CHAPTER 13

Redesigning Political Economy

The Promise and Peril of a Green New Deal for Energy

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For well over a hundred years the global political economy has centered on ownership and control of carbon-based energy resources. This is true in the narrow sense that, beginning in the 1850s, power and wealth increasingly flowed to those individuals, companies, and countries who dominated the extraction, refining, and sale of fossil fuels. By the end of the twentieth century, oil and automobile companies and cartels occupied center-stage, geopolitically, and stood atop the ranks of the world's largest corporations and most powerful organizations. During this period, in a subtler yet broader sense, carbon-based forms of energy also structured the cultural forms and imaginations of modern industrial societies, economies, and politics, as Timothy Mitchell so importantly describes in *Carbon Democracy*.[1] It is not an accident that, for both capitalists and communists, the oil and steel, railroad and automobile, and coal and electricity industries defined industrial policy and international economic competition; that military supremacy was established through the power of aircraft, tanks, rockets, and steel-hulled ships (and that the U.S. military became, as a result, the largest purchaser of oil on the planet); or that blood was frequently shed in efforts to control or secure lands with carbon-rich mineral deposits. It was the carbon century.

Looking forward, as the world contemplates the end of carbon-based energy, two of the central questions are whether the forms of political economy it engendered will also end and, if so, what they will be replaced with. While there are, in theory, other ways to achieve carbon neutrality for the global economy, there is a growing sense that, for a number of reasons, by the middle of the twenty-first century, half or more of the world's energy supplies will be

generated by solar power.[2] If this reconfiguration of energy regimes eventually ends the power of petro-states and petrocultures—and there is little reason to suppose that it won't, although the paths forward will be at times uneven, tortuous, and marked by efforts to manipulate supply wherever fossil fuels are used—what alternatives will it bring into being?[3] What will the solar-states and photon-cultures of the latter half of the twenty-first century look like?[4] How will they distribute power and wealth among the world's diverse peoples and organizations? What kinds of security and insecurity will they enable and entail?

In *Dreamscapes of Modernity*, Sheila Jasanoff theorizes that what makes modernity different from other eras of human history is that its core imaginaries are sociotechnical, forged in the power of science and technology to undergird compelling visions of human futures.[5] For industrial societies, those dreamscapes have been fashioned around global technological systems for mining, refining, transporting, and burning carbon: geoimaginaries of oil and cars, coal and electricity grids.[6] What will the sociotechnical imaginaries of a solar future look like? Whose voices will shape the articulation of those visions and the political and economic orders they seek to call into being? Will they follow the footsteps of carbon imaginaries in anchoring visions of tomorrow grounded in totalizing, globalizing, and often exclusionary and colonizing narratives of technological progress? Or will, instead—as science fiction writers in the solarpunk tradition have mused—the return to a world powered by the daily and seasonal ebbs and flows of the sun allow the possibility of, catalyze, or help secure a more diverse and inclusive set of imaginaries of the relationships among energy, industry, and community?[7]

This is the promise and the peril of a Green New Deal for energy: to reshape and redesign the very foundations of global political economy. This is the fight that is already amid us. Too much of the rhetoric and focus of the fight against climate change and the desire for a worldwide energy revolution is framed in terms of renewables versus fossil fuels—solar versus coal and oil. That fight is over. Fossil fuels have lost. As you read this passage, companies in every industry from banking to automobiles to the electricity industry are reworking their plans for the future to eliminate carbon. The year 2020 opened with an announcement from BlackRock, the world's largest financial asset manager, with $7 trillion under management, that it would put the transition to a low-carbon economy at the center of its investment decisions, redirecting both the advice it gives its clients—the world's largest insurance companies, pension funds, and other pools of capital—and its directives to the companies its funds own, which include virtually every publicly traded corporation on the planet.[8] To be sure, this announcement

reflects a bid for improved public relations from a company being pressured to act more strongly on climate change—and also a pitch for new money from investors looking to green portfolios—and its immediate impact on BlackRock's internal practices and decisions as a stockholder remained hotly contested. Nonetheless, it sent shockwaves through financial markets and corporate board rooms. Following BlackRock came a parade of others: BP, Delta, General Motors, a rapidly growing stream of electric utilities, and the European Union. While overshadowed by the growing coronavirus pandemic, for historians, these announcements will make 2020 the year that carbon's stranglehold on the global economy and global politics began to unravel. It will, inevitably, take longer than we might like to dismantle carbon-based energy systems and replace them with alternatives. And the work will be bloody, as we are witnessing in Russia's invasion of Ukraine, which is bound up in many ways in the geopolitics of oil and gas. The systems we've built are too big to fail, too central to the forms of societies, politics, and economies we've forged for ourselves, too tightly woven into their networks and infrastructures—but they are nonetheless history.[9]

Even as the fight to end carbon economies rages, there is another, equally important fight underway that deserves our attention—a fight over the future that will replace carbon. This fight is between solar and solar—that is, between very different pathways for weaving billions of photovoltaic panels and other renewable energy technologies into the political and economic orders of tomorrow. The full ramifications of this shift to disputes within and among alternative political economies of solar and other low-carbon technologies have not yet fully penetrated energy politics. The Biden administration, for example, has pushed hard in its first year for large-scale investments in solar energy while simultaneously acknowledging that environmental justice and labor-force transitions are also critical to the pursuit of a just, green energy future. At the same time, the administration's policy proposals largely remain built around arguments about the need to invest heavily in green technologies rather than, in a clear and transparent fashion, about the hard choices that need to be made about which green future to build and the implications of those divergent futures for the future of democracy and political economy. The opportunity to revamp the political economic fundamentals of the world comes along only once in a great while. It is an opportunity to create new models of economic and social life that bring peace, prosperity, and democracy to the coming decades and even centuries. Or not. It is a moment in history that should focus humanity's utmost attention on the kinds of futures we want to inhabit.

ALTERNATIVE IMAGINATIONS

Tomorrow's political economy of renewable energy is far from obvious, and many different futures are possible. In *Sustainable Energy Transformations, Power and Politics*, Sharlissa Moore recounts the surreal history of the DESERTEC project, a very real yet almost fairy-tale-like proposal to power Europe's future from gigantic fields of solar arrays built in the deserts of the Sahara, from Morocco to Saudi Arabia.[10] It is an Orientalist and techno-colonialist dream of almost unimaginable technological hubris, and yet there its website sits for all to see.[11] Most recently it has been tweaked with a somewhat more inclusive slant: desert sunlight harnessed to power not just European factories and coffeeshops but also the dreams of Africa's rising youth. Cecil Rhodes would no doubt find it inspiring.[12] And in North Africa and other deserts around the world, large-scale power plants are already rising by the hundreds, with plans for thousands more.

Amory Lovins imagines a very different future for solar energy. For almost fifty years, since the oil crises of the 1970s and the nuclear meltdowns of the 1980s, Lovins has advocated passionately for distributed solar energy as an environmentally friendly and economically and politically inclusive solution to the energy needs of the future: "Energy in the hands of citizens is power in the hands of citizens. That's good for democracy."[13] For Lovins, the fact that solar energy can be owned by individuals, not just corporations or states, and placed on their household rooftops or in their backyards has the potential not only to solve climate change but also to help reverse the concentration of economic and political power that has accompanied the growth of industrial societies over the past two centuries. Today, individuals, families, and communities all over the world are pursuing this vision, deploying a variety of bottom-up solar energy strategies.

I present these alternative imagined futures not necessarily to argue for one or the other, nor because they exhaust the possibilities of future worlds powered by sunlight, but simply to illustrate the enormous interpretive flexibility of solar energy. The idea of interpretive flexibility comes from the field of science and technology studies. It highlights, early in the development of new technologies, the ability for those technologies to be imagined and shaped along multiple potential technical trajectories, each with very different social, economic, and political valances. Over time, as technologies become more mature, they

experience closure: becoming more path dependent—their technical forms more standardized and more narrowly scripted in terms of their intersections with human imagination and life.[14]

The vast interpretive flexibility of solar energy is a big part of why solar is able to challenge fossil fuels.[15] Solar cells are capable of being integrated into devices as small as a handheld calculator or lantern or, a billion times larger, into gigawatt-scale solar power plants and every size in between. And in each configuration, at each scale, solar energy has high value for its users. Comparisons of energy technologies often focus on the abundance of solar energy (enough sunlight falls on the earth in an hour to power the global economy for a year) and its ultra-low cost (solar now has the lowest levelized cost of energy of any electricity generation technology). But part of the appeal of oil, like electricity, is that it can go anywhere and be used in a variety of combustion engines on a variety of scales for a variety of purposes. Solar matches oil in its flexibility: present every day, everywhere, and able to be configured in a multiplicity of valuable ways, making it as relevant to the decision-making of the world's poorest villages as it is to the world's biggest electric utilities. It also matches well with other key technologies that will drive a global clean energy transition, especially electric vehicles, which can soak up solar electrons whenever they are available and then hold them in batteries until needed to power the future of mobility.

The flexibility of solar energy has created multiple vibrant solar markets that present a mixed solar landscape. In the United States, for example, distributed solar installations made up approximately 40 percent of the 4 GW solar market in 2018 (as measured by installed capacity), with utility-scale solar projects comprising the other 60 percent.[16] Within the distributed portion of the U.S. market, approximately half has been installed on household rooftops and the other half on commercial rooftops, with a much smaller fraction installed on buildings owned or controlled by nonprofits, houses of worship, the public sector, or other noncommercial properties or organized into community solar initiatives. Solar-powered lighting devices, while comprising a tiny fraction of the installed solar energy capacity, nonetheless constituted a $3 billion market in 2018.[17] This diversity highlights the interpretive flexibility of solar at the present moment, but it also illustrates the almost complete privatization of U.S. solar energy. Even public entities that have invested in solar energy have typically done so via what are called power purchase agreements, in which the public entity contracts with a private company to supply solar-generated electricity on a long-term basis.[18] The solar panels may even be on the rooftop of public buildings yet owned by the private power supplier. In other parts of the world, especially in Europe, energy cooperatives, community solar, and publicly owned solar are somewhat more viable options than in the United States.[19] Yet worldwide the current reality is that, while half of global energy supplies are publicly owned, renewable energy is far more likely to be held privately.[20]

With solar energy, we are at the moment of choice, the cusp of massive global investments in solar infrastructure. As these investments get made, trajectories will begin to coalesce and converge on models of political economy that will increasingly acquire power and influence and organize the future. Solar panels are now being deployed at an increasingly rapid clip. In 2019 the world installed over 115 GW of photovoltaic panels, more than any other form of electricity generation.[21] This remains a drop in the bucket compared to future installations, of course, which are estimated ultimately to be in the range of 10–100 TW over the next thirty years, depending on how we choose to power the future of the global economy.[22] Yet it reflects a serious commitment of financial resources, to the tune of roughly $150 billion per year from 2014 to 2019.[23] As a result, major actors in both the financial and energy sectors—including both companies and regulators—are increasingly focusing their attention on what solar energy will mean for their futures. As highlighted above, a growing cascade of organizations are committing to 100 percent renewable energy.[24] In the absence of clear alternatives that integrate photovoltaics into the social, economic, and political organization of society in new and different ways, the decisions made by these entities about how to buy energy and to direct investment in the future of solar energy will likely have outsized impact on the global economic and political future.

THE INTRICACIES OF SOLAR-POWERED POLITICAL ECONOMIES

No one should presume that some magical characteristic of photovoltaic technologies will necessarily lead to just and inclusive futures in a world powered by solar energy. In locations around the globe, we already see rising concerns about human rights in renewable energy and cases of poor, Indigenous, and rural communities as well as endangered species being forced out of their homes to make room for solar power plants that provide electricity to urban and industrial

centers—or militaries seizing solar energy assets from communities.[25] We see corrupt governments favoring solar investments from their friends over alternatives that would enhance community ownership of renewable energy assets. More prosaically, we also see ordinary governments all over the planet establishing policies that incentivize private firms over community-owned alternatives. Renewable-energy supply chains are creating new sacrifice zones in places where scarce mineral resources required by solar technologies are found.[26] Major financiers like Masayoshi Son of SoftBank see in solar energy new opportunities to grow their financial empires through investments in vast new solar arrays around the globe and the electricity grids to carry their power across continents.[27]

In fairness, it will be very difficult for the injustices of solar energy to rise to the scale of corruption, human rights violations, violence, health risks, and colonial forms of oppression that attend fossil fuel economies. The world has been granted a great boon in the generally human-friendly character of most renewable energy technologies. But it is not impossible for renewable energy regimes to create new forms of injustice, inequality, and insecurity.[28] Just as significantly, clean energy transitions will create vast social and economic disruption in communities that currently supply carbon fuels, many of which already suffer from a variety of environmental and economic injustices associated with carbon extraction.[29] Questions of justice must be central to planning the photon-powered political economies of tomorrow.[30]

Properly addressing justice in energy transitions requires careful attention to the diverse ways that solar technologies are and could be layered into the fabric of our social, economic, and political relationships.[31] At stake is not merely whether solar systems are big or small, centralized or decentralized, publicly or privately owned. Rather, the pathways to solar-powered futures raise nuanced, intricate, and complex questions about how to design the political economies of the future.[32] Imagine a suburb: houses and yards and driveways as far as the eye can see. Imagine its rooftops, covered in solar panels, maybe even solar roof tiles. What is the political economy of that landscape? From the image as described thus far, we cannot tell. Who owns the panels: the homeowners; a company like Elon Musk's former company, SolarCity, who rented out rooftop space; the local electric utility; the city; a neighborhood co-op? How are the financial benefits, costs, and risks divvied up? What capital pools supply the resources and at what interest rates? To whom is the capital provided, granting how much control over the investment choices? Who manufacturers the

panels and where? Are the installers and maintenance teams unionized? Are the additional systems components, like the mounting racks, locally sourced? Who governs these choices?

Answers to all of these questions matter—in detail—for the political economies that follow, via their implications for material and social outcomes, distributions of wealth and power, and the forms of imagination that relate those to projects such as democracy and justice. If the panels are owned by homeowners, then those who rent their homes do not benefit, even as those who own their homes and have the savings to pay for the panels garner the largest fractions of the net financial benefit and the overall energy economy becomes more decentralized. If, by contrast, the panels are owned by SolarCity, then the homeowner may still benefit a small amount. While the energy economy may become more diverse and competitive with SolarCity competing with the local utility, it is likely not any more decentralized. SolarCity may become a large but distributed utility in its own right—perhaps even larger than the local utility in terms of total electricity generated and sold. Only if the solar panels are owned by the city or by a neighborhood co-op is there an opportunity for fashioning opportunities to participate for renters or for tilting the playing field to include those who don't already have access to significant economic resources.

Trade-offs in these models are very real too. The total costs of a solar system are a combination of the cost to manufacture the panels and the cost to install them.[33] The latter includes labor expenses. Reducing labor expenses reduces the price of the solar system, creating greater benefits for the solar system owner and contributing to faster deployment of solar energy—at the cost of lost wages for solar installers. By contrast, ensuring that solar installers are able to make a living wage, unionize, have health insurance, and otherwise benefit from good jobs raises the cost of installing solar panels, thus reducing the benefits to homeowners and slowing the transition to clean energy. Similarly, if, instead of buying solar systems outright, homeowners borrow money from banks to pay for the panels, opportunities for solar ownership expand significantly—at the expense of sharing the resulting revenue with the owner of the debt and granting them some control over who is and is not allowed to go solar. If public entities choose to subsidize solar energy, they can significantly reduce the costs of going solar and therefore open up opportunities for and accelerate solar adoption by middle class households, but this will likely create little benefit for low-income

communities. If they instead use the same funds to purchase solar panels for installation in low-income housing, they will acquire the same amount of solar energy with public money while benefiting low-income households at the expense of not drawing additional private capital into solar markets.

Consider a very different example. Annually, the economy of Arizona burns approximately $15 billion worth of carbon-based fuels.[34] Currently, the vast majority of that carbon is imported from other parts of the United States and the world. Reinvesting those funds in locally sourced, locally generated solar energy would bring significant economic benefits to the state on the whole, even as it might lead in the short term to small increases in the price of energy. It would also deprive other parts of the world of jobs and revenue. How should those considerations be balanced? Similar conditions apply in Puerto Rico, where residents import and burn $3 billion worth of carbon each year, contributing deeply to the colonial nation's ongoing indebtedness, macroeconomic challenges, and colonial dependencies.[35] Going further, given the up-front capital costs of creating solar energy economies, both Arizona and Puerto Rico would benefit even further from manufacturing solar panels locally rather than importing them from some other part of the world. As of today, roughly three-quarters of the world's solar panels are manufactured in China, with the rest distributed around the globe.[36] For much of the past decade, the global solar panel manufacturing industry has operated with zero profitability, as companies and countries have fought with China for market dominance.[37] The result has considerably benefited solar consumers (via low and falling prices for solar panels) even as it has also tended to drive down wages and undercut unionization in solar panel manufacturing and installation as well as laid the foundations for potentially deep concerns about the political economy and geopolitics of solar manufacturing of the future.

One final, very different example: in the early twentieth century, in the early days of modern electric utilities, large-scale, steam-fired, coal-burning power plants dominated urban electricity systems. Their expense was enormous. In order to provide for low-cost electricity, they needed to sell as much electricity as possible to as many people as possible. This became the basis of the settlement, described by Thomas Hughes in *Networks of Power*, in which utilities were granted monopoly power to sell electricity within delimited jurisdictions in exchange for complete social regulation. Ramping the power levels of these plants up and down during the day damaged their systems, incentivizing utilities to find ways to operate plants in modes that produced constant amounts of

power, day and night, winter and summer, consuming carbon all the while. Utilities faced significant pressure, therefore, from both their business and technology models, to find buyers for electricity at various periods of low ebb in industrial economies, and especially at night, when most of society slept, and on weekends, when they rested. Without such buyers, capital costs would be higher, forcing utilities to charge higher prices for electricity, reducing their benefits to society, lowering demand for electricity, and irritating their regulators.

Utilities took numerous actions to create electricity consumption at night and on weekends.[38] For example, they invested in businesses like amusement parks, electric trolley cars, and radio and television that simultaneously boosted electricity demand, grew demand for electrical equipment (which they also manufactured and sold), and shifted electricity demand to new times, outside of normal business hours. They encouraged homeowners to electrify their homes and purchase electrical devices for use in the morning, before work, and in the evening after work. At the same time, they incentivized businesses to do the same, arguing, for example, that businesses could more rapidly amortize the cost of new capital equipment by running multiple shifts through the night. Those incentives took the form of price structures that raised electricity rates to higher levels during the daytime, when consumption was high, while significantly lowering them at night, when it was lower. Through these activities, and especially through this pricing regime—high energy prices during the day, low energy prices at night—the electricity industry took the lead in helping to remake modern societies and economies into the 24/7/365 cultures and workplaces of today and, at the same time, to shift the balance in the economy between labor and capital.

One of the striking features of solar energy—one that makes it fundamentally different from its fossil cousins—is its diurnal variation. We divide day and night, dark and light, one of the oldest and starkest divisions in human imagination and social organization, by the presence and absence of the sun in the sky. This diurnal variation threatens to topple the century-old regime of energy prices that built today's 24/7/365 societies. Already, in California, where solar energy provided a mere 14 percent of the total energy produced in 2019, the pricing of electricity has irrevocably altered. Since 2017, for significant portions of the year, the price of energy is dirt cheap—even negative—at noon.[39] That's right, on many days they give energy away in the middle of the day. California's

independent system operator, CAISO, which operates the California electricity grid and marketplace, was forced to introduce a new regulatory structure, called the Western Energy Imbalance Market, to create a real-time market across Western states to sell—and on occasion give away—excess solar energy to nearby states.[40] Especially in the spring, Arizona and Nevada utilities, among others, take solar electrons from the market and provide them to their residents.

The reversal of daytime and nighttime energy prices will only grow as time goes on, as countries around the world deploy growing arrays of solar panels, forcing a major reconsideration of the organization of energetic work in the global economy. There are technical solutions—charging electric vehicles at work or electrolyzing water to make hydrogen are two frequently discussed options—but none that will change the fundamental logic that solar energy will vastly overproduce unbelievably inexpensive electricity in the middle of the day and underproduce electricity in the middle of the night for our modern, globalized economy, reversing traditional electricity pricing structures. It's hard to anticipate just what social and economic trajectories will flow from this repricing of basic energy services, but we should not disregard the possibilities. I often joke that lunch meetings will become a thing of the past: they just don't consume enough energy. Some people and businesses may choose to curtail nighttime work, returning to patterns more reminiscent of agricultural societies from our past, winding down in the evening and sleeping at night. Deeper shifts may in turn become possible. Activities and forms of work and labor that require high energy consumption may become concentrated in the middle of the day, creating an incentive to analytically decompose work practices according to the density of their energy requirements. We may need to relearn ordinary practices of daily life—the charging of phones, for example—to shift them to less costly periods of the day. And perhaps most deeply of all, deprived of the ability to significantly reduce costs by running equipment at night, companies may rebalance the ratio of capital and labor, ending three-shift manufacturing and the propensity to replace people with machines. How that will impact the contours of the so-called fourth industrial revolution is not at all clear.[41]

Because it is hard to predict the precise changes that will occur in tomorrow's socioenergy systems as people rethink and reconfigure their behaviors, values, relationships, and institutions around new technologies, the political implications also remain unclear. A truism of sociotechnical change is that, in freedom-loving America, even as attempts by governments to impose small behavioral changes on short time frames through new policies can create significant political backlash, far larger shifts in our day-to-day routines and practices—and even in our political and legal norms and institutions—occur when navigated through changes in markets or through the adaptive work of the U.S. legal system.[42] In the years following the rejection of Bill Clinton's five-cent-per-gallon gas tax, for example, Americans managed market-led changes in gasoline prices that routinely added dollars to the price of gasoline. Similarly, despite critics calling it a constitutional infringement of core rights and freedoms, efforts to end the sale of incandescent light bulbs in favor of far more efficient LED alternatives have gone relatively smoothly. So even though a proposal to realign American society overnight with the availability of solar energy would be dead on arrival, the idea that people and institutions will adapt over time to even rapid changes in technology and markets, creating deep changes in culture and organization, is highly plausible—and they may even do so enthusiastically in cases where those changes are symbiotic with societal goals and objectives. For example, a growing movement of communities known as the International Dark-Sky Association is already exploring the benefits of going dark at night, even before a solar-powered economy makes it desirable from a cost perspective.[43]

Yet we should not neglect the significance of shifts in daily routines and practices at home and at work. As Michel Foucault reminds us, political economy is built outward from the body and the daily routines through which it is disciplined by the knowledge and machinery of the state and the economy. For over a century, that discipline has been imposed by regimes powered by fossil fuels, and the characteristics of carbon-based energy systems have shaped the exercise of their disciplinary power. Going forward, as we shift from fossil fuels to solar energy, we will increasingly inhabit very differently configured energy regimes that express potentially very different capacities and inclinations to discipline our bodies and minds. Especially as the worlds of energy and data are increasingly intertwined, through the development of smart energy networks and technologies, the politics of energy behavior are likely to grow significantly. The transformation to a solar-powered economy will create new incentives for utilities, employers, and states to surveil the energy practices of workers and citizens as well as new tools both for pursuing that surveillance and for incentivizing or enforcing new forms of energy discipline.

One of the key opportunities of the coming energy transition—and one of its central challenges—is to rebuild, from the intimacies of the body to the geopolitics

of the globe, the intricacies of political economy along new, more humane lines. Modernization and industrialization transformed the lives people live—not least through the ability to organize and deliver massive new quantities of energy in the service of human enterprise—but they didn't always make life more worth living or create what we might refer to as human thriving. Using clean energy transitions to do better will require careful rethinking of the intricacies and intimacies of the solar-powered political economies of the future. In the next section, I offer a few thoughts on what it might mean to make energy more humane.

THE OPPORTUNITIES BEFORE US

The Green New Deal presupposes a green transformation of global energy systems. It often also seems to assume, however, that social and economic justice will largely be found elsewhere, such as in increasing the number and quality of jobs, redressing racial injustice, or increasing home ownership. My argument here is that social and economic justice will *also* be won or lost in the intricacies of the redesign of energy systems, the reforms of political economy that accompany it, and their implications for the distribution of power and wealth and the possibilities of democracy and freedom in future societies. All too frequently, those intricacies are afterthoughts in the design of Green New Deal policies. They shouldn't be.

One of the central goals of a humane energy future should be to democratize energy governance.[44] There is no ideal model of the future of a solar-powered political economy—no singular vision that will fit the needs and opportunities, desires and imaginations of the many peoples of the world. The design of energy futures therefore needs to be more locally responsive than the approaches taken by current energy companies and regulators. Fundamentally, there is a growing recognition that democracy demands open, inclusive, and transparent governance of the design of technological systems that empowers diverse communities to participate in imagining and constructing futures and, where they feel it necessary, to establish sovereignty over technological decisions.[45] Energy is no exception, as the recent escalation of social protest movements around oil pipelines, renewable energy siting decisions, biofuels plantations, and other aspects of energy decision-making have illustrated—as well as the renewed engagement of publics and nonstate actors in energy governance in many parts of the world.[46]

Especially given the flexibility of solar to diversify energy systems and render them more inclusive in a variety of ways, energy democracy seems likely in the future to take a more decentralized, distributed, and self-determined approach to the design of future energy systems, as Richard Lachmann also argues in chapter 16 of this volume.[47] This does not foreclose the possibility of democratically authorized solutions that retain more centralized elements, which are common in today's energy systems, or reject the reality that energy governance is and will likely always remain multiscalar and polycentric.[48] It acknowledges, however, that centralized energy systems construct and exercise forms of social, economic, and political power that have proven difficult for democratic politics to exert control over. Monopolistic regional and national electric utilities and quasi-monopolistic global oil companies alike have contributed, among other things, to corruption of political institutions, ongoing energy poverty of multiple forms around the globe, mistreatment of workers, support for authoritarian regimes, and a wide range of violations of human rights, including manifold environmental injustices, murders of journalists and activists, and the displacement of communities in order to build energy infrastructure—prioritizing power over people.[49] Nor is decentralization a magic solution. Deregulation constitutes a form of decentralization, for example. Yet while the introduction of electricity markets has disrupted the market power of former monopolistic electric utilities, it has also created even larger, more centralized, and often unaccountable market institutions while simultaneously reducing the power of democratic publics over energy system design and performance. In short, whatever particular configuration we choose to design for tomorrow's energy systems, the details will matter for how power, wealth, and political economy—as well as systems performance and environmental and social impacts—play out.

Diversification of the design and governance of energy systems may well be the norm, however. Combined with the already disaggregated character of electric utilities around the globe—nearly 3,400 electric utilities currently operate in the United States, for example, with 2,800 publicly owned utilities that include rural cooperatives, municipal utilities, and federal power agencies[50]—the flexibility of solar technologies has the potential to allow for future political economies of energy to be tailored in numerous ways to fit diverse local contexts and sensibilities.[51] Energy systems can be organized to provide services, such as mobility and power, in ways that are better attuned to local needs, priorities, and values and that create and return significantly more value for local economies

and communities. Doing so, however, will require careful attention in the coming energy transition to enhancing local capacity to imagine and transform energy systems in the service of more diverse and inclusive futures.[52] In the century since the last great debates over the constitutional integration of energy systems into democratic governance, energy has unfortunately become a fairly exclusive realm of experts in which public participation is made difficult and sometimes actively discouraged.[53] Although that is slowly changing as publics come to recognize the significance of energy futures, one key focus of a Green New Deal should be the empowerment of local communities to imagine and construct their own energy futures.

A second key focus of a Green New Deal for energy should be to end energy poverty. The political economies of energy set up in the early twentieth century around electricity and gasoline were built on a simple two-plank model: energy as the basis of modern life with inexpensive energy for all. As a consequence, residents of modern societies today confront a simple reality: energy is a routine cost of life. Every week we buy gasoline for our cars. Every month we pay our electricity bills. At current prices, for the majority of U.S. and European citizens, those payments are trivial. For low-income individuals, households, and communities, those payments are a regular extraction of scarce economic resources that systematically undermine their ability to escape poverty.[54] Combining electricity and fuel payments can lead to energy burdens, defined as the percentage of income that goes to pay for energy, that are as high as 30, 40, and even 50 percent. Low-income households often trade off between buying energy and food, routinely facing the possibility of having their energy cut off, not to mention other energy challenges that make it harder to accumulate savings, to work, and to pursue education that would improve their economic security.[55]

Nor are financial issues the only dimension of what might be termed the energy-poverty nexus. Diverse negative feedback loops tie together energy, economic, food, and health insecurities in extractive relationships. For example, we are now seeing the perilous combination of health, environmental, racial, and economic injustices that add up to much higher infection and death rates from COVID-19 in communities of color in the United States.[56] In developing regions of the world, ending the energy-poverty nexus has the potential to become one of the most important drivers of economic and social progress for the bottom half of the world's peoples, many of whom still do not have reliable access to electricity.[57] The problem isn't just powering these communities, however; it is ensuring

that the transition from their current socioenergy systems (often built on kerosene, firewood, or diesel generators) to solar-powered energy systems creates new opportunities to use energy in valuable ways to advance social and economic thriving.[58] One of the central goals of a Green New Deal, both in the United States and around the globe, should be to untangle the energy-poverty nexus and instead create future solar-powered political economies that are generative for low-income communities; that enhance their economic, social, and political opportunities; and that flow money in instead of out. This is a doable goal if we set not only our minds but our policies to properly structuring the ownership and control of future solar energy economies.

The final, closely related key focus of a Green New Deal should be to redress the deep social and economic inequalities driven by energy economies over the past century plus. On the latest list of the Global Fortune 500 companies, nine of the top ten by annual revenue are oil, electricity, or automobile companies.[59] That concentration highlights the deep historical connection over the course of the twentieth and twenty-first centuries between the distribution of political power and economic wealth and the rise of three modern, global energy industries: the automobile complex, the oil and gas complex, and the electricity complex. More than any other sector of the global economy, these industries have driven and actualized inequality between the haves and the have-nots.[60] If we design them properly, so they distribute wealth and power rather than concentrate it, solar energy—and the forms of mobility that we build upon it—have the potential to redress inequality head on. Through more decentralized models of ownership, strengthening of energy rights and protections for energy workforces, and other innovations, we can ensure the vast economic benefits of energy systems are distributed widely and generate new sources of economic security and empowerment.

The challenge for the Green New Deal is to seize this unique opportunity in human history to take seriously political economic design—as well as the design of societies more broadly. The International Energy Agency estimates that the global renewable energy transformation will run $70 trillion or more.[61] That sum represents an enormous opportunity to invest in the human future. How we decide to spend that money will have a massive influence not only on the distribution of wealth and power but also on the kinds of cultures and societies that we invent through energy innovation. We must get to zero carbon—and fast. But it's not good enough to waste that money just building carbon-neutral energy

systems that replicate the ones we currently have. If we're smart about how we get to zero carbon, we can arrive at our destination having vastly improved human futures.

This redesign will not be easy. Competition and conflict over the political economic design of the future of energy is already well under way and backed by some of the biggest sources of power and money on the planet. Design choices will be made by real institutions with real power dynamics. Advocates of political economic redesign will need to show up, commit to engaged participation, fight for a place at the table, and have clear and implementable objectives with respect to the intricacies of energy system engineering and market design—not just broad slogans. The process will need new voices involved in decision-making who haven't historically been part of energy governance and new research and data to inform decisions with insights into the societal implications of energy design that don't currently exist. It's wildly inaccurate to envision the transformation just in terms of installing a bunch of solar panels. It's also about the future constitution of energy ownership, the kinds of future jobs supported by the energy sector and the rights, protections, and responsibilities we grant to energy workforces, the future organization of energy governance, how inclusive future energy systems are, how broadly they contribute to economic and human security, and much, much more.

And we don't get to screw up. The transformation process itself will be highly complex and in systems that we utterly depend on for economic, physical, and military security. We cannot, along the way, collapse our current transportation and electricity systems in unorderly fashions. The Green New Deal thus faces two fundamentally intertwined challenges: redesigning human futures through energy innovation that generate far more societal benefits than just carbon neutral energy while simultaneously managing transformation in some of the world's most complex and intertwined sociotechnical systems. This is not a case of set-it-and-forget-it. Creating a more just energy future will be a long slog, yet it is eminently doable.

Already around the globe solar energy is transforming industries and economies, people's lives, and the politics of energy around multiple diverse models, and it's happening at multiple scales, from individual households to neighborhoods and communities to cities and industrial sectors to nations and even whole regions of the planet. Comparing across these emerging solar "markets"—which are really whole new ways of ordering human existence—we can already see the

remarkable possibilities that open up in front of a Green New Deal. In reimagining the political economies of the future, we have the opportunity to make real some of the most ambitious societal objectives of our time: enhancing democracy, ending extreme poverty, reducing violence and conflict, and strengthening the resilience of human communities. To take advantage of this opportunity will require a detailed focus on the central sociotechnical systems dynamics, organization, and ownership of energy-based political economies: the linkages between energy-based value creation and the flows of benefits, risks, and burdens that stream outward from energy technologies to create social and environmental footprints across the globe through the dense sociotechnical fabrics of hypermodern, informatically networked societies. A century ago, the detailed design of energy systems intricacies and their implications for political economy were front and center in U.S. and international politics. It's time to take a close look again. Our future depends on it.

NOTES

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