powers is not at all modular; it is not possible to swap out dirty energy and swap in clean energy, even if all political obstacles were removed and some polity found itself able to rearrange the building blocks of industrial society as it saw fit. The technology they would inherit works with and only with fossil fuels. This lack of modularity is clearest in the case of the more than one billion vehicles built around combustion engines; these can be replaced by non-fossil energy only by manufacturing batteries through highly energy- and resource-intensive processes. At present, even if one were to ignore everything but the arithmetic of greenhouse gases — and given the highly destructive mining processes these batteries require, this means ignoring quite a bit — the benefits of such an energy transition are uncertain, especially if overall energy use continues to grow year on year. As for electricity itself, while one can generate it from cleaner, renewable sources such as wind and solar, the inconsistency of these sources means that, if people want continuous, on-demand energy (and most current technology requires it) they would need to invest massively in resource- and energy-intensive technologies for storage and transmission that would render the emissions-reducing benefits of such reconfiguration uncertain. The technologies of capitalism fit together into technical ensembles that exhibit a strong degree of *path-dependency*, meaning historical implementation strongly influences future development, precluding or making difficult many configurations we may find desirable. The authors of *Inventing the Future* are, by contrast, path autonomists. Their blindness to the way that technological systems fit together into non-modular ensembles is what leads them to assert, incredibly, that “clean energy technologies make possible virtually limitless and environmentally sustainable forms of power production.”⁹

The fettering thesis continues to manacle thinking about revolution

and technology in part because no alternative perspective has been consolidated. In the pages that follow, I build upon my previous work and consider the obstacles, infrastructural and technological, that a twenty-first-century revolution will encounter. I take as my primary object of inquiry agriculture and the food supply chain, the belly of the revolution, as I call it, not only because revolutions will either provision themselves or die but because agriculture and food supply depend upon all the other technical systems of industrial capitalism: energy supply, manufacturing, and logistics. In the ancient political fable I use for my epigraph, the belly admonishes the rebellious organs of the body, reminding them that if they revolt they die, since all nourishment passes through the belly before being distributed outward. This is the counterrevolutionary lecture that capitalism continually whispers into the ears of would-be rebels; its words are the technical arrangement of the means of production, the organization of the land and its powers.¹⁰ The two “revolutions” capital effected in the last half of the twentieth century — the green revolution and the logistics revolution — are really counterrevolutions. Together, they have reorganized agriculture and the food supply system in such a way that real revolutions must break with them or perish. Furthermore, as I will show, although many leftists continue to believe that these technologies provide the basis for an ecological reorganization of industry capable of warding off the worst effects of capital’s ecological destabilization, whether within capitalism or beyond it, these hopes are misplaced. Our best hope is communism, and communism means, as we will see, breaking the spine of this industrial infrastructure and ending the tyranny of the belly.

In order to respond to these old agrarian fables, we need a new theory of technology, one that reckons with path dependency. We also need to return to an insight that has been lost but which was at the center of Marx’s thinking — technology is nature, an organization of natural elements and powers.¹¹ The productive forces are social forces through and through, determined by the *social* relations of capitalism, but they are also *natural* forces. Technology utilizes, reconfigures,

and shapes nature, but part of what a path-autonomous view of technology overlooks is that the qualities and characteristics of natural forces themselves, along with social relations, determine the range of possible uses a technology affords. Here I find two new contributions to Marxist ecology, Andreas Malm's *Fossil Capital* and Jason W. Moore's *Capitalism in the Web of Life*, quite helpful.¹² Malm argues that the direction of capitalist development and industrialization was influenced by the difference between coal-fueled steam power and the water power that preceded it. As technologies, coal power and water power feature entirely incongruent profiles that have to do with the different natural forces they recruit as much as the social relations through which these natural forces are organized and developed; capitalist development selects from and eventually synthesizes these forces, based not only upon their ability to meet human needs but upon their fit with the imperatives of accumulation. Steam power cannot be made to do what water power can do, nor vice versa. The limits these technologies present to those who would adapt them are double: they have to do with their social character but also the material character of the powers and forces they use.

The natural and the social are not two separate layers, one base and the other superstructure, but intermixed. In Moore's account, capitalism is a way of "organizing nature"; capitalist reproduction involves the reproduction of certain social relations and institutions as well as the reproduction of nature in forms conducive to capitalist accumulation. Moore for his part emphasizes what he calls "the double internality" of "humanity-in-nature/nature-in-humanity."¹³ Reprising Marx's own dialectical understanding of human labor, where "man acts upon external nature and changes it, and in this way... simultaneously changes his own nature," Moore reminds us that humans are animals, whose social and cultural forms regulate a constant transformation of the material world, including themselves.¹⁴ An attentive reader of Justus Von Liebig's works on soil chemistry, Marx borrowed from Liebig the term *stoffwechsel* (metabolism) and used it to describe human activity in the most expansive sense.¹⁵

Liebig's term helped Marx to think about the transformative character of human activity, "a process between man and nature, a process by which man, through his own actions, mediates, regulates, and controls the metabolism between himself and nature."¹⁶ Largely associated now with biological processes internal to human bodies, metabolism is a particularly salutary concept for thinking the double internality. Metabolism captures the connection between the social belly and the belly as such. Neither Malm nor Moore put things in exactly this way but the implications are clear: the productive forces of capital are natural forces, their productivity derives not only from the organization of people and processes but also from the characteristics of various material elements, from powers of water, earth, air, and fire, from biological, chemical, and physical processes, from gravity, electro-magnetism, and the forces internal to atoms.

Town, Country, and the Double Internality

The romantic or post-romantic perspective on these matters opposes nature and technology — the machine in the garden and against the garden, the tractor as leveler of wilderness.¹⁷ But the garden is also a machine, a way of organizing nature. In a certain sense, the difference between these views is semantic. If nature means a forest, then it makes sense to see it as opposed to technology. If nature means something like fire, though, then it is easy enough to see it as both a spontaneously emerging extra-human force and a human technology. Agriculture and the food system mediate between these different meanings of the word "nature," since a farm is a collection of living things organized toward human needs, and unlike an oil refinery much more clearly both social and natural.

Agriculture is also the place where the relationship between capitalist social relations and labor-saving innovation is first established, as Robert Brenner's persuasive account makes clear. Brenner's writing on the transition to capitalism is, among many things, an argument against technicism and against the fettering thesis.¹⁸ The emergence of capitalism in the English countryside

did not naturally evolve through the increase-seeking decisions of peasants and lords, such that the underlying productivity gains in agriculture made feudal property rights into “fettters.” All things being equal, the direct producers and their exploiters under feudalism would struggle against each other in ways that stabilized feudal relations and inhibited increased productivity. Only a shock to this system could introduce a new set of specifically capitalist property relations in which producers were compelled to exchange their product on a competitive market in order to reproduce themselves. Medieval agriculture relied on fallowing to restore soil fertility, but in the sixteenth century a new agricultural regime emerged, chiefly in the Netherlands and England, based on crop rotation rather than fallowing. Planting of fodder crops would follow the planting of cereals, with no rest for the land. This had two advantages for soil fertility — the fodder crops, such as clover and alfalfa, were nitrogen-fixing rather than depleting, but they also fed animals that produced manure and thus fertilized the soil. Peasants were unable to adopt the system, however, given the open field system of property rights, where fallow lands were common property on which anyone could graze their animals. If anyone tried to plant fodder crops there, they would run the risk of having them eaten by someone else’s animals. Furthermore, the new system required more animals, not only to graze on and fertilize the newly cultivated lands, but also to replace human labor, since the activity required per cultivated acre increased massively in the crowded calendar of the crop rotation system, with more animals and lands requiring care and work.¹⁹ Most peasant producers were without these resources, relying on the labor of a single family and, at most, one or two animals. For all these reasons, crop rotation was adopted in the sixteenth century only when common lands were enclosed and the peasants turned into wage laborers who could then be set to work on larger, non-fallowing farms involving increased animal power and new tools. As yields per acre and per worker increased, the peasants whose lands had been enclosed were no longer needed as agricultural wage laborers. This provided the

engine for development elsewhere. As the productivity of labor in the countryside increased, ex-peasants dispossessed of their right to the land migrated to the towns, forming the labor pool for industry. Fed by the surplus of grain and meat, the towns fattened into cities. The takeaway here is that the reorganization of human society prompts a reorganization of nature. Changes in the relations of production prompt a change in the productive forces, whereas the fettering thesis imagines the reverse.

Agriculture is a complicated area of study in part because it is easy to confuse two important forms of technical change — land-saving innovations, which increase yield per acre, and the more familiar labor-saving innovations which increase yield per worker. The first agricultural revolution involved both types, but the chief importance of the crop rotation system was in land-saving. Afterward, and until the twentieth century, land-saving innovations were few and far between. Most of the important agricultural innovations of the nineteenth century were labor-saving and involved better use of draft animals through new tools and motorless machines for plowing, cultivating, and harvesting.²⁰ Moore argues that nineteenth-century increases in yields came primarily from aggressive farming on heretofore uncultivated land in the Americas, stripping it of nutrients and then moving on to new plots once the fertility plummeted.²¹ The nineteenth century also saw a scramble for fertilizer imports — first guano from South American islands, then saltpeter from South American deserts, but these extractable deposits were scarce and the imminent depletion of these resources formed the context for Marx's reading of Von Liebig and his critical commentary about the self-undermining character of capitalist agriculture. For Marx, the nineteenth-century crisis of soil fertility originated first and foremost from the division between town and country, which the transition to capitalism from agrarian society deepened rather than overcame. By concentrating workers and the natural fertilizers they produce in cities, capitalism "disturbs the metabolic interaction between the man and the earth, i.e., it prevents the return to the soil of its constituent

elements consumed by man in the form of food and clothing; hence it hinders the operation of the eternal condition for the natural resource of the soil."²²

As Marx saw it, the solution to this problem, the rebalancing of the metabolic interaction between humans and the land, involved a revolutionary project that has largely been forgotten despite its centrality to most nineteenth-century conceptions of society after capitalism: the overcoming of the division between town and country, returning human excrement to the land from whence it came. People forget that this was one of the revolutionary measures (many of them comparatively modest, and easily incorporated by liberal reformism) outlined by Marx and Engels's *Communist Manifesto*: "Combination of agriculture with manufacturing industries; gradual abolition of the distinction between town and country, by a more equable distribution of the population over the country."²³ The first part has already been achieved by today's factory farms and industrialized food systems, but once we read on we see that Marx and Engels imagined something very different: the breaking up of big cities, the localization and dispersal of food production, so that it was close to where people actually lived, and the dispersal of industry throughout the countryside, so that its polluting effects were mitigated. This was not a passing fancy but something that Marx and Engels referred to continuously from 1848 on, taken up by many of the socialists they influenced. Today, questioning urbanization or imagining the destruction of cities as part of a communist revolution is seen by accelerationists and other proponents of the fettering thesis as concomitant with primitivism, despite the centrality of these objectives to the nineteenth-century radical tradition.

Finding agreement on this point with the utopian socialists he typically criticizes, Engels puts it rather pointedly in *Anti-Dühring*:

The abolition of the antithesis between town and country is not merely possible. It has become a direct necessity of industrial production itself, just as it has become a necessity of agricultural production and,

besides, of public health. The present poisoning of the air, water and land can be put an end to only by the fusion of town and country; and only such fusion will change the situation of the masses now languishing in the towns, and enable their excrement to be used for the production of plants instead of for the production of disease.²⁴

For Engels, this does not mean isolated, autarkic villages. He remains a proponent of decentralizing some productive processes and centralizing others. Bebel, discussing the same thematic in his book *Women and Socialism*, notes that it is “due to the complete remodeling of the means of communication and transportation... that the city populations will be enabled to transfer to the county all their acquired habits of culture, to find there their museums, theaters, concerts halls, reading rooms, libraries.”²⁵ The abolition of town and country requires extensive coordination, and the communication of both goods and information. However, some things do not need to be and should not be so communicated. He continues:

Each community will, in a way, constitute a zone of culture; it will, to a large extent, itself raise the necessaries of life. Horticulture, perhaps the most agreeable of all occupations, will then reach the fullest bloom. The cultivation of vegetables, fruit trees, and bushes of all nature, ornamental flowers and shrubs — all offer an inexhaustible field for human activity, a field, moreover, whose nature excludes machinery almost wholly. Thanks to the decentralization of the population, the existing contrast and antagonism between the country and the city will also vanish.²⁶

On this point, contrary to received opinion, the Second International writers share a good deal with anarchist communists such as Piotr Kropotkin and Elisée Reclus, who also imagined an intermingling of industry and agriculture and, contrary to later mischaracterizations, saw need for balance between self-sufficiency and communist distribution among productive sites.²⁷ The difference between the

anarchists and the Marxists will of course concern the mechanisms whereby such coordination is achieved. Even on this point, however, Marx and Engels were less statist than many supposed, locating the ultimate power of decision in the hands of the people themselves, though both did have more faith in the possibility of a layer of administrators and technicians who could decide what goes where.²⁸

Moore argues that interpreters of Marx's writings on metabolism have reinstated a Cartesian duality (society vs. nature) that the concept was meant to transcend.²⁹ In places, Marx describes an "irreparable rift in interdependent processes of social metabolism," a formulation that has sometimes been read as describing a rift between nature and humans rather than, as Moore has it, a rift within "singular metabolism."³⁰ The split between town and country becomes, in this dualist reading, an ontological split between humanity and nature. What Moore proposes in the place of this cloven understanding is a picture of human and extra-human nature as a "flow of flows of matter and life."³¹ Humans are biological organisms, Moore reminds us, whose activity, building up matter into bodies and transforming living and nonliving things, is regulated by language and culture and other oddly powerful mediations such as value. But thinking the unity of humanity and nature does not overcome the practical rifts in this flow of flows; it does not overcome the division between town and country, which is a real break within matter, not merely a theoretical one. For Marx, there was no contradiction between thinking humanity as a part of nature *and* separate from nature; this was because, at a practical level, humans were a part of nature that had separated itself from nature. Through labor "man regulates and controls the metabolism between himself and nature" and at same time "confronts the materials of nature as a force of nature."³² This is not an epistemological division so much as a real one, and dealing with its effects requires practical reorganization of the relationship between humans and nature, not a mere rethinking of the problematic. Moore has little to say about this practical reorganization, and misses what is a fundamental point for those of us investigating these matters from a

revolutionary perspective: the abolition of the division between town and country and the metabolic rift stands as part of the *realization* of the double internality, the instantiation of a state of affairs in which humans no longer stand over and against external or internal nature.

Filling in the Rift

The union of industry and agriculture that Marx and Engels and others advocated has happened, but not at all in the way they imagined. In one sense, the old oppositions between town and country have vanished in the developed world and in most of the developing world too. One can browse the web via smartphone from many a backcountry road. Farms operate with million-dollar machines as complex as those in any factory. And yet, the rifts remain, widening every year; our food travels ever-greater distances from farm to table and undergoes complex industrial processes before being digested by us. The fundamental issue which Marx and Engels identified, that the resources which are taken from the soil are not returned to it, remains with us in a transmuted form. Soil fertility is limited first and foremost by the amount of biologically available nitrogen; such nitrates and ammonia are produced regularly from atmospheric nitrogen by bacteria, a process that can be sped up by certain crops, such as legumes. Biologically available nitrogen is also found in decaying plant material and in manure and human waste. The rate at which nitrogen can be converted to a usable form is limited, however, and even the most careful management of inputs and waste material runs the risk of depleting the soil. Without nitrogen, plants cannot produce protein, and without plant protein humans and other animals cannot produce themselves.³³ The nitrogen cycle is “singular metabolism” in a very basic sense, a chain of biochemical reactions moving from the air to soil and back to air, passing through the bodies and bodily excretions of plants, animals, and humans. In the twentieth century, the limits of various systems of managed organic inputs, such as the crop rotation discussed above, were radically transcended by the invention of the Haber-Bosch process, which uses natural gas to

convert atmospheric nitrogen into ammonia. As such, the amount of nitrogen now available is constrained only by the supply of natural gas. The invention of nitrogen-fixing technology averted the imminent crisis of soil fertility Marx and Engels identified, obviating the need to return organic wastes to the land, and therefore widening the metabolic rift while filling it in with megatons of synthetic fertilizer.

One of the most intriguing moments in Malm's *Fossil Capital* (2015) may help us theorize the shift to synthetic nitrogen, developing our sense of the ways in which productive technologies incorporate both social and natural forces whose character strongly determines their possible use. Malm helpfully extends Marx's categories of formal and real subsumption in order to explain the difference between water power and steam power.³⁴ Most attempts to expand these important categories misconstrue their original meaning for Marx, or attempt to make them the basis of an impossible periodization.³⁵ Subsumption is often seen as identical to commodification — that is, producers are subsumed when they are made market dependent and begin to produce for exchange. Subsumption as Marx defines it, however, has to do with the labor process and with capital's control over workers. Formal subsumption occurs when capitalists take over an existing labor process, owning the means of production that peasants or artisans formerly possessed as well as the products generated by those means of production, and paying wages out of the revenue they earn. Yeoman farmers or artisans who produce for the market using their own labor are not in this sense formally subsumed, even though the products of their labor were commodified. Real subsumption occurs when capitalists not only own but reorganize and materially transform the means of production, in order to increase productivity and profit. Malm's extension of these categories works because it concerns the labor process and direct capitalist control. For Malm, nature is formally subsumed in the case of energy sources, like water power, derived from what he calls "the flow" — a category that also includes solar and wind power. The flow is curiously resistant to commodification; it can be appropriated but not exactly owned, since

it does not have a precise location, diffused throughout the landscape and atmosphere in ways that resist contract. It is also unpredictable; levels of rivers swell and subside in ways that cannot be controlled, clouds cover the sun for days, and wind rises and falls.³⁶ This makes water power inferior to things like coal, despite the fact that it is free as a result of its uncommodifiability. Coal and other energy sources like it form what Malm calls “the stock,” and these things *can* be really subsumed by capital, meaning that, with coal, capital can produce energy when and where it wants it, disciplining and regulating nature’s provision of motive power. In the context of the early nineteenth-century class struggle, Malm argues, the turn to the stock was necessary — capitalists who used water power were exposed to destabilizing class struggle by their need to stay close to water sources, where workers were in short supply and could thus drive up wages. Furthermore, water power displayed great seasonal variation. The mills would capture water in a mill pond overnight and then let it out during the day; in the summertime when water was low, this could power only a short working day, such that mill owners made up for lost time when the water returned in the autumn, driving their workers toward very long days. When the Factory Acts of the 1830s were passed, limiting the working day, this latter practice was rendered impossible, further compromising the ability of water power to compete with steam. Despite being cheaper, the unpredictability of water power combined with the resistance of labor to render water capitalists less competitive. Only steam power could deliver the needed predictability. Water mills did, of course, involve complicated mechanisms unavailable before capitalism and therefore featured a really subsumed labor power, but Malm argues that really subsumed labor is incompatible with an only formally subsumed nature. Factories need a steady energy source that can be increased or decreased at will.³⁷

Jason Moore would perhaps critique Malm’s use of these categories for their latent Cartesianism. If nature is seen as something that can be subsumed, formally or really, then it is treated as something

external to humans that is only brought under human control through technology. But as I argue above, this terminological precision risks occluding very real differences in different types of relationship between human and extra-human nature, making it difficult to gauge how much extra-human nature is or is not radically reorganized by humans. Perhaps the useful term, in addition to subsumption, is *synthesis*: in the case of coal power, gasoline, electricity, and nuclear power, natural forces are not simply appropriated by humans but actively synthesized by them. The implications of synthesis and real subsumption for the discussion of the nitrogen cycle above are, I would hope, obvious: in the system of managed inputs, the life-making powers of nitrogen are formally appropriated through the conservation and recycling of organic wastes, crop rotation, mixed farming, and the planting of legumes. With the Haber-Bosch process, these powers are actively synthesized by humans.

Food and Logistics after the Green Counterrevolution

Malm's use of the terms "stock" and "flow" is an interesting modification of their standard usage by economists, where the first refers to a simple mass of value (or commodity units) and the second to a rate, given in value or commodity units over time. Joan Robinson, quoting Michał Kalecki in conversation, is remembered for her acerbic description of economics as "the science of confusing stocks with flows," because people tend to treat these two measures as commensurable, comparing GDP (a flow) to national debt (a stock), for example.³⁸ Though not commensurable, one can make the two things into a ratio: debt to GDP, for instance, or the profit rate. Stock is simply what builds up where inflows, into a bank account or a factory, are greater than outflows, and thus the relationship between the incommensurables can be modeled mathematically, as one can model the relationship between the depth of a river in feet and its rate of flow.³⁹ Malm's use of the terms means to indicate a distinction between energy flows that build up into a meaningful stock and those that do not. The inflows of wind and solar energy are always passing

into outflows in ways that never form a stock, unlike the chemical energy of former biomass contained in coal deposits. In political economy, the concepts offer ways of thinking about the relationship between revenue, investment, costs, and value transferred. The fixed capital invested in a waterworks would typically be measured as a stock, an initial outlay sunk into machinery at a particular date in time, but one might also calculate its depreciation as a flow of value transferred to the goods the mill produces. Likewise, the coal used by a steam-powered plant will typically be measured as a flow (of value or tons per year or day), but one might also measure it as a stock, by taking its level at a particular moment or its average level over the course of the year. This is where Malm's usage gets interesting, and perhaps confusing, since the turn to coal and the stock that Malm describes was a turn to an increased flow of circulating commodities, traveling ever-further distances, and requiring a vast transportation network, itself powered by coal and itself requiring the very coal flows it made possible. Conversely, the waterworks that preceded the turn to steam required no circulating energy inputs but did involve costly fixed capital investment. The free use of the flow was a way of avoiding cost flows for energy inputs but involved fixed capital stock, and the turn to the stock was a turn to flows of energy inputs.

In the postindustrial era, the so-called "logistics revolution" has focused on reducing stocks through a careful management of flows. The goal of "just-in-time" production is to reduce standing inventory as much as possible, by making sure that inputs arrive at the plant exactly when they are needed. Since stock is usually treated as the average level of inventory, this kind of distribution system ends up being "capital saving," inasmuch as it reduces the level of capital tied up in production, freeing it for other uses. Capitalists measure their profit rate as flow of net profit over capital invested for a given period of time, taking the average level of circulating capital; therefore, by reducing the latter, the rate rises (though there is the question of what happens to the capital freed up and whether capitalists can find productive uses for it, which is no easy matter). But inventory is not

the only cost that capitalists seek to reduce. Fixed capital is inferior to circulating capital because it must be paid for far in advance of its use, making accurate prediction difficult. If demand for the product that a factory produces falls precipitously, one cannot go back in time and change the size of the factory one built, whereas circulating capital can be adjusted as one goes in order to correspond to existing demand. Labor costs are similar, given the difficulty of firing workers, either because workers will strike and shut down plants when fired or there is legislation preventing arbitrary dismissal. By making the circulation and coordination of various inputs easier, the contemporary logistics revolution should really be understood as an outsourcing and contract-production revolution. Instead of producing goods or services directly themselves, many firms reduce their permanent employees as well as their fixed capital investments to the lowest level possible, engaging a network of contract producers and service providers as needed and according to changing market conditions. The result is that capital's power over labor — now fragmented and dispersed across the logistical grid — increases massively. As I have argued, such logistical restructuring cannot in any way be understood as a simple increase in efficiency. Though costs of circulation and transportation are reduced through more efficient technologies, the gains wrought from these restructurings come largely from their ability to drive wages to the floor and force workers to accept the greatest possible insecurity. This critical understanding of logistics extends the critique of technicism and productive force determinism one finds in Malm. Indeed, the turn to logistics and the turn to steam are remarkably parallel, undertaken in both cases in order to disarm an insurgent laboring population.

Food is logistical now, too. Under the coordinative power of the supermarket system, food travels farther than ever before. But even where source and destination are proximate, the logistics of agricultural inputs — from seeds, to fertilizers, to machinery — are themselves complex and likewise dependent upon long supply chains for their production. And so on and so forth, until after a dozen

iterations, the commodity circuit more or less turns back in on itself. Grain and other staple agricultural products have been traded across vast distances since at least the first millennium BC, but in the postwar period international agricultural trade has expanded massively not just by volume but by type of good traded. From 1973 to 2013, the volume of agricultural exports grew by 250 percent. Some of this can be attributed to the underlying growth in agricultural output during the height of the Green Revolution, as chemical fertilizers and pesticides began to be used in great volume. But total output only grew by 142 percent during this period.⁴⁰ In money terms, the increase was sharper still: the real value of exports grew 1,364 percent. Part of that astronomical increase derives from the commodity and energy boom that occurs from 2002 to 2012. The real value of agricultural exports increased six times more quickly from 2001 to 2013 than it did from 1973 to 2001, but the steeper increase also reflects a shift in the type of agricultural products imported and exported during this period, from bulk goods to “high-value products” such as fruits and vegetables, enabled by new refrigeration technologies and long-range transportation and logistic networks. By 2013, 19 percent of the food that Americans consumed was imported.⁴¹ As indices of international travel, these numbers are only partly useful in estimating the extent to which logistics has canalized the food system and with it the productive flows of the earth. A tomato may travel farther from farm to refrigerator when grown in California and sold in Washington, DC than when grown in Mexico and sold in Colorado.

The effect of all this has been a reorganization of agriculture in many areas toward high-value cash crops and away from staples and cereals, which are now imported from places where they can be grown with the most capital-intensive, high-yield techniques, such as the American Midwest. One of the reasons for the logistics revolution is that productivity increases are not uniform across different sectors, and even today, there are many activities that remain unmechanized. For example, while the manufacture of components in electronics is highly automated, the assembly of these components is not, and so

assembly companies, Foxconn being the most notorious, are located in places where wages are lowest. Similar processes hold in the garment industry, where textile production is automated but sewing is not. In agriculture, most of the labor takes place during harvesting but this work has only been automated through more or less crop-specific and highly expensive machines, leaving a number of fruits and vegetables to be harvested by hand, despite the near-total automation of other crops. What Bebel says about the machinery-exclusive nature of horticulture still holds true in many areas 135 years later. Harvesting is seasonal, too, meaning that the labor needs of modern farms fluctuate massively, shrinking to zero for much of the year and then ballooning at harvest times. Under capitalist social relations, only a population of marginally employed and underpaid workers, dismissible for any reason, can satisfy the fluctuating labor demand of farms. In the U.S. and Europe these needs are met by populations of informally employed immigrant laborers, though often logistics enables retailers and distributors to go directly to zones and countries with large unemployed populations and low wages to purchase labor-intensive foods. The result is that the distribution of agricultural capacity over the crust of the earth has little to do with the direct food needs of the nearby population, and everything to do with the antagonistic conditions of production for profit.

Malm argues that the real subsumption of nature, and the need for consistent, predictable energy sources has to do with the imperative to really subsume labor, to create massive machine works that can be run at all hours and at any speed and that will determine the discipline, pace, and quality of work by the character of their material design. But the unpredictability of labor, he notes, is constitutive and impossible to extirpate fully. No technology yet exists whereby capital can control the human nervous system and compel motion directly; there is still need for coercion and incentive of one form or another. Even in slavery, with the most violent coercion imaginable, the laborers have the power to refuse work and suffer the consequences. Indiscipline can only be controlled, not eliminated. The unpredictability of nature

is, also, difficult to eliminate completely. However much the nitrogen cycle is really subsumed in modern agriculture, the productive powers of the earth analyzed and manipulated at the molecular level, agriculture remains a high-risk business, dependent upon climactic factors that are impossible to anticipate let alone control. Like labor, the weather can only be managed indirectly. The result is that few small- or medium-sized farmers producing for market can survive without relying on complex forms of credit, insurance, state subsidy, price control, or other support. The prices of agricultural products fluctuate wildly, and the intervention of powerful distribution and supply monopolies has the effect of imposing terms on producers. After the final and total defeat of the global peasantry, meaning that nearly all farmers are market-dependent, food prices always run the risk of being sent to the floor by competitive forces. The result is that states often intervene in the market. (The U.S. has for decades, as many know, paid its cereal producers to destroy excess grain in order to maintain market conditions, such that the price of U.S. grain is often far below its actual production cost). Given such interventions, and the effect of profit taking at every level of the chain from farmer to consumer as well as complex forms of credit, there is often little relation between the prices that consumers see and the actual production costs of agriculture. For example, the expansion of commodity futures and other agricultural derivatives means that small rises in cost due to changing conditions can be amplified into massive price explosions, as seems to be partly the case for the now-deflating commodity and food boom of 2003–2012. This has the effect of creating massive overinvestment with the ultimately perverse result that, once conditions settle down, such strong deflationary pressures emerge that revenue can no longer cover costs, initiating a wave of bankruptcies that bring down costs for the next generation of producers. Production for profit stamps agriculture, with growers changing the crops they offer according to the shifting winds of the market and a series of complex guarantees from states. What is grown first is money, and only then food for human needs.

The rise of contemporary logistics has enabled a shift from so-called “push production” models. In push production, suppliers build out capacity and output, first, and then subsequently clear the market through promotions and sales. In “pull production,” output is linked directly to demand signals, with retailers replacing inventories as they are sold. The limit case, and the ideal for firms like Walmart and the network of suppliers, is one where items aren’t produced until they have already been purchased. Inventory never builds up anywhere, and stocks are kept near zero. Pull productions effect a shift in power from producers to retailers or, in some cases, distributors. In agriculture, one notices that distributors such as Cargill and Archer Daniels Midland have enormous power, but retailers or producers for consumption such as Walmart and McDonald’s can also cut out distributors and go directly to farmers. Under logistics, supermarkets become a new locus of power.

The combination of the logistics and green revolutions has led to an increasingly wasteful food supply system. One might think that elimination of standing inventories from retailers and distributors would make for less waste, but unlike manufacturers, food producers have far less ability to alter their output. Agriculture has relatively long turnover times, and farmers have to make decisions about output levels far in advance of actual sale, all while anticipating the possibility of a bad harvest due to uncontrollable factors. They often make advance contracts with distributors and retailers, but given unpredictability, find it more profitable to overproduce, as the costs of producing too much are lower than the opportunity costs of producing too little. In other words, push production remains the norm in agriculture, despite the demand-side dominance of the industry, and thus producers are often left with more food than they can sell at decent prices. Supermarkets also have stringent aesthetic and quality standards, rejecting agricultural products that do not conform to rather superficial consumer values. And because retailers and distributors now dominate, their contracting allows them to switch from supplier to supplier, forcing the costs of compelled

overproduction further down the value chain. This dynamic results in a staggering scale of food wastage, with somewhere between 29 percent and 34 percent of all food produced globally not consumed.⁴² In industrialized countries, a good portion of food wastage happens during consumption, as food rots in refrigerators or pantries. But the relative power that logistics has given retailers and distributors over farmers is a big part of the problem. As the edges and vertices of the food system multiply, so too do the cracks into which food might fall, never reaching human bodies. The reorganization of the food supply by the green revolution has doubtless led to increased output per acre, but it has done so while massively amplifying waste and severely compromising its ability to meet human needs. The system looks highly inefficient even before we begin to consider energy-intensive and water-intensive methods for production and distribution, and how much they contribute to total carbon emissions and, in turn, destructive climate change that will adversely affect food production. In Moore's account, the ratio of energy calories to food calories has almost doubled since the 1970s and grown by almost ten times since the 1930s under "petro-farming" conditions.⁴³ Scaling up such a system to meet the needs of nine or ten billion people will be difficult, to say the least. Doing so while reducing overall emissions and energy use will be impossible.

Revolution and Agriculture

With a few important exceptions, the social revolutions of the nineteenth and twentieth centuries were agrarian revolutions, undertaken in societies that had not yet fully transitioned to capitalism and where agricultural production was still mediated by the conflict between peasants and landlords. Some of these revolutions were led by peasants, as in China, or by alliances between peasants and workers, as in Russia and Spain. In many cases, the rebellious workers were newly proletarianized and still retained some connection to peasant traditions and values. The question of land reform was central in all these cases, as the peasantry was squeezed by the encroachment

of capitalism on one side and the rapacity of the old regime on the other. To say that these social revolutions were agrarian means that their dubious successes had the effect of accomplishing, through various processes of expropriation and violence, what the normal development of capitalism in many other countries could not: in Russia and China, the landlords were eliminated and the productive use of the land entirely reorganized. In other parts of the developing world, the old landed powers retained their hold for much longer, even after the peasantry had been more or less dispossessed, and as a result reorganization of agriculture there has been much more slow going. Yevgeni Preobrazhensky, one of the most clear-sighted of the economists that the Bolsheviks had on their side, explicitly describes what needed to happen in the Soviet Union as a form of "primitive socialist accumulation," displacing the peasantry and converting the land to new use, though he doubtless imagined something different than Stalin's genocidal collectivizations.⁴⁴ By 1936, the Soviet Union was producing 112,000 tractors per year, nearly double the number of 1933 and only slightly below the number of motor vehicles produced, part of a massive push to industrialize agriculture.⁴⁵ By the 1970s, the Soviet Union was the world's second largest producer of both potassium and nitrogen fertilizers.⁴⁶ Though the Soviet food system was mired by chronic shortages and inefficiencies in production and distribution, something that derived from the contradictions of what Hillel Ticktin called its "non-mode of production," this was not for want of industrializing nature. Indeed, the peculiarities of Soviet accumulation made it particularly wasteful, even judged by the standards set by capitalism.⁴⁷ Since defects marred nearly all final goods, the system tended to overproduce raw inputs (steel, coal, or cement) in enormous quantities, and to generate stockpiles of intermediate goods that could not be utilized because of bottlenecks in the supply system.⁴⁸ The fact that the Soviet system could produce things like fertilizer more easily than it could produce wristwatches or radios no doubt contributed to its high utilization.

An authentic twenty-first century revolution, breaking with

capitalism and all class society, will likewise have to be an agrarian revolution, though in a far different sense than those described above. It will have to radically transform the way food is produced and distributed, not only because the present food system is wasteful, toxic to humans, and environmentally destructive, and not only because climate change stands to radically alter what can be grown and how and where it can be grown, but also because, even more importantly, the capitalist organization of nature as agriculture will, if relied on, entirely incapacitate such revolutions, guaranteeing the restoration of class society. Agriculture as we know it now is saturated with market relations; the distribution of various domesticated organisms across the surface of the planet, as well as the inputs which make their cultivation possible, has been undertaken with an eye toward the maximization of profits first and satisfaction of human needs second. Based on the historical record, we must assume that revolution will break through — that is, defeat the reigning powers, and find itself in possession of the means of production — in isolated zones first, as part of a global revolutionary wave. The partisans in such situations will find among their most immediate tasks the maintenance of an adequate food supply, most likely under conditions of civil war. In modern societies, maintaining the food supply depends, in turn, on several other essential industries and infrastructures: for water and energy, for transport, and for the manufacture of the goods used directly or indirectly by agriculture.

Revolutions cannot survive persistent food shortages, inasmuch as the absence of food activates the most powerful forms of self-interested and survival-oriented activity, even among those who are committed to the revolution — pilfering, hoarding, marketeering. Exhorting people to sacrifice and discipline will only work for so long; eventually a split will emerge, between the activist minority fanatically devoted to the revolution, even unto the point of death, and those masses whose attachments are weaker, who want the revolution to succeed but will withdraw their support when the risks are too high, the prospects uncertain, and the miseries unbearable. In most

revolutions, the activist minority turns, at this point, from moral exhortation to violent coercion, inducing even more demoralization, distrust, and disaffection. The Bolsheviks provide an object lesson; having earned the distrust of a partially sympathetic peasantry during the war years, when the Red Army was in the practice of seizing grain, they encountered intractable underproduction and hoarding of grain during the 1920s. The Bolsheviks concluded that they could regain control over agricultural production only by violently dispossessing the peasants, arrogating to themselves a degree of state power that assured the revolution was definitively dead, albeit a better-fed sort of dead. In Civil War Spain, where many of the partisans were significantly more skeptical of state power and violent coercion, and committed to democratic ideals and participatory, locally controlled organization of agriculture, the fact that the Francoist rebels controlled the rich grainlands and cattle-grazing areas of the Southwest meant that the Republic and its armies were continuously undersupplied. The predicament induced all manner of cynical, opportunist, and survival-oriented behavior among peasants and townspeople that only increased as the militants betrayed their democratic ideals and instituted forms of military policing and punishment in order to compel compliance.⁴⁹ Revolutions that rely on such police action in order to insure compliance — which is not at all to argue against the use of violence as defense against counterrevolutionary forces — effectively sign their own death warrant.

Fortunately, twenty-first-century revolutions will not have to reckon with the problem of the peasantry, especially if we define peasants as those who produce for their own subsistence first and for the market second. Almost all global agricultural production is market-oriented now. In developed countries like the U.S., while the number of farms has stayed the same for decades at around a few million, many owner-operator enterprises generate negligible output (with the owners usually working elsewhere); a few hundred thousand farms generate most output, a number that has fallen decade after decade as average farm size rises. As such, the number of people

who control the land differs from that of Russia or Spain by a few orders of magnitude, and most of these farms are highly capitalized if also noncorporate enterprises that employ significant numbers of workers. These people will need to be won over to the cause or expropriated, but they form an incredibly tiny minority compared to the great masses of people that would be involved in such an undertaking. In less-developed countries, control over agricultural resources is more fragmented and involves a higher number of underclass people, but still fewer people than the thoroughly peasant-based societies of old.⁵⁰

More significant will be the problem, seen already in the Spanish case, that revolutions confront when they discover that neither the necessary means of subsistence, nor the means to produce such means of subsistence, exist within the revolutionary zone. In such conditions, partisans will have to decide between, on one hand, trading with capitalist partners for necessities and therefore organizing production for export or, on the other hand, radically reorganizing agriculture in order to meet endogenous need. If the partisans choose trade, they expose themselves to the powerful disciplinary effects of the global market and the law of value, needing to produce at competitive levels, even when they do not confront more active intervention in the form of embargo and blockade. Capital flight happens immediately in conditions of political instability, and in all likelihood, by the time the reigning powers have been deposed, international capital markets will have exerted profound disciplinary pressure, offering credit under the most punitive terms. Since exchange rates are connected to the credit system, everything imported will cost much more. Unless revolutionaries try to go it slow and not freak the credit markets, guaranteeing their total ineffectiveness (see, for instance, the sad fate of SYRIZA), the only solution that import-dependent revolutions will discover is to hyperexploit their producers in order to maintain competitive terms. But revolutions generate conditions in which managerial control over the workplace breaks down entirely; productivity levels will certainly fall, especially if wages and money

continue to be used, fostering antagonistic relations in the workplace. The only way to raise productivity for partisans in such conditions will be through indirect and direct violence — instituting systems of incentive and punishment that will run, probably very quickly, from the use of piece rates to the establishment of work camps. This is precisely what happened in Spain, accepted as baleful necessity even by the erstwhile libertarians. The result: massive demoralization, insubordination, and all but the most fanatical turned against the revolution as a matter of survival.

Recognizing that this way lies certain failure and that revolution will not break through globally in the short time frames that would be necessary to prevent the relative isolation of revolutionary zones, one can only hope that partisans will try a different way, reorganizing agriculture (and everything else) in order to meet existing needs independent of trade with capitalist enterprises and powers, or with, at the very least, a very small amount of such trade, not large enough to induce the crippling effects described above. I take as my framework here a view that the horizon of revolution in our time involves “communization” of all resources and relations: that is, the immediate abolition of money and wages, of state power, and of administrative centralization, and the organization of social activity without these mediations on the basis of direct, personal, or immediate social relations.⁵¹ The inherited impasses of the logistical reorganization of production are one of the reasons why I think revolutionaries will turn to communization, but they will do so in situations in which various factions are trying out different paths and in which state power and trade may continue to exist at the same time as people are breaking with them, inaugurating a revolution within the revolution and attempting to organize in order to meet their needs directly.⁵²

As far as food production goes, this will mean, by necessity, a return to the old nineteenth-century project of abolishing the division between town and country and recognizing more clearly Moore’s double internality, a project that will involve everything

from neighborhood gardens and urban farms to large-scale farming projects at the suburban perimeters of various towns and cities as well as the replanting and reorganization of vast tracts in agricultural heartlands. Even when the revolutionary zone is rather large and production at a distance of thousands of miles is possible, the sensible path will be to localize food production as much as possible, not only in order to cut down on energy use in transportation but also to establish a situation in which some large portion of people's food needs is immediately available and ready to hand, within some reasonable distance, making it much harder for them to be subjugated by a bureaucratic layer, a hostile power, or an emergent attempt at capitalist restoration. Partially localizing the production of foodstuffs and other necessities would obviate the need for money or pseudo-money, wages or labor tickets, allowing the ready-to-hand goods to be distributed on demand, with a relatively low level of administration. Production and distribution of the fruits of social activity could, on this basis, happen voluntarily and freely; even if money and exchange persisted on the fringes for a time — most likely due to the presence of different factions, pursuing different revolutionary paths — if most of what people needed to live were organized this way successfully, on a communist basis, communism would stabilize. And if it stabilized it would spread, as the existence of people meeting their own needs and thriving without the mediation of money, wages, or violent compulsion would be enormously destructive for capitalism and class society elsewhere. It would mean either the beginning of the end for class society or the moment at which class powers gathered their forces to extirpate the threat. Although the aspiration of communism is to be global and universal (if also full of endless internal variation) and to establish a situation in which everything belongs to everyone and no human has more of a claim on the necessities of life than any other, it must begin somewhere. Previous generations of communist theorists have misunderstood the transition to communism as temporal in nature, passing through the intermediate stage of socialism, when it is in fact better thought of as spatial transition: the geographical

spread of an immediately social communism that is contagious for the precise reason that it is fully realized. Such geographical extension will itself take time, however, and even though communization means the establishment of immediately communist relations, the material basis of such relations as well as the processes through which they are effected will no doubt develop, deepen, and stabilize in time.

In a thoughtful essay on contemporary logistics, Alberto Toscano asserts, *contra* my views here and elsewhere, that “the world market remains, in however arduous a way, a presupposition (not a framework!) for any transition out of capitalism.”⁵³ Toscano suggests that I am more right than I know: the reorganization of global production has made breaking from the world market not only difficult but impossible. On one aspect of the problem, we agree: revolutionaries will undoubtedly use, when possible, the technologies of transportation and storage upon which the world market depends. But they will find such resources inadequate and even, in some cases, inimical to their needs: located in the wrong place, designed in the wrong way, and so on. The world market is a presupposition, inasmuch as it is the world revolutionaries inherit, but it is a presupposition that will provoke, by its very inadequacy, new techniques and methods. The market is more than a means for distributing necessary goods in space; it is the circulation of such goods as mediated by exchange, stamped by the contortions of the law of value. Markets involve numerous activities — banking, retailing, advertising — that have no reason for being aside from exchange and no purpose except for the reproduction of the commodity form, that is, production for exchange.

Many of these counterarguments derive their force from a commitment to Marxist modernism, a belief not only in the progressive character of technological development but the “civilizing” effects of the world market, which, for all its violence, breaks down national and cultural barriers and provides the basis for international proletarian solidarity. For many, the scenarios described above violate a deeply held commitment to “internationalism” and an allergy to “socialism in

one country.” Evaluating the contemporary conjuncture with a crudely dogmatic schema inherited from the 1917 revolutionary sequence, these critics confuse a set of normative positions on international proletarian organization and solidarity with a description of the actual conditions in which revolutions will unfold. Obviously, *it would be better* if revolution could break through in several parts of the world all at once. But revolutions occur on the basis of what is, not what ought to be. The problems described here depend very little on the character of organizing; even if there are proletarian organizations linking struggles in different parts of the world, proletarians in zones where they do not control the resources will be limited in their ability to help the revolutionary zones, except inasmuch as they force revolutionary breakthrough where they are. This should not in any way be seen as an acceptance of the framework of national boundaries and the nation state as the basis for a revolutionary unfolding. On the contrary, the immediate establishment of communist reproduction and relations, making it easy for people to feed themselves directly and without money or centralized administration, dissolves state control and national designation, producing rifts within and across national boundaries. The opposition of “internationalism” to “nationalism” discounts the ways in which Marxist internationalism was, in practice and as far as the Second and Third Internationals were concerned, something that proceeded *through* nation states and on the basis of nationally coordinated blocs of proletarian power mediated by the world market. The necessary turn to communization described above would do more to destabilize the nation and state power than those forms of “internationalism” that take these institutions as their basic presuppositions.

Neither would this revolutionary trajectory involve what Toscano calls a “re-ruralization, where social form is based on comradeship, friendship, or some kind of band of brothers bond.”⁵⁴ Overcoming the division of town and country would mean the end of the rural, through processes involving at a minimum tens of millions of people and probably hundreds of millions if not billions; it would involve

the coordinated distribution of necessary and useful things at all sorts of scales from the immediately local to the intercommunal and across the revolutionary zone. The salient distinction, however, is that such coordination would take place under conditions in which as many basic and necessary goods as possible are generated close to those who need them, making it much more difficult to dispossess or disempower people, who would both understand and have control over the processes that matter for them. This is what is at stake in the abolition of the division between town and country. Nonetheless, one need not fear a retreat into autarkic, isolated communities, which is as impossible as remaining tied to the world market. Many infrastructures, such as those for water or energy, will require coordination at scale, as will the generation of many necessary and useful goods. Furthermore, not all food production can be shifted close to where people live, nor can people be quickly shifted to the places where food is grown without great suffering, and until a reorganization of towns and cities through processes of voluntary resettlement can take place, people will no doubt rotate seasonally out to the agricultural heartlands where food is currently produced.

In the scenarios described above nearly everyone would have some hand in growing the food they eat. In such a state of affairs, agriculture would doubtless become more effort intensive in the developed world, as breaking with the world market will leave many without access to the machines and fertilizers and pesticides that industrialized agriculture uses today. This is not such a problem: as a share of total human effort, the amount of time devoted to agriculture in countries such as the U.S. could increase by a factor of ten and still not account for a very large part of people's overall activity. In the developing world, agriculture would no doubt become less effort intensive by eliminating the need for the poorest producers to work the most marginal plots of land with the worst techniques and equipment. This is not to imagine anywhere some regression to premodern techniques and relations. Agriculture will be immediately social, rather than organized by family or clan (or capitalist firm), and people

will doubtless continue to employ many of the technologies, if not the chemicals, used to grow food today. There will surely be tractors and other machines for working the earth and harvesting its fruits, trucks for the transport of produce, but these will, I suspect, exist alongside methods that rely more on the human hand, associated with permaculture, mixed planting, and other “traditional” techniques. In certain areas, people may find it impossible to meet their food needs without synthetic fertilizers and as such will have to figure out, for instance, how to run the ammonia plants and supply them with natural gas or track down phosphorus and potassium deposits. In any case, the use of such fertilizers will surely decline, if they are not eliminated altogether. Agriculture under such situations will involve a mix of high and low technique, where methods are selected for their suitability for human needs and their ecological imprint rather than their usefulness in production for profit.⁵⁵ Though many like to imagine “planning” as only referring to centrally administered production occurring at national or international scales, any activity that is social at any sort of scale will involve planning — though not central planning — and partisans in the scenarios I imagine will need to engage in various infrastructure projects: for irrigation, for the recycling of organic wastes, and for energy generation and transmission.

Revolution and its Motive Forces

Speculation of the sort I engage in here is essentially impossible without making assumptions about the kinds of choices people might make in such a scenario, and this implies speculating, as well, about the reasons for those choices. I take as my baseline an assumption that people organize their lives with an eye to their own survival and well-being and the survival and well-being of those they care about, where the radius of care can be as small as the family nucleus or “friend group” but far more expansive as well. This makes thinking about a less destructive organization of nature both human and extra-human extremely difficult. Most attempts by anti-capitalists to think

through meaningful political response to the ongoing ecological catastrophe that is capital fail because of their inability to reckon with human motives and with the fundamentally human-centered character of human action. The absence of significant response to the mass extinction wave sweeping the planet, not to mention the mounting certainty that anthropogenic ecological change will have profoundly negative impacts on human life in the near future indicates that, unless their immediate well-being is at stake, people are unlikely to engage in the risky, difficult action that revolutionary change requires. The exceptions to this comparative quiescence almost always occur in the case of groups, such as Indigenous or agricultural communities, whose livelihood and social forms are endangered by ecological destruction. Those who would point to the radically different conceptions of human nature and its relationship to extra-human nature that occur in various cultural formations are no doubt correct, but these conceptions usually articulate the interdependence of human and extra-human forces and therefore do not provide exceptions to the rule of human-centered action, only an awareness that valuing human life means valuing extra-human life as well. Revolutions emerge when human reproduction is at stake, though in some cases people are more aware that human reproduction is also the reproduction of nature. To summarize, the argument of the preceding pages might be understood thus: if twenty-first century proletarians communize the food supply and reorganize agriculture, overcoming the division between town and country, they will do so not because this accords with their ideals but because these communist measures will emerge as the best, and indeed only, way to meet their needs in a revolutionary conjuncture, given the path dependencies of productive resources they inherit from capitalism. Seen from the vantage of the ideal, however, these measures will fortunately also involve a profound break with the toxifying food regimes of capitalism, dumping less carbon into the air and less nitrogen into the oceans and fewer poisons into the groundwater. These ecological benefits will emerge, however, as a result of choices that are more or

less anthropocentric.⁵⁶

Despite its lucid account of the path dependencies fossil fuel technology engenders, when Malm turns to the present crisis of fossil energy, he ends up relying on a normative theory of motives or perhaps no theory whatsoever, giving us an account of what we must do or should do rather than what we can do. In the first pages of the book, he illuminates nicely the strange temporality of anthropogenic climate change. The consequences of fossil energy use present a singularly difficult problem for collective action: by the time their effects are felt most pressingly, obliging people to act in order to preserve their well-being, *it will already be too late*. In a phrase in which we can hear echoes of Marx's discussion of rising organic composition — that is, the rising relative weight of dead labor to living labor — Malm tells us that, with fossil energy, “the causal power of the past inexorably rises.”⁵⁷ At a certain point, the moment of “too late,” one witnesses the “falling in of history on the present,” as the weight of past action breaks through the ceiling. Unfortunately, Malm's answer to this predicament leaves much to be desired, relying on wishful thinking rather than sober realism. Malm rejects the “revolutionary” response to ecological destruction — that is, the response which says capitalism is incapable of averting ecological disaster — for the simple reason that revolution will not come quick enough to stop a temperature rise of two degrees Celsius. But deciding that two degrees is your line in the sand does not necessarily mean that anything will be done to stop it. And, of course, too late is relative. There is, when it comes to these matters, bad and worse. We appear to have long missed our chance to avert the bad, if not the worst, and sober analysis may require accepting this fact and preparing accordingly.

Malm's own account of the origins of fossil capitalism and the turn to steam appears to put in question his confidence that climate change can be averted from within capitalism simply because it has to be. His central claim is that capitalism can return to the flow as an energy source, leaving behind the carboniferous stock. However, as he knows, the very properties of the flow which led capital to turn away from

it remain a powerful obstacle to such a transition, haunting wind and solar power just as much as they did the streams of the English midlands. The flow is unpredictable; it cannot be turned on and off at will. This causes a problem for industrialized societies that run on the premise that energy is available on demand, part of an “abstract spatiotemporality” in which neither distance from energy source nor the variable rhythms of natural forces matter at all. One can store the electricity generated but doing so requires manufacture of energy-intensive batteries, such that the ultimate environmental benefits of such a switch are unclear. In confronting this problem, Malm returns to an intriguing counterfactual account he developed when examining the decline of water power: *it might have been possible*, he tells us, to build massive waterworks, capable of delivering steady, reliable energy to various factories, across large distances, had capitalists been able to solve their coordination problem. The competitive urgencies of production for profit, however, made this impossible. If it were the twentieth century, the state might have undertaken such projects, as it would eventually with the highways, railroads, utilities, and other vital infrastructures individual capitalists could not fund on their own. Now, however, it is not the nineteenth century but the twenty-first, and Malm argues that we might “return to the flow” through a massively coordinated global effort, led by states and international organizations, in which the variability of flow energy (due to diurnal rhythms and weather) is rendered predictable through a planetary network of energy transmission from flow sources. Since the sun is always shining and the wind always blowing somewhere, long-distance transmission can, potentially, overcome the unpredictability of the flow, rendering it as homogeneous as stock energy and as capable of meeting the abstract spatiotemporality of capitalist production. It is not at all clear, however, that the energy and emissions accounting will really work in the favor of such scheme — even with high-voltage direct current, much electricity is lost in transmission and those losses increase as a function of distance traveled. Second, the transformers, power lines, and wind and solar fields will themselves require massive

energy outlays to build and install and those costs will also increase as a function of transmission distances. To build clean and cheap energy generation, one will almost certainly have to use dirtier, less-efficient energy, and this may render any benefits nil.⁵⁸

Even if we were to allow for the possibility of producing the materials in such a way that net emissions fall, why would states engage in such a process? As Malm indicates, the resources mobilized by such an undertaking would be massive, on the order of tens of trillions of dollars at least. He makes a comparison with World War II, which is a good benchmark. World wars, however, represent immediate existential threats for states and capitalists and also offer strong opportunities for capital to profit; they also involve alliances that, because of the antagonistic character of warfare, are actually less extensive than the sorts of alliances Malm envisions. The temporality of future threats still obtains in the case of states, and, furthermore, the hurdle is much higher, since a significant fraction of capitalists (petro-capitalists, in particular) will be ruined by such a turn. One must imagine, then, either an international political elite willing and able to act in the interest of human life in general, or a social movement capable of exerting massive pressure on the state. The first scenario is absurd, and the second returns us to the question of motives and the belatedness of action. Such a social movement will appear only when severe consequences of anthropogenic climate change have already begun to manifest. Even if such a turn were likely in the next decade, these states would face the problem of social democratic governments everywhere: infrastructure projects of this sort require, as their primary condition, that states first ensure general conditions of profitability. Otherwise, they will find themselves without sufficient credit or tax revenues. How does one maintain conditions of profitability while ruining a large sector of the capitalist economy and spending trillions of dollars on unprofitable utilities? And how does one do this with a stagnating world economy, mired by low profit rates and high debt overhangs? Here and elsewhere, latter-day social democracy depends on scenarios far less

plausible than the revolutionary ones. Malm might be said to offer a strange inversion of the fettering thesis; instead of attempting to overturn the social relations of capitalism in order to accord with the underlying technical possibilities, he imagines reconfiguring those technologies to suit the requirements of abstract spatiotemporality. Both approaches capitulate to the extortionist logic of the parable of the belly, and therefore preserve, in one form or another, the very forces which will ensure their failure.

In short, we have to accept that our only hope of averting the worst effects of the present ecological crisis lies in the rekindling of revolutionary class struggle in our time, either in response to the first effects of climate change or the continuing meltdown of the world economy. Belatedness, however, is at this point a given, and such a revolution will be forced to reckon with the problems of a warming planet, rising sea levels, acidifying oceans, creeping deserts, depleted water supplies, and the human displacements to follow. The biggest problem for such revolutions will concern energy: how to continue to supply electricity? How to run or replace the motorized machines which require refined petroleum? Answers to these questions will vary from place to place. For the next couple of decades, few areas will find it possible to break free from the stock completely, but by the same measure they will also find themselves compelled to conserve energy sources massively, devoting energy to the most important human needs, in ways that capitalism never could. Renewables will likely form a part of this, though people will need to reckon with the mining processes that some of these technologies involve. The so-called “rare earth” minerals that solar panels and wind turbines require are not actually very rare at all; the extraction processes they involve are, however, so environmentally destructive and toxic at present that they are currently confined to countries, such as China and the Democratic Republic of the Congo, willing to convert hundreds of square miles into toxic “sacrifice zones.” In any case, without profit or price mechanisms and without a need for continuous growth, diurnal or seasonal variability of energy supply would be much less

of a problem. Though certain systems will require continuous energy, communism will prove itself much better able to adapt to the rhythms of flow energy, turning machines off and encouraging afternoon naps, perhaps, when the clouds cover the sun or the wind dies.

There are no guarantees, it should be clear: the revolutionary horizons described in the preceding pages are happy outcomes surrounded by tragedy and affliction on every side. The obstacles that capitalism has placed in the path of revolution, defeating all half-measures and vacillations, are formidable indeed. This is a cause for optimism as much as pessimism: because of capital's total transformation of the earth, an immediately communist reorganization of human society makes rational sense today in a way that it did not in 1917. In any case, these are the futures visible from here. Not what must happen, but what can.

Notes

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1. In Livy's history of the Roman republic, patrician Menenius Agrippa relays this older Greek fable of the body politic to the plebeians who have seceded from Rome in protest and encamped on a nearby mountain. Livy, *History of Rome: Books 1-2*, trans. B. O. Foster, Loeb Classical Library, no. 114 (Cambridge: Harvard UP, 1948) 253.
2. G.A. Cohen, *Karl Marx's Theory of History: A Defence* (Princeton: Princeton UP, 1978) 326–341. For a critical response to the technicism of Cohen, see chapters 2 and 3 of Derek Sayer, *The Violence of Abstraction: The Analytic Foundations of Historical Materialism* (Oxford: B. Blackwell, 1987).

3. Karl Marx, *Capital: A Critique of Political Economy Volume I*, trans. Ben Fowkes (London: Penguin Books, 1976 [1867]) 929.
4. Marx, *Capital Vol. I* 549.
5. Harry Braverman, *Labor and Monopoly Capital* (New York: Monthly Review Press, 1975); Raniero Panzieri, "The Capitalist Use of Machinery: Marx Versus the Objectivists," *Outlines of a Critique of Technology* (London: Ink Links, 1980) 44–69; Herbert Marcuse, *One-Dimensional Man: Studies in the Ideology of Advanced Industrial Society* (Boston: Beacon Press, 1991).
6. Nick Srnicek and Alex Williams, *Inventing the Future: Postcapitalism and a World Without Work* (Brooklyn, NY: Verso, 2015). See in particular the section "Repurposing Technology" at the end of Chapter 7, which engages with my argument in Jasper Bernes, "Logistics, Counterlogistics, and the Communist Prospect," *Endnotes* 3 (September 2013) 172–201.
7. Bernes, "Logistics, Counterlogistics, and the Communist Prospect."
8. I am thinking here of the concept, in evolutionary game theory, of "evolutionarily irrelevant equilibria." While most neoclassical microeconomics and game theory model situations of equilibrium, these disciplines rarely consider how such stable states may be arrived at from an out-of-equilibrium situation. Evolutionary game theory tries to distinguish between equilibria that are viable, that might emerge from an out-of-equilibrium situation, and those that are not. Samuel Bowles, *Microeconomics: Behavior, Institutions, and Evolution* (Princeton: Princeton UP, 2004) 63.
9. Srnicek and Williams, *Inventing the Future* 5.
10. *Capital Vol. I* 481–2.
11. Notice how, for Marx, capital's power is a scientific organization of natural forces against labor, establishing a ternary rather than purely binary relation: "The special skill of each individual machine-operator, who has now been deprived of all significance, vanishes as an infinitesimal quantity in the face of the science, the gigantic natural forces and the mass of social labour embodied in the system of machinery, which, together with these three forces, constitutes the power of the 'master.'" (*Capital Volume I* 548.)

12. Andreas Malm, *Fossil Capital: The Rise of Steam-Power and the Roots of Global Warming* (Brooklyn: Verso, 2016), and Jason W Moore, *Capitalism in the Web of Life: Ecology and the Accumulation of Capital* (Brooklyn: Verso, 2015).
13. Moore, *Capitalism in the Web of Life* 5.
14. Karl Marx, *Capital: Volume II: A Critique of Political Economy*, trans. David Fernbach (New York: Penguin, 1993) 283.
15. For a fascinating history of the metabolism concept, see Hannah Landecker, "The Biology of History: From the Body as Machine to the Metabolic Community," (Talk, IAH, Boundaries of the Human in the Age of Life Sciences, November 6, 2015). Parts of this essay began as a response to Landecker's talk: <http://sites.psu.edu/iahboundaries/jasper-bernes/>. Many thanks to Heather Davis and Michael Berubé for the invitation.
16. *Capital Vol. I* 283.
17. Leo Marx, *The Machine in the Garden: Technology and the Pastoral Ideal in America*, 35th anniversary ed. (Oxford: Oxford UP, 2000).
18. Robert Brenner, "Property and Progress: Where Adam Smith Went Wrong," *Marxist History-Writing for the Twenty-First Century*, ed. Chris Wickham (London: British Academy, 2007), 49–111.
19. Marcel Mazoyer and Laurence Roudart, *A History of World Agriculture: From the Neolithic Age to the Current Crisis* (New York: Monthly Review Press, 2006) 313–353.
20. Mazoyer and Roudart, *A History of World Agriculture* 355–372.
21. Moore, *Capitalism in the Web of Life* 248.
22. *Capital Vol. I* 637.
23. Karl Marx and Friedrich Engels, *The Communist Manifesto* (New York: Penguin Books, 2002) 244.
24. Quoted in CDW, "The Transformation of Social Relations," *International Review* 14.25 (1996).
25. August Bebel, *Woman Under Socialism* (New York: New York Labor News Press, 1904) 316.
26. Quoted in CDW, "The Transformation of Social Relations."
27. Marshall S. Shatz, Kropotkin: "The Conquest of Bread" and Other Writings

- (Cambridge: Cambridge UP, 1995) 68–74, and Elisée Reclus, *The Evolution of Cities* (Petersham: Jura Books, 1995), <https://libcom.org/files/Reclus%20-%20The%20Evolution%20of%20Cities.pdf>.
28. See Kristin Ross's writings on the aftermath of the Commune for an account of the way these themes cut across the lines drawn between anarchists and Marxists. Kristin Ross, *Communal Luxury: The Political Imaginary of the Paris Commune* (Brooklyn: Verso, 2015).
 29. *Capitalism in the Web of Life* 75–91.
 30. Karl Marx, *Capital Volume III*, trans. David Fernbach (New York: Penguin, 1991) 949.
 31. *Capitalism in the Web of Life* 84.
 32. *Capital Vol. I* 283. For a dialectical exploration of these themes, see Alfred Schmidt, *The Concept of Nature In Marx* (Brooklyn: Verso, 2014).
 33. For a discussion of the nitrogen cycle and its manipulation by humans throughout history, see Vaclav Smil, *Enriching the Earth: Fritz Haber, Carl Bosch, and the Transformation of World Food Production* (Cambridge: MIT P, 2001). Nearly every agriculture system has emerged as an attempt to conserve or, in the case of slash and burn, gain biologically available nitrogen, as well as other important nutrients (phosphorus, potassium). For a history of these systems, see Mazoyer and Roudart, *A History of World Agriculture*.
 34. Malm, *Fossil Capital* 309–315.
 35. For a corrective account, see “History of Subsumption,” *Endnotes* 3 (April 2010) 130–54.
 36. See Hitchcock in this volume.
 37. Intriguingly the argument formally resembles the fettering thesis with its idea of mismatch between energy source and labor process. Unlike the fettering thesis, though, Malm's argument describes a mismatch between different technical regimes, rather than between technique on the one hand and social relations on the other.
 38. Joan Robinson, “Shedding Darkness,” *Cambridge Journal of Economics* 6:3 (September 1, 1982) 295.
 39. For a lucid, though technical, treatment of simple and expanded capitalist reproduction in terms of stocks and flows in time, see Duncan

- K. Foley, *Understanding Capital: Marx's Economic Theory* (Cambridge: Harvard UP, 1986) 62–90.
40. Calculated from Table A1A WTO, "International Trade Statistics 2014," 2014, https://www.wto.org/english/res_e/statis_e/its2014_e/its14_appendix_e.htm.
 41. Alberto Jerardo, "Import Share of Consumption," United States Department of Agriculture (2016), *Economic Research Service*, <http://www.ers.usda.gov/topics/international-markets-trade/us-agricultural-trade/import-share-of-consumption.aspx>.
 42. Calculated from Jenny Gustavsson et al, *Global Food Losses and Food Waste: Extent, Causes and Prevention* (Rome: Food and Agricultural Organization of the United Nations, 2011) 5.
 43. *Capitalism in the Web of Life* 252.
 44. Eugenii A. Preobrazhensky, *The Crisis of Soviet Industrialization* (London: Palgrave Macmillan, 1980) 20–30.
 45. Donald A. Filtzer, *Soviet Workers and Stalinist Industrialization: The Formation of Modern Soviet Production Relations, 1928-1941* (Armonk: M.E. Sharpe, 1986) 126.
 46. CIA, "Soviet Fertilizer: Expansion of Output and Exports," March 1975, CIA Reading Room, https://www.cia.gov/library/readingroom/docs/DOC_0000316269.pdf
 47. Hillel Ticktin, *Origins of the Crisis in the USSR: Essays on the Political Economy of a Disintegrating System* (Albany: M.E. Sharpe, 1992) 33.
 48. Filtzer, *Soviet Workers and Stalinist Industrialization* 254–271.
 49. Michael Seidman, *Republic of Egos: A Social History of the Spanish Civil War* (Madison: U of Wisconsin P, 2002), and Michael Seidman, *Workers against Work: Labor in Paris and Barcelona during the Popular Fronts* (Berkeley: U of California P, 1991).
 50. Many of these semi-peasants are forced by the overproduction of the market elsewhere to farm with the most rudimentary of techniques on the most marginal land, contributing very little to overall output, which is to say that overproduction in certain countries leads to underutilization of the land elsewhere, and a large population of people who remain in the countryside but are more or less dispossessed. Mazoyer and

Roudart, for instance, argue that problems of undernourishment in the developing countries and not at all technical but in fact social (*History of World Agriculture* 440–491).

51. For a good description of communization as practice, see Gilles Dauvé and Karl Nesis's explanation from *Troploin*: <https://libcom.org/library/communisation>.
52. I borrow this conception of communization as revolution within revolution from *Theorie Communiste*: R.S., "Self-Organisation Is the First Act of the Revolution; It Then Becomes an Obstacle Which the Revolution Has to Overcome," *Revue Internationale Pour La Communisation*, September 2005, http://meeting.communisation.net/spip.php?page=imprimir_articulo&id_article=72.
53. Alberto Toscano, "Lineaments of the Logistical State," *Viewpoint Magazine* 4 (Fall 2014) <https://viewpointmag.com/2014/09/28/lineaments-of-the-logistical-state/>.
54. Toscano, "Lineaments of the Logistical State" 4.
55. For an account of the necessary mixture of high- and low-tech in future agriculture under conditions of climate change, see the article "Contemporary Agriculture: Climate, Capital, and Cyborg Ecology," *Out of the Woods*, July 27, 2015. They emphasize the plasticity of "traditional" farming systems and their ability to incorporate practical, modern technologies where useful.
56. This is a difficult point, and one that requires more attention than I can give it here, not least because of the difficulty of speculating about human motives in general. While revolutions are ineluctably human-centered, not all action is, and people are for the most part not simply indifferent to their effect on extra-human nature. Given a choice between two ways of arranging their lives that seem more or less equally acceptable, where one will lead to the degradation of ecosystems, the death or diminishment of species, most people will choose the kinder path. They will even, in many cases, give up substantial comforts for the sake of the birds, rivers, and forests. But these values are, for the majority of people at least, too weak on their own to provide the motive force for revolutionary change. One way to think about a classless

society of the sort described above is as a situation where, inasmuch as everyone's needs are met, people can value the flourishing of life as such for its own sake. Furthermore, once people are no longer driven by the day-to-day demands of survival, on the one hand, or the imperatives of accumulation on the other, they can begin to think about the generational effects of their actions and may care about human effects on extra-human nature for reasons that are, in the end, human-centered. I hope to develop a theory of revolutionary motives adequate to these questions elsewhere.

57. *Fossil Capital* 9.
58. For a more pessimistic take, see this piece by former researchers at a Google-sponsored initiative to develop cheap renewable energy. They argue that even if one could develop renewables to replace all electricity, it would still be impossible to reduce emissions significantly, partly because capitalist producers would not switch over quickly enough. Their argument assumes, like Malm, transition within capitalism. Ross Konigstein and David Fork, "What It Would Really Take to Reverse Climate Change," *IEEE Spectrum*, November 18, 2014, <http://spectrum.ieee.org/energy/renewables/what-it-would-really-take-to-reverse-climate-change>.