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Toward feminist energy systems: Why adding women and solar panels is not enough☆

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ABSTRACT

Growth in renewable energy does not displace fossil fuel use on a one-to-one basis, but rather increases the total amount of energy that is produced. As numerous scholars have argued, an energy transition away from – rather than in addition to – fossil fuels will require more than technology and financial capital. Here we argue that a feminist perspective on energy provides an important framework for understanding what keeps us stuck in unsustainable energy cultures, as well as a paradigm for designing truly just energy systems. Feminist approaches have been widely taken up in environmental and ecofeminist work, as well as in climate change research. In energy studies, however, gender-related research has tended to focus more narrowly on women's issues. Although this is crucial work, the focus on women represents just one dimension of what feminism can bring to the study of energy. Feminist theory also offers *expertise in the study of power* more broadly, which is widely applicable to the full spectrum of energy research. This article outlines a feminist energy research agenda that addresses many aspects of energy system design, planning, exchange, and use. We analyze energy along four intersecting coordinates: the political (democratic, decentralized and pluralist); economic (prioritizing human well-being and biodiversity over profit and unlimited growth); socio-ecological (preferring relationality over individualism); and technological (privileging distributed and decentralized fuel power and people power). In doing so, we show that feminism is well-suited for navigating the tangled web of power, profit, and technological innovation that comprises human fuel use.

1. Introduction

Over the past decade, renewable energy production has averaged more than 16% growth annually [1], leading numerous researchers to conclude that we are in the midst of an energy transition [2]. However, as Richard York and Shannon E. Bell argue [3], it is more accurate to characterize the current growth in renewables as energy *additions*, given historical trends and the limited impact that renewables have had on fossil fuel consumption to date. As they demonstrate, over the past two centuries, each so-called energy transition from one fuel source to another has resulted in an *increase* in the absolute quantity of energy consumed from all sources, even as the proportion of energy produced by the older source has declined. Thus, rather than replacing older sources of energy with new ones, adding new energy sources has simply facilitated continued growth of overall energy consumption. York's cross-national study of energy data between 1960–2009 [4] provides compelling evidence that this trend holds true for the current growth in renewable energy: displacing one unit of fossil fuel energy requires between four and thirteen units of non-fossil-fuel energy sources to be brought online. Moreover, reductions in the carbon intensity of total energy and electricity production are linked to *higher* total energy and electricity use throughout the world [5]. In many cases, the addition of new energy sources has also stimulated the consumption of older energy resources in non-energy sectors [3,6,7]. Thus, through what Zehner [8] terms a "boomerang effect," cheaper renewable energy risks adding to global energy consumption, rather than supporting more sustainable outcomes.

This “displacement paradox” [4] can be explained by the structure

☆The **Mayapple Energy Transition Collective** is the name that we, the authors, have given to the non-hierarchical and collaborative research we are doing together. Mayapple is an understory plant that grows throughout the forests of the Appalachian mountains that we call home. It is also a plant that grows in communities via a shared rhizome. In many ways, we think the symbolism of this plant represents our work together.

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of market economies, which are characterized by a profit-driven growth imperative, and not by a concern for conserving resources or environmental protection [9]. Thus, facilitating an energy transition *away from* (rather than in addition to) fossil fuels is more than a problem of technology. Rather, changing the historic trend of "energy additions without energy transitions" will require challenging the supposition that we must continue to follow our current path of unrelenting economic growth [3]. Moving beyond this path requires an understanding of – and intentional efforts to curtail – social inequalities tied to unjust energy cultures and practices.

Here we argue that a feminist perspective on energy offers an important and underacknowledged framework for understanding what keeps us stuck in unsustainable energy cultures, as well as a paradigm for designing truly just energy systems. As Sheena Wilson, who leads a "Feminist Energy Futures" project, argues [10], "energy transition is a feminist issue" because decarbonizing our energy supply "could provide opportunities to develop more socially just ways of living that put the concerns of those most exploited – women, people of color, and the global 99 percent – at the core of energy transition politics." Perhaps contrary to popular thought, a feminist perspective on energy research can reach far beyond simply providing a lens for understanding gender inequalities as they relate to energy production, use, or policy-making. Feminist scholarship provides a means for understanding how power works more broadly, whether it is political power or fuel power.

Our article has two aims: first, to outline a feminist energy research agenda that has broad application for researchers; and second, to introduce insights that could guide the design of feminist energy systems. Our vision is feminist in that it puts traditionally marginalized bodies at the center of analysis; it is intersectional in that it is attuned to the many hierarchies through which power (and energy) operate. We analyze energy according to four intersecting coordinates: the **political** (democratic, decentralized and pluralist); **economic** (prioritizing human well-being and biodiversity over profit and unlimited growth); **socio-ecological** (preferring relationality over individualism); and **technological** (privileging distributed and decentralized fuel power and people power). Rather than attempt an exhaustive overview of feminist work in each of these areas, we demonstrate the utility of a feminist perspective on energy by featuring key insights for each coordinate. The article concludes by arguing that feminism offers a uniquely valuable approach to energy studies, one that is well-suited for navigating the tangled web of power, profit, and technological innovation that attends human fuel use.

2. Feminism is more than gender

Feminist approaches have been widely applied in science and technology studies [11–14], environmental and ecofeminist work [15–19], and climate change research [20,21,43]. Energy scholarship, on the other hand, has focused more narrowly on women, perhaps due to the masculinization of fuel and fuel technologies [22–27]. The latter analyses have focused on women's *access* to energy [28–33], women's *representation* in the energy workforce and in decision-making [34,35], and on the disproportionate harm that women *experience* from environmental degradation [20,36]. Gender-sensitive approaches to energy have also studied how gender norms can influence perceptions of energy, technology, the environment, and political participation [37–42]. Cohen [43] argues that much of this work has been done under the auspices of "development studies," primarily because of the centrality of gender to that field; this has limited our understanding of how gender and energy operate in the Global North.

We view each of these women-centered issues as crucial for a just transition. However, in focusing primarily on women, this scholarship represents only one dimension of what feminism can bring to the study of energy systems. Feminist theory offers *expertise in the study of power*, one that is under-utilized yet applicable to many aspects of energy system design, planning, exchange, and use. Feminists have long linked the simultaneous and compounded "oppressions of gender, ecology, race, species, and nation" [44,28] and, by studying gender hierarchically, have demonstrated the centrality of ordering to the operation of power, including the techno-centrist guise of fuel power. Indeed, "[t]reating ideological distinctions as objective difference misses the most central and enduring core argument of feminist scholars—namely, that it is through the making of such categorical distinctions among human actions and actors that inequality is generated" [45]. Subordinated social identities, in other words, and their correspondingly uneven access to political and economic power, emerge when differences are ranked.

Many claims are made in the name of feminism, but the feminist approaches that have informed our arguments are *intersectional* [46–48] in that they are continually attuned to how gender combines with other interlocking modes of oppression, including race, class, ethnicity, nationality, ability, sexuality, Indigeneity, colonial history, and Global North/South divides. To practice intersectionality is to deploy an "analytic sensibility … a way of thinking about the problem of sameness and difference and its relation to power" [49: 795]. Feminist researchers must recognize that women's experiences of energy are not all the same and must also ensure that their analyses do not let gender become "shorthand for other differences" [50: 149], including race. In short, energy systems function as "structures of power and exclusion" [49: 795–97] that shape who benefits from and who is burdened by available energy technologies.

Intersectionality also brings with it an awareness that knowledge is situated and partial [14,51], which is a direct challenge to the universality claimed by techno-literate, white masculine perspectives in the field of energy research. Instead, post- and decolonial theorists, particularly from the Global South, insist that there are a plurality of worldwide knowledge systems. Alliances formed between social justice movements and actors should proceed on the basis of "hospitality" [52: xiii] toward, rather than a simple "tolerance" of, others' knowledge claims, and ask questions about what "different intellectual heritages bring to the discussion" [53: 5].

A related concern is that of *value*, or what Braidotti refers to as "difference as pejoration" [54]. Feminists "tend to ask critical questions [about] … if, why and how something has come to be devalued" [55: 52], as well as about the social and political exclusions that follow. This issue was central for early ecofeminists, who used it to connect forms of gendered, racial, and ecological violence [19, 17]. Though often caricatured as reductive "Earth Mothers" who have essentialized women's connections to nature, ecofeminists have long examined the ways in which those constructed as "feminine" (e.g. women, nature) are oppressed in an effort to infuse investigations of a variety of topics – such as environmental racism, global economics, maldevelopment, and militarism, among others – with questions of devaluation and exploitation [44]. Moreover, ecofeminists use empirical research and political activism to demonstrate that "social justice, interspecies ethics, and environmental concerns" [44: 33] cannot be approached as separate issues. This early wave of feminist environmentalism challenged "nature as the naturalization of inequalities" [54: 21] by posing the question of who and what counts as human. This latter concept is especially taken up within post- and anti-humanist feminisms.

Ecofeminism is only one line of feminist scholarship that informs our arguments here; others include gender and development studies, feminist political ecology, post- and decolonial feminisms, Black feminist thought, Indigenous studies, environmental justice, Marxist feminism, queer theory, and disability studies. Our feminist energy genealogy stretches between gatherings in 1991 (the Women's Environment and Development Organization meeting, one year before the Earth Summit in Rio) and 2014 (an "Anthropocene Feminism" conference in Milwaukee, Wisconsin) and beyond. At times, these different strains of feminist thinking may focus less on gender, and more on related experiences of exclusion and domination. Hird and Zahara [56], for example, show how colonial systems in Nunavut, Alaska

constructed aboriginal residents—"real life people who happen to coincide with categories of negative difference" [54: 24]—as both waste and, by association, those who should "unburden white people from the toil of their own cleaning" [56: 126]. In a contemporary context of ramped up fossil fuel extraction (facilitated by warming temperatures), and via a national narrative invoking "thousands of years of successful Inuit stewardship" [56: 131], this construction is redeployed—alongside tropes of the noble savage—in order to burden Indigenous northern Canadians with the management of extractive waste. In a similar vein, Sasser [57: 4] describes how women in the Global South are constructed as "sexual stewards" by population-environment advocacy groups. As such, they are enjoined to scale back their reproductive lives in order to accommodate a climate-resource crisis generated by almost everyone but them. In each of these cases, arguments that emphasize forms of racialized injustice offer insights about power, exploitation, and value that are also feminist. Both groups are disproportionately impacted by anthropogenic climate change not because they are intrinsically vulnerable to its catastrophes, but because of the "matrices of domination" [51] that feminists consistently interrogate.

While matrices of domination work through multiple identities beyond the man-woman axis, the feminist critique of masculinity nevertheless remains essential to achieving a just energy transition. Feminism does not mean faulting any particular group of men but viewing gender as a system through which particular expressions of masculinity become ascendant "through culture, institutions, and persuasion" [58: 832–3]. Understanding masculinities as "configurations of practice" [58: 836] links them to all levels of energy extraction, production, exchange, and consumption, including in the policies of "political 'strongmen'" [54: 38]. For instance, Cara Daggett [59: 4] uses the concept of "petro-masculinity" to point out the intimate relationship between fossil fuels and white patriarchal orders, arguing that "while misogyny and climate denial are often treated as separate dimensions of new authoritarian movements, a focus on petro-masculinity shows them to be mutually constituted, with gender anxiety slithering alongside climate anxiety, and misogynist violence sometimes exploding as fossil violence." Similarly, Rebecca Scott [60: 94] notices how "tough guy" and "family man" forms of masculinity inform miners' relationship to the coal industry in Central Appalachia, such that gender norms "work together with cultural institutions such as heteronormativity" to deter coal industry workers and coal-mining communities from mobilizing for environmentalist causes. In a feminist cultural analysis, these norms are never fixed and can be rearticulated to create new social identities and political possibilities. New commonsense understandings about masculinity, productivism, and energy are key to the uptake and distribution of feminist energy systems [61; see also 62].

Finally, feminism is a space of *world-making and visioning*. Though often disparaged as the face of grievance studies, many feminists have embraced their reputations as angry and even as "killjoys" in order to translate individual emotions into collective struggle [63]. Importantly, however, feminism is also a space of care, joy, and pleasure; as much a space of political utopia as of tension and unhappiness [64]. Haraway [14: 594] argues that it is our commitment to partiality and contingency that facilitates this capacity: feminists "make room for surprises and ironies at the heart of all knowledge production [because we know that] we are not in charge of the world" [see also 45]. Others argue that a predilection "for knowing and becoming otherwise" [11: 18] is a survival skill, given the "illicit appropriations of self-determination, power, and wealth from Indigenous people, women, queers, animals, and nature to elite men" [44: 28]. Feminist energy systems must accommodate both the perils and the pleasures of energy systems—those with which we are familiar and those we have yet to conjure—and such systems must be imagined from outside the logics of uninterrupted growth, social and geopolitical hierarchies, and anthropocentric conceptions of the non-human world [65]. Moreover, critique need not be reduced to complaint; understood as a form of historical encounter, feminist critique can lead to meaningful redistributions of material rights and responsibilities.

Our feminist approach to energy acknowledges the inherent complexity of humans' entanglement with energy and eschews calls for ecological or social purity. Feminist frameworks help to navigate such complexity, having long noted that binaries such as clean-dirty, rational-emotional, foreign-domestic, and nature-culture serve to reinforce unjust hierarchies. Nor does a feminist approach advance universal solutions to fuel problems. Ambiguity and pluralism are embraced in most feminist praxis and theory. However, feminist theory can and does make *judgments* about energy, alongside envisioning and enacting more just energy systems. Such judgments will necessarily be situated, i.e., within the contexts of specific communities and energy actors. Embracing plurality does not mean a collapse into relativism, where all energy practices are equally celebrated. Energy approaches that point toward monocultures and that work to exclude and discourage biodiversity and human difference – such as market-centric thinking, extractivism, white supremacy, or patriarchy – can and should be resisted. Likewise, renewable energy "fixes" that ignore the systematic subordination of marked social groups do not constitute feminist energy solutions [61]. In that spirit, we offer the following feminist propositions, tailored to four central aspects of energy studies: political, economic, socio-ecological, and technological.

3. Feminist energy systems: Four guiding principles

The following four dimensions emphasize activities, infrastructures, and agents that are thoroughly intertwined. Considering them separately risks overlooking their entanglement. Nevertheless, they reflect actual disciplinary divides in human knowledge, each approaching energy systems according to different logics of power. A feminist reconstruction of energy will require its own array of counter-logics, minutely tailored to contesting, for instance, capitalism, techno-centrism, authoritarianism, and eco-violence, which can appear in combination or in isolation (see Fig. 1). A feminist approach to energy thus requires a multi-pronged, collective approach to knowledge.

Feminist Energy Systems	
Dimension	**Vision**
Political	Democratic; decolonial; decentralized; pluralist; publicly owned
Economic	Prioritizes human and more-than-human well-being and biodiversity over profit; refuses the growth imperative; committed to community economies and pink-collar jobs
Socio-ecological	Relational; transparent; attuned to the violence of energy production and engaged in efforts to mitigate or compensate that violence; committed to building a culture of care
Technological	Distributed; community-directed and collaborative; heterogeneous and multiple

Fig. 1. Dimensions of Feminist Energy Systems.

3.1. Political

Renewable energy systems do not automatically produce democracy and justice, nor are they necessarily sustainable. New fuel technologies alone, without a matching new fuel politics, are unlikely to resolve the looming climate disaster. Public, democratic ownership of energy systems is the most likely means of ensuring energy justice and sustainability.

Solar and wind power are sometimes assumed to have traits more conducive to a democratic and egalitarian organization of power. Their spatial diffusion and flow make them readily available to decentralized and distributed energy arrangements and also put them in tension with private property and enclosure regimes [66-69]. However, renewable energy systems do not guarantee democracy and equality, as they can be easily harnessed by authoritarian and exploitative regimes. Indeed, the development of many large-scale renewable energy projects has involved land grabs and “energy dispossessions” [70] typical of fossil fuels and biofuels, “increas[ing] the precariousness of vulnerable communities” [71]. For example, Karen Eugenie Rignall [72: 542] shows how Morocco's drive to build mega-solar projects for the global energy market – much of it serving Europe – has operated according to neoimperial scripts of land dispossession in the Global South, in which popular political resistance is transformed “into a technocratic problem to be addressed through development interventions.” Rignall points out that solar's transformative political potential is dependent upon its mode of development, as “renewable energy developed on a large scale and based on centralized generation models that plug into existing infrastructure may serve to perpetuate the inequalities and environmental damage associated with incumbent energy regimes” [72: 542]. Likewise, in her study of wind development in Mexico's Isthmus of Tehuantepec, Cymene Howe [73] finds that a planned wind park was in keeping with the traditional model of extraction, a reflection of how renewable energy projects “risk repeating old conventions that end in ruin.”

The political diversity of emerging solar and wind projects tells us that more than one renewable energy future is possible, and that political struggle will be necessary to ensure that these futures are just and sustainable. Troublingly, authoritarian inclinations are on the rise in multiple sites worldwide, among both proponents and critics of renewable energy and other climate mitigation policies. Far-right populist movements are seeking to shore up the carbon-intensive *status quo* alongside misogynistic and racist worldviews [59, 74, 75]. Others suggest that a new global form of sovereignty – a "climate Leviathan" [76] – may emerge to implement mitigation policies. On the ground, exploitation at the point of solar production can be obscured by “the fetishism of solar energy - especially its inexhaustibility, cleanliness, and immateriality” [72: 541], which helps to depoliticize renewable energy development and makes "greenwashing" by corporations and political leaders more effective [8].

Part of the struggle, as Rignall, Howe, and others point out, is to insist upon the political nature of energy systems, as energy is too often dominated by neoliberal, market-oriented thinking toward fuel and other so-called natural resources. Ecofeminists have shown how the depoliticization of the environment rests upon the devaluation of reproductive activities, which are relegated to the exploited, hidden spheres of "nature" and "household." Nancy Fraser [77: 64] has referred to these as two "background conditions" - social reproduction and "Earth's ecology" – that make capitalism possible. The third background condition, Fraser writes, is political power, which capitalism relies upon to create a legal and geopolitical “framework underpinning private enterprise and market exchange.” Like capitalism's debts to reproduction and nature, its reliance on political support remains purposely hidden and disavowed, perpetuating a belief in economics as separable from politics.

To the extent that renewable energy is treated as an asset for private finance, it, too, risks appearing as a "depoliticized arena" in which the market price of solar or wind serves as the most important bellwether of a hoped-for transition. An over-reliance upon the logic of the market is infused into renewable energy projects, which have thus far been highly privatized and financialized. Over 90% of renewable energy investment came from private sources in 2016, according to the International Renewable Energy Agency, with public policy and regulation described as important "enablers" to investment. Political power is thus characterized as a friendly partner to capital interests, and renewable energy is heralded as an attractive asset that can be conducive to the continued expansion of commodity consumption. So when the city of Georgetown, Texas decided to switch its publicly owned grid to 100% renewable energy, its Republican mayor could explain it as “purely a business decision” and declare that he gave no thought to energy equality [78], while at the same time largely ignoring the significant public role in expanding transmission infrastructure in Texas and forging renewable-friendly policy that made the city's decision appear as business common sense. In contrast, energy scholars more readily appreciate the fundamental role of public policy and regulations in constructing renewable energy markets, but the mainstream assumption still treats political power as a force that ideally sets the stage for, and cooperates with, enlightened private investment, thus ceding renewable energy to market forces.

Any critique of the state of renewable energy development raises an important question, oft heard from ecomodernists: given the high stakes of the climate crisis, should we quibble over the means by which we achieve decarbonization? If not only human life, but the multi-species lifeworlds of the Holocene, are at stake, can we dismiss methods that may involve finance capitalism, authoritarianism, or geoengineering, if the result is faster progress toward climate mitigation? Such a question rests upon several assumptions that have not thus far been empirically demonstrated: that authoritarian-, imperial-, and/or capital-led forces exist with sufficient motivation to lead a global decarbonization; that such pathways would in fact be easier and faster than more democratic and inclusive ones; and that a decarbonization effort brought about via hegemonic political styles could ever be truly sustainable from an ecological and social perspective. A feminist energy perspective, attuned to the violent outcomes of other political hegemonies, is skeptical of all three assumptions. This skepticism aligns with the work of Indigenous scholars such as Kyle Powys Whyte [79], who argues that the “call to urgency is used to justify [mitigation] solutions” that may succeed in providing clean energy, but that will continue to harm Indigenous and other marginalized peoples. As he and others maintain, trust, consent, and accountability - all of which take time to build - must be central to the process of forging political relationships that are truly resilient in the face of dramatic climate change.

The political means of transition matter to its success. And market logics have a poor track record in terms of energy sustainability. While private investors can deliver more solar and wind power to the grid, they rely upon ever-expanding energy consumption to sustain profits, and so cannot be counted upon to lead the way to achieving decarbonized and just energy systems [4, 80]. This is evident in the fact that, alongside private investment in renewable energy, investors simultaneously have continued pouring money into fossil fuels. A report titled “Banking on Climate Change,” compiled by several environmental nonprofits, found that while renewable energy investment fell after the Paris Agreement was signed, private financing to the fossil fuel industry continued to rise, with 33 leading banks contributing $1.9 trillion between 2016 and 2018.[2]

[2] Indeed, this outcome should not be unexpected. As Hans-Werner Sinn (2008) argues, the passage of environmental regulations aimed at demand-side solutions, such as cutting carbon emissions, often have the effect of *speeding up* the extraction of fossil fuels through a process he terms the “Green Paradox.” When carbon reductions are announced, fossil fuel companies and owners attempt to “pre-empt the corresponding wealth losses by extracting and selling their fossil fuels before their markets disappear” (xii).

Moreover, even if decarbonization could be achieved by hegemonic means, renewable energy by itself does not ensure sustainability. Energy is a central problem driving global warming, but it is not the only stressed element. A decarbonized energy system that remains plugged into the pursuit of endless economic growth and ever-expanding production and consumption (the current hegemonic system) will continue to overrun planetary limits. This is what James O'Connor [81] refers to as the "second contradiction of capitalism," or as Foster, Clark, and York call it, the "absolute general law of environmental degradation under capitalism" [82: 207].

The ongoing sixth mass species extinction event and the over-accumulation of nitrogen and phosphorous in the biosphere are both exacerbated by global warming and would be mitigated by decreased carbon emissions from fossil fuels; however, they are also exacerbated by land use, agriculture, and consumption practices [83]. In other words, green technologies do not ensure socio-ecological well-being, notwithstanding the eco-modernist desire to decouple "human development from environmental impacts" [84]. Indeed, a large body of cross-national empirical work [85-87] counters the "socio-techno optimism" of ecological modernization theorists, who claim that modernization will ultimately allow humans to overcome the environmental crises created by capitalism. As Foster, Clark, and York [82: 124] argue, capitalism has created an "'irreparable rift' (rupture) in the metabolic interaction between humans and the earth" that has affected all of the nine "'planetary boundaries'…crucial to maintaining an earth-system environment in which humanity can exist safely" [82: 14].[3] It is telling that a subsection of eco-modernists, many of them wealthy, white, Western men, have been driven to consider leaving Earth and its political constraints in order to extract resources – and even to seed space colonies – in order to sustain the fantasy that endless capital accumulation is possible, despite clear ecological limits. Such visions correspond to what Martin Hultman [27] calls an "ecomodern masculinity," which embraces the human mastery of nature while ignoring humans' interdependence with each other, and with multispecies life. Hultman notes a resonance between ecomodern masculinity and Francis Bacon's seventeenth century utopia, *The New Atlantis*. As Carolyn Merchant [19: 185–7] argues, Bacon's utopia, run by patriarchal scientists and merchants who longed to tame a "wild tempestuous nature," helped to "lay the intellectual origins of the modern planned environments" of the technocrats, which were envisioned to be completely artificial and oriented toward profit accumulation.

A feminist energy approach refuses to cede energy to the supposedly depoliticized market utopia of Bacon, the ecomodernists, and profit-seeking developers. Following Fraser, feminist energy begins by according visibility and value to the "hidden abodes" that make capitalism possible. By injecting a feminist politics into energy, we aim to redirect political power from the pursuit of private profit to the pursuit of communal wealth, which will involve building new legal and geopolitical landscapes that are unlikely to be consistent with *status quo* hegemonic interests. To begin with, a feminist energy politics means more than adding renewable fuels to the grid. Feminist energy aims to transform energy (and sociopolitical) regimes into communally designed, owned, and managed systems.

The *means* of energy production, transmission, and consumption are as important as achieving the right fuel mix. A commitment to democracy goes hand-in-hand with a commitment to pluralism. In terms of energy, this means that instead of advancing a single, universal energy solution for everyone, feminist energy analysts would support the blossoming of multiple ways of designing and living with energy. While there are many benefits to decentralized and distributed fuel production and consumption, feminist energy approaches do not rule out in advance that larger, democratically coordinated systems may be appropriate for certain regions, or that longer-distance energy sharing and gifting (as opposed to buying and selling) may also play a role. In Howe's [73: 6] words, an energy transition (in the true sense of the word) needs to be centered upon "an ethos of rehabilitation rather than resource extraction. This should be an exercise in rebalancing human aspirations for energy with the energetic life needs of the more-than-human beings with whom we are in orbit." Energy democracy entails the freedom for each energy system to become uniquely adapted to the bioregion in which it emerges. Feminist energy systems will be as diverse and distinct as the communities that they power.

3.2. Economic

Instead of giving up energy, which is mostly framed as individual sacrifice, feminists articulate what could be gained by diverting energy from carbon-intensive and production-heavy activities. We resist the ascetic framing of energy consumption – in which only economic growth, based upon intensive energy consumption, produces well-being – and build upon feminist visions of community thriving and pleasure predicated upon alternative energy systems.

Feminist and other critical economists have long argued that the Gross Domestic Product (GDP) is not a useful measure of the well-being of a nation because levels of inequality, poverty, health, pollution, land degradation, and educational attainment are not reflected in GDP calculations [88, 89, 90]. Likewise, the common assumption that high energy consumption is correlated with high levels of societal well-being is also not supported by empirical research [91, 92]. Therefore, a feminist perspective on energy systems prioritizes human well-being and biodiversity over profit. There is a recognition that, to be sustainable, energy systems must relinquish the underlying growth imperative.

Feminism also reminds us that not all people share societal benefits and burdens equally. Many people who live in rural fossil-fuel extraction communities, such as the coalfields of Central Appalachia and the oil and gas fields of the southeastern, northeastern, and western U.S., contend with multiple, intersecting forms of marginalization that make transitioning to a low-growth energy economy particularly difficult. Many extraction communities are mono-economies by design (see Bell [22] for a discussion of coal communities in West Virginia), and as such, there are limited living-wage job opportunities outside of fossil-fuel companies. Moreover, the logic of capitalist production, which prioritizes technological advances and automation to increase productivity, leaves ever-fewer jobs for an already-underemployed population. In the Appalachian coalfields, for instance, automation and the advent of mountaintop removal coal mining caused a more than five-fold reduction in coal-mining jobs in a fifty-year time span [22].

Declining jobs within a mono-economy leave many people living in these communities particularly susceptible to fossil fuel industries' rhetoric and public relations schemes promoting the importance of preserving jobs over protecting the environment [22, 93]. As Daggett [23: 204] contends, "most arguments mobilized in favor of fossil fuels begin and end with jobs," arguments that are particularly compelling because work in the United States is so closely tied to the "American notion of hegemonic masculinity and citizenship" [22: 205]. Furthermore, Bell and York [80] show how extractive industries are very effective at constructing and reinforcing a "community economic identity" that connects hegemonic ideals of manhood to local industry. As Bell and Braun [94] and Bell [22] demonstrate, this industry-defined hegemonic masculinity prevents many men from speaking out against industry-caused environmental injustices in fossil-fuel extraction communities, a silencing effect that even extends to local men who are not employed in that industry.

In recognition of the challenges associated with decarbonizing the energy system, Daggett [23] argues for a shorter work week and a Universal Basic Income, or UBI, for all people, regardless of whether

[3] These planetary boundaries include "climate change, ocean acidification, stratospheric ozone depletion, the nitrogen and phosphorus cycles, global freshwater use, change in land use, biodiversity loss, atmospheric aerosol loading, and chemical pollution" (Foster et al. 2010, p. 14).

they are employed in the formal economy. Freeing time from work and providing a UBI, provided these are partnered with strong progressive programs, she argues, would "[liberate] energy from work" and assuage the fears and anxieties associated with limits-to-growth arguments [23: 203]. Basic Income pilot projects are taking place worldwide, including in U.S. cities like Stockton, California; Santa Monica, California; and Jackson, Mississippi [95]. And preliminary results from a basic income experiment in Finland show that those receiving a basic income report higher levels of well-being, fewer health problems, and more confidence in their future prospects. Meanwhile, the basic income recipients had similar rates of employment as a control group composed of unemployed Finns who received only traditional unemployment benefits [96].

In addition to a UBI, reorganizing work time could also have ecological and social equity benefits. There is a positive relationship between labor time (not including care- and service work) and greenhouse gas emissions, leading scholars and activists to propose shorter work weeks as a climate mitigation strategy [97], albeit usually in tandem with a more systemic economic reorganization that would include elements like a UBI. The British think tank Autonomy argues that, given current carbon intensity levels, a sustainable work week would need to be fewer than ten hours [98]. Although wage labor has been tightly connected to personal worth, as well as to hegemonic masculinity, feminists help us to realize the many other activities, economic and otherwise, that could be more fulfilling and healthier for people, communities, and the ecosystems that sustain them [99]. There is ample evidence, for instance, that the excessive working hours demanded by many blue- and white-collar industries make people unhappy and unhealthy, especially those working multiple jobs to sustain their families. Meanwhile, low-carbon activities and leisure, including art, music, and social engagement, are "associated with a triple dividend - low resource, socially beneficial, and individually satisfying" [100].

As such a vision suggests, curbing energy growth need not mean austerity or suffering. Bell [101] argues that limiting energy growth in high-powered societies could lead to many quality-of-life *gains*. For instance, capping the amount of energy that could be consumed in a given day might lead wealthy communities to make different choices about what to do with their free time. Instead of taking work home or answering emails in the evening, people might decide to spend time playing outside, gardening, connecting with neighbors, or joining a sports team. Instead of watching television to decompress after work or school, friends and families might make music together or play board games. Rather than ascribe to the American fantasy of living in a large suburban house (often with a long car-commute to work), the "good life" could be reimagined as denser communities where we walk, bike, and use public transit more. Changing commuting habits has the potential to decrease stress, as people who bike or walk to work report significantly higher levels of satisfaction with their daily commutes than those who commute via single-passenger cars [102]. Thus, powering down energy-intensive lifestyles might actually mean living happier, more socially integrated and physically active lives. Cross-national analyses support this proposition. The New Economics Foundation's "Happy Planet Index" (HPI), a "global index of sustainable well-being" that combines quality-of-life measures with a nation's ecological footprint, reveals that the nations with the highest HPI values are not the richest nations. In fact, most of the top-ranking nations are in Latin America, with Costa Rica scoring the highest in the world [89].

Of course, it is privileged communities that most need to power down, given the highly unequal rates of energy consumption worldwide, where Americans, on average, consume about ten times more energy per capita than those in India, Nigeria or Peru. The widely repeated calculation that five Earths would be required for everyone to live like an American also contains a dark truth: the U.S. "owes the rest of the world at least four worlds … the problem above all is that there are too few people with too much world, and too many people with way too little" [103: 186]. And many people long for better energy access in order to improve their well-being. Dipesh Chakrabarty [104] points out that there is a "desire for modernity or so-called development – or at least for the conveniences of modernization – among many if not most humans everywhere," and that modernization is not solely a Western project, as "the global project of modernity got a second and original life in the hands of anti-colonial modernisers" in the mid-twentieth century.

However, *contra* the eco-modernist position, energy justice does not have to mean that everyone "adopt[s] that bizarre modern version of *vivir bien* that is the American way of life" [103: 186]. For one, it is "ecologically well-nigh impossible" given planetary limits [104]. Moreover, the eco-modernist vision ignores that energy-intensive lifestyles were and are made possible by the underdevelopment of the Global South, and by violence enacted upon marginalized communities and ecosystems. The notion that such a development pathway can be extended worldwide, absent its unequal and violent underbelly, is a fantasy without an empirical basis. Isabelle Stengers [105: 86] calls the West a "world-destroying machine [that] cannot fit with other worlds" and that must be resisted. But Stengers suggests that we mark the political difference between "agents of modernization" who drive the machine and must be fought, and "modern practitioners" who are "captured by, but liable to betray, the destroying machine," and who can become allies [105: 86].

In that spirit, a feminist energy perspective insists that there are many other pathways to building energy systems that provide communities with the fuel they need to thrive and live well. It will not be easy to loosen the attachments that bind us to the one-worldism of high-growth modernity. Boyer [106: 21] reflects that desire poses a serious problem for any energy transition, given that "a backward-looking investment in past pleasure" typically overwhelms rational judgment, for the simple reason that "the future has no memories to offer." So while we grieve the ravages inflicted by global warming, many Westerners simultaneously suffer what Stephanie LeMenager [107] calls "petro-melancholia" for the loss of a modern world premised upon cheap and unending oil.

Feminist thought offers many resources for this work of cultivating desire for economies-to-come – in Boyer's words, "creat[ing] memories of the future that we hope to attain" [106: 21]. We join scholars like Viveiros de Castro and Danowski [103: 186] who make a "plea for us to prepare for a nonmaterial intensification of our way of life, which is to say, a total transformation thereof … a technology of slowing down, a diseconomy no longer mesmerized by the hallucination of continuous growth, a cultural insurrection (if the expression may be pardoned) against the zombification of the citizen-consumer." Such a "diseconomy" might correspond to what feminist economic geographers J.K. Gibson-Graham [108] call a "community economy" built on ethical action. A community economy provides a useful framework for considering what the economic foundations of a feminist energy system might look like. Applying their four "ethical coordinates or foci" [108: xviii] to a feminist energy system, we would:

1) Identify our collective **energy needs** and determine how those needs can be met most equitably
2) Acknowledge how much of the energy that is produced **is surplus** to our needs, and decide how that surplus should be distributed to improve community well-being
3) Determine the **resources that will be consumed** in the production of energy and develop a plan for consuming those resources sustainably and equitably; and
4) Work to **protect, renew, and expand the commons** so that our collective natural and energy resources can be sustained for future generations.

An important aspect of a new economy is a higher valuation for so-

called pink labor jobs: caring, service, and regenerative labor, including everything from child and elder care to teaching, community art and events, and environmental rehabilitation, which could include caring for brownfields and other polluted ecosystems, especially those where vulnerable populations live. An economy centered around social reproduction will not necessitate intensive energy consumption, for, as Alyssa Battistoni [109] argues, “pink-collar jobs are green jobs.” Similarly, Kendra Coulter [110: 168] urges us to move beyond both androcentrism and anthropocentrism when thinking about "green" jobs. She proposes more "humane" jobs that “prioritize both human and animal well-being,” such as "multispecies green care" programs, where health care “incorporate[s] positive interactions with nature, such as care farming and animal-assisted therapy” [110: 174]. Valuing humane and pink-collar work has a strong social and ecological justice component, as it means valuing previously marginalized people and processes, both human and nonhuman.

New economic visions are often dismissed on the assumption that they demand sacrifice and discipline. Instead, feminists note that our existing economy does not serve people or the Earth well and leaves much room for improvement, and that the hegemonic ideology of GDP growth (correlated to energy growth) obscures alternative visions. Because feminists have categorized the breadth of hidden violence upon which growth relies, they are freer to imagine modes of well-being beyond the constraints of GDP and consumption. While wasteful and trivial kinds of commodity consumption will need to decrease, the focus should be upon what can be *increased* as a result: in slowing energy consumption, we stand to gain in free time, justice, dignity, artisanship, community engagement, beauty, and rest – provided we are prepared to fight for such a feminist energy system.

3.3. Socio-ecological

Energy systems, like all human terraforming projects, are inherently violent and unjust. But waiting for purity results in paralysis and serves the interests of the carbon-emitting status quo. *Building ethical energy systems means making the full life-cycle of fuel technologies transparent in order to support ongoing efforts to mitigate violence. By analyzing violence as a central component of energy design, we can also make more ethical decisions about when and how to pursue energy-production projects. These decisions will be oriented around the needs and interests of all the more-than-human communities involved in its production, distribution, and consumption, which will often transcend nation-state borders.*

Feminist energy systems acknowledge that we are complicit in the violence of exploitation and in the creation of the conditions that have led to our present-day ecological crises, while simultaneously acting to change these destructive practices. Donna Haraway [111] calls this “staying with the trouble,” which in this case would require an honest look at the resources and labor that are needed to produce energy and an acknowledgement of the unintended consequences of our energy choices [112]. In other words, feminist technologies and energy systems are accountable to those with whom they are in relation, and this includes the more-than-human world. Accountability can mean transparency regarding externalities, keeping track of and responsibly disposing of the waste that an energy system generates, or refraining from using an inadequately understood technology. It can also mean increasing collective awareness about the origins and trajectories of energy sources.

As an example, in April 2019, the NAACP released a pamphlet urging communities of color to respond to the fossil fuel industry from a civil rights perspective. Enumerating a list of the fossil fuel industry's “top ten manipulation tactics” to which African-American and low-income communities must remain “vigilant,” the pamphlet draws explicit connections between corporate economic interests, biased science, health risks (such as disproportionate rates of asthma), political influence, and the undermining of democracy. The pamphlet's discussion of tactic number eight—“Pacify or co-opt community leaders and organizations and misrepresent the interests and opinions of communities”—is a sharp critique of energy corporations who “leverage[d] their wealth to create … an appearance of community dismay for clean and renewable energy” [113]. Indeed, and as *The New York Times* subsequently reported, the utility companies Duke Energy and Florida Power & Light had pledged donations to their local NAACP chapters that were contingent on public denunciations of rooftop solar and energy efficiency initiatives [114]. The National NAACP's efforts to counter the energy companies’ bribe align with feminist energy principles by centering and illuminating power relations and through explicitly linking the multiple and *interlocking* systems of oppression [51] faced by communities of color. Also visible is the way in which care and well-being are prioritized over a reductive economic framing of energy needs. For example, a member of one NAACP board, when polled, reported being willing to pay more for her electricity if it meant that she could keep “her asthmatic grandbaby out of the emergency room” [113]. Here, a Black woman draws on a social location that is — in the words of Patricia Hill Collins — “deeply embedded in [a] specific race and class formation” [51:222] to not only care for her family but also to shift a narrative within her community about what *other* energy worlds are possible.

Although it is important to expose the consequences of fossil fuel production, a feminist energy system must also name the injustices inherent in the lifecycles of all types of energy production – not just fossil fuels. For instance, a great deal of hazardous materials are used and generated in the process of manufacturing solar photovoltaic (PV) panels, and a large percentage of these PV panels are manufactured in Global South nations, which have fewer environmental and worker safety regulations [115, 112]. The disposal of these panels after they have reached their usable lifespan (30–35 years) should also be of concern. As Dustin Mulvaney [116] argues, there is a “looming tidal wave” of solar e-waste that will be dumped in Global South nations if mandatory recycling programs are not put into place.

A feminist energy system acknowledges these very serious problems and seeks to mitigate them. Communities committed to a feminist approach to energy production will seek out energy sources whose lifecycle can be traced, and will understand that energy systems are rarely contained in one city, or even in one nation state. Writing in defense of a transformational Green New Deal, Kate Aronoff and colleagues [115: 141] call for a "recharged internationalism" that “engage[s] directly with the supply chains where the essential minerals of the renewable energy sector are mined, manufactured, and eventually deployed.” This could involve building cross-border worker and activist coalitions, supporting trade deals with strong labor and environmental standards, enacting policies that reduce Global North energy demand, and accounting for and minimizing the waste generated in the disposal of solar panels and other renewable energy equipment.

In addition, recognizing the “ecological debt” owed to these communities must be part of this process. Ecological debt can be understood as the “accumulated, historical, and current debt” that Global North nations (and their corporations and institutions) owe to the people of Global South nations “for having plundered and used their natural resources, exploited and impoverished their peoples, and systematically destroyed, devastated and contaminated their natural heritage and sources of sustenance” from colonial times through the present [117]. As the U.S. National Academy of Sciences concludes, “through disproportionate emissions of greenhouse gasses alone,” rich nations of the Global North may have caused damages to poor Global South nations related to climate change that are “greater than the latter's foreign debt” [118, quoted in 119: 2]. Given the minerals involved, a renewable energy transition could unfold as "eco-colonialism", with intensive and unjust extraction from the Global South and Indigenous peoples [115: 151]. In order to counteract this risk, a feminist approach to energy production seeks to build global solidarities that support claims of ownership and control by communities involved in the lifecycle of energy, while also compensating those communities for the harms and

losses they have and may continue to suffer.

Feminist modes of accountability can be understood as forms of care: listening to, understanding, and addressing, acknowledging, recognizing, and resolving the concerns of a given community. Subramaniam [12: 226–7] argues that ignoring these responsibilities "dooms [us] … to a future as co-conspirators in the production of inequality." Feminist modes of care include not only "accept[ing] our culpability" regarding energy injustices but also "join[ing] efforts to disrupt them." In their study of Zápara communities in Ecuador, whose ecologies and cultural practices are being actively displaced by national oil projects, Cielo and Sarzosa [39: 12] demonstrate that "taking care" is an expansive practice of "mutual interdependence" not limited to one's own family: "not only do people care for the land and animals, but they also enable the continued survival of human communities." For Cunsolo and Ellis [120], care work in the Anthropocene includes confronting ecological grief: "becom[ing] open, in a personal sense, to the magnitude of the ecological challenges facing our global society." Empathy is central to each of these theorizations of care-as-accountability; a dialectical bearing witness to not only one's own ecological losses but also, and more crucially, to how those losses can precipitate connection and community with others.

Haraway [121: 49] argues that "'Who cares?' is the fundamental question for technoscientific liberty and science studies;" as such, care work involves asking questions about the distribution of benefits and burdens. Alber et al. [122: 75] maintain that care is "both a set of values and a series of concrete practices." A tool known as "the four-R method" asks "Who gets what and why, or why not?" in order to increase awareness of representation, resources, reality, and rights [123]. These and similar questions might be most successfully posed in the context of a "consensus conference," where heterogeneous stakeholders, including "ordinary" citizens, can learn, debate, and ultimately make decisions about technology policies that will affect broader publics [124]. These endeavors explicitly recognize that "what it means to be human and what it means to occupy a world with others" [11: 13] are questions for collective deliberation, requiring "careful analysis, not mythological treatment" [60: 63]. Moreover, these modes of accountability strive to replace the "naming and shaming" of so-called bad actors with restorative practices of caring and mutual aid.[4]

The growing interest in co-housing communities throughout Europe and North America is one potential avenue for applying the insights of such collective deliberation efforts and attempts to build what Alber et al. [122] term a "culture of care." Originating in Denmark in the late 1960s, co-housing communities are intentional neighborhoods built within mainstream society[5] to foster social connections among residents and promote the sharing of resources. The hallmarks of co-housing communities are shared common spaces and design principles that seek to maximize social interactions among neighbors, reduce environmental impacts, and promote gender equality [125]. Housing units are clustered together, typically around a central common space, or a "common house" where community meals can be prepared and shared. Residents also often share resources such as tools, laundry facilities, recreational and fitness equipment, playgrounds, guest rooms, workshops, transportation, and land. A systematic review of quantitative studies examining the ecological and carbon footprints of intentional communities demonstrates that co-housing communities and ecovillages are more environmentally sustainable than mainstream housing developments [126]. The sharing of resources and amenities within co-housing communities allow for smaller, denser and more energy-efficient homes that – rather than feeling like a sacrifice – enhance the well-being and quality of life of local residents [127, 128]. Moreover, as Coldham [129] notes, co-housing communities are able to promote uptake of more sustainable technologies by offering "'an intermediate scale between the single family and the town or municipality – thereby expanding the palette of technologies that can be applied'" [quoted in 130: 15]. In addition, high levels of social trust and community cohesion can smooth the process of instituting community-wide sustainability projects and technologies [130], leading many co-housing neighborhoods to become "living labs" for energy transition efforts [125: 230].

Co-housing and other intentional communities could serve as (and some may already be) testing grounds for the implementation of feminist energy systems that not only produce renewable energy locally, but that also grapple with how best to address the hidden injustices associated with renewable energy production. For instance, communities might mandate that their solar panels be sourced from the most ethical and environmentally conscious producers and that those producers have recycling programs in place. They may seek to learn about the demands of local activists and workers who mined the minerals in their panels, or constructed them, and mobilize politically to support them. Such discussions might also drive communities to develop solutions that reduce the overall demand for electricity, whether that be through increased energy efficiency, passive solar heating designs, geothermal heating and cooling, or other locally grown solutions.

We view the casual and often violent disregard toward communities disproportionately burdened by extractive and polluting corporations as a fundamentally unjust mode of energy exchange. Feminist energy systems should encourage people to uncover the asymmetrical benefits and harms that are integral to energy production and weigh those asymmetries in the design of energy systems. Crucial for a feminist politics, this reframing of accountability distributes care work across all genders, making the affective labor of energy transitions everybody's job. As Alber et al. [122: 73] maintain, such a culture of care is, in fact, a "prerequisite for a low-carbon city."

3.4. Technological

A feminist energy approach is not inherently anti-technology. Instead, it insists that technology is not politically neutral, and should not be controlled by the highest bidders, who are almost always transnational corporations that emphasize profit over people. Technological innovation should be developed in collaboration with the communities that it seeks to serve, and it should orient itself to these diverse economic, political, and ecological worlds. In terms of energy, this will likely privilege distributed fuel power, which often corresponds to diverse and decentralized people power.

Energy discourses often frame technology in a limited sense, that is, as "any intentional extension of a natural process" [131, quoted in 132: 55]. Science studies scholars employ a more capacious definition, however, understanding technology as "intentional action that constitutes a gap between the world as it was … and the new world [that technology] calls into being" [132: 55]. Thinking from here, feminism constitutes a "practical technology," a dynamic and evolving cluster of concepts, practices, and tools that, "rooted in yearning" [121: 72], work to enact social and political change. This more expansive definition allows us to view "technologies," such as earthmovers or fracking fluid, narrowly—i.e., as tools involved in the production of fossil fuels—but also in their world-making contexts: as elements of broader technologies of capital accumulation, imperialism, and racial-gender formations.

Technologies are stabilized by users, often in ordinary and even intimate social relations. Rather than being simple instruments under our control, technologies emerge alongside and in conversation with the ideologies and concerns of their human communities: an oil pipeline exists only in its relations with the pumping stations, operators, consumers, and political arrangements that sustain or contest it [133].

[4] http://bigdoorbrigade.com/mutual-aid-toolbox/

[5] In contrast to communes or ecovillages, which are often separate from mainstream society. However, it is important to note that there is some overlap between these categories, as some ecovillages are also co-housing communities. For a detailed description of these differences see Anitra Nelson (2018) *Small is Necessary: Shared Living on a Shared Planet.* Pluto Press.

Science studies scholars use the concept of socio-technical systems in order to highlight that technical artifacts are always interwoven with organizations, institutional rule systems and structures, social actors, and cultural values. Feminists have long recognized these entanglements, and have provided some of the earliest intersectional arguments regarding the complexity of technological relations.

Feminist science studies scholars in particular focus on the "mutually shaping relationship between gender and technology, in which technology is both a source and a consequence of gender relations" [134: 7–8], whether those relations facilitate or challenge hegemonic gender hierarchies. A bumper sticker, spotted by one of us on the truck of a local pipeline worker, reading "Wine 'em, dine 'em, pipeline 'em," invokes a configuration between gender and energy technologies that, on the surface, is radically distinct from that of Indigenous women who explicitly deployed tradition as part of their resistance to the North Dakota Access Pipeline, or who face higher rates of sexual violence as a result of oil extraction in the Bakken region of North Dakota [135; see also 136]. Feminist scholars are interested in all of these cultural configurations, in that they each reveal important insights about gender, race, and energy technologies. Such analyses extend the work of intersectional feminism by arguing that socio-technological systems reflect and participate in hegemonic modes of interlocking oppressions and that actors embedded within these systems are themselves organized hierarchically. In short, power relations are frequently normalized via how "people do gender through technology" [60: 81], whether that be in the guise of an Indigenous grandmother or a sexually violent pipeline worker.

Feminist analyses foreground the *material and semiotic* dimensions of sex and gender, showing how material "sex" is often recruited to rationalize gender conventions. In a study of construction engineers, Clarke, Gleeson, and Wall [137] show that the prevailing social and contractual worlds of these industries, which are highly masculinized, actually impede "low-energy construction" and its need for a coordinated approach to sealing the building envelope. Interestingly, they show that the barriers to more gender diversity in construction fields, including fragmentation and subcontracting, poor support and training, and a long-hours culture, "are also barriers to achieving effective low energy construction" [137: 66]. Their insight bears repeating, given how often technical efficacy is called upon to dismiss feminist policy demands: The current, and highly masculinized, sociotechnical culture leads to worse buildings from an energy perspective, and gender equity policies would likely lead to greener buildings. Similarly, Jessica Smith Rolston [138], in her study of Wyoming surface miners, found that the routine use of coveralls and oversize equipment led many women to drink less water in order to avoid the logistical difficulties and subtle forms of harassment that accompanied their bathroom breaks (coded as "excessive" via capital-extractive temporalities that structured the workday). Here, productivist and gendered logics are simultaneously deployed in order to stabilize hierarchies through which hegemonic forms of masculinity are privileged. Cultural narratives about women who compete with men for a "family wage" articulate with very specific technologies, which are themselves designed around an able body whose elimination habits are compatible with coveralls, in order to naturalize the marginalization of certain workers.

Because they are relational, feminists understand that technologies must be developed in interactions with users and must be organized around the needs of communities as opposed to the accumulation of capital. Pinch and Bijker [139] call this "interpretive flexibility," foregrounding how meaning, "rather than being fixed, is interpreted and negotiated by those social groups connected to it" [133: 25]. Benjamin Sovacool [133: 25] suggests that (energy) technologies stabilize through consensus, when "problems arising in the development of technology have been alleviated." We want to stress that such closure is often illusory, however, given that communities are not always informed about the full range of a given system's positive and negative effects. Feminist energy systems are transparent and do not erase, sublimate, or displace the burdens that particular communities might be asked to bear. Organized intersectionally, feminist energy systems will strive to respond to the multiple energy needs of a community, and to generate energy worlds that may not yet have been imagined. For Mies [140: 274–5], this includes the development of "subsistence technologies" that respect the limits of nature and reject exploitative relations, including with the more-than-human world. As part of a broader economy, in which money can circulate but is not a means of wealth accumulation, subsistence technologies emerge within a plural knowledge economy and are reciprocally distributed; as such, they align feminist energy systems with the degrowth and solidarity economy movements, both of which focus on the simultaneous crisis of capital and the finiteness of natural resources [63].

Systems that honor variation and plurality resist the imperialist, colonizing, and xenophobic fears of difference associated with global monocultures and universalizing technologies [12]. Energy systems that "think difference differently" [11: 19] are not designed with "everyone" in mind, nor do they interpellate specific and socially constructed constituent groups, such as "women" or "racial minorities." Feminist energy systems do not consist of top-down, centralized, or unidirectional distributions of any singular form of energy, renewable or otherwise; rather, they assume that: 1) Humans are in intimate relations with one another and with technologies; 2) technologies enable particular relations and can be used to engender new ones; 3) humans are in relation with an other-than-human world, and; 4) heterogeneity is key to plural and responsive energy systems.

Such local systems are already being built. In the wake of Hurricanes Irma and Maria, and the devastation of Puerto Rico's fossil fuel-dependent grid, Puerto Ricans began to reimagine their energy systems. Resilient Power Puerto Rico, for example, is installing solar micro-grids that are community controlled and that support key social infrastructure. Social experiments like this understand community grids as more than a mode of fuel provision; redesigning fuel power goes hand-in-hand with reorienting public space and social power. Local and distributed energy systems connect rather than isolate users, increasing the intimacy and relationality between community members [140]. In these exchanges, distinct energy users activate what philosopher Simone Bignall [141] refers to as "complex selves," through which "heterogeneous differences compose interdependencies" [quoted in 39: 13]. When contoured to the multiple needs of heterogeneous pluralities, energy systems can generate collectivity, accountability, well-being, and even pleasure.

Feminists recognize that such relations of interdependence are no more vulnerable or precarious than are the unstable and contingent networks of capitalism with which we are entangled, networks that are "more fragile and more intimate than accounts of … determining economic logics would have us presume" [45]. Foregrounding the mutuality of contingency and variation reminds us that corporate ownership of and dominance over energy systems is anything but natural; recognizing the ways that this dominance has been actively, even violently, achieved is key to dismantling its hegemony. Regarding the coalfields of southern West Virginia, "where more than two-thirds of the land is owned by corporations," Scott asks us to ponder what it means for local politicians to assert that "'land use decisions remain at the local level'" [60: 160]. Feminist energy systems attend to how local and heterogeneous energy communities intersect with markets, cultures, and technologies that are actively naturalized via state and parastate regulatory bodies. "Such a focus," argue Bear et al. [45], "returns us to the contingent production of inequality and structural violence. To notice heterogeneity is not to deny the depth or breadth of these injuries, but to explain and thereby, ultimately, to challenge them."

A commitment to plural energy systems is also a technologically sensible response to the stochastic and geographically limiting nature of some renewable energy sources. As Sovacool et al. [142] and Cai et al. [143] discuss, seasonal, geographic, and temporal variations of wind and solar power lead some to argue that such systems are too

unpredictable to manage. A feminist orientation to energy would center this variation and develop technologies that work with, rather than against it. Indeed, planning for and around such variability need be no more labor-intensive than is the often post-hoc work of remediating the externalities, injuries, and inequities produced by fossil fuels. Planning for these negative eventualities is often undertaken at the barest of risk management levels and enacted only under regulatory or legal duress. Feminist energy systems would center the technological challenge of planning around stochastic supply and shift the labor of after-market remediation, injury repair, and legal defense into designing systems that help to align energy and human variation. For Haraway [144: 30], such "structural rearrangement[*s*]"—i.e. of the problems that we choose to recognize, center, and attempt to solve—contain "serious potential for changing the rules of the game."

This is also in line with a tradition of feminist architecture, planning, and design, which has imagined and built communities that are not only more inclusive and livable, but are also more sustainable, with an emphasis on public transit, pedestrian-friendly areas, and common and green spaces for many ages and abilities. Because technology and infrastructure are integral to sealing relations of power, feminist designers recognize them as uniquely impactful fulcrums for social transformation. Even forty years ago, when Dolores Hayden [145] famously asked what a "non-sexist city" would look like, her answer connected consumption, sustainability, and gender equity. Hayden argued that building a non-sexist city would start with reorganizing the isolated, American suburban home, which was a site of combined capitalism and anti-feminism – as well as a site that relied upon intensified fossil fuel consumption [146]. With its reliance on mass consumption and automobility, and its cementing of racial segregation, the home is "the commodity par excellence, a spur for male paid labor and a container for female unpaid labor" [145: S172].

The household and its consumption (of energy and other commodities) is also a key site in energy studies. As feminist planners have shown, the reorganization of work and home – how they are spatially related, their temporal rhythms, the activities they support – can loosen the grip of fossil-fuel reliance and patriarchal power. And it can do so while opening up possibilities for post-carbon pleasure, where energy reduction is achieved through simultaneous energy reclamation and redirection [23]. With the right planning, and with support from built and social infrastructures, such energy reduction strategies may also correspond to greater well-being, as in the case of co-housing communities noted above. Addressing this over two decades ago, Mies [36: 217] proposed a recalibration of productivity, in which "time is not segregated into portions of burdensome labor and … supposed … leisure, but in which times of work and times of rest … are alternating and interspersed" [see also 99]. Because needs will vary, communities can and should develop their own work-energy-rest rhythms; distribution of energy would reflect a given community's priorities. A neighborhood in Lima, Peru, for example, that contains a public park, play structure, artisan market and even a public cat colony is illuminated late into the night in order to encourage public gathering and connection. Residents of rural mountain towns, on the other hand, might choose to keep things darker at night, enhancing their appreciation of summer fireflies and year-round starry nights. Indeed, a 2019 blackout in New York City made headlines, partly because of the contingent collectivities that formed in the darkness: Broadway actors sang on the street, restaurants gave away food that might have gone to waste, and volunteer pedestrians directed traffic. Our point here is that (technological) design problems can only be "solved" if they are understood as such. Centralized systems leave many energy users un(der)aware of how *else* they might power their lives and communities, as well as the pleasure they might take in identifying and contributing to their local energy profile.

Like other marginalized communities, feminists have long imagined alternatives to extant social arrangements [147, 148, 149]. Feminist energy systems will harvest these imaginative capacities in order to design exchanges based on the principles we have thus far elaborated: relationality; democracy; pluralism; biodiversity and well-being; accountability; and decentralization. Feminists understand that technologies evolve via their implementation and that our past, present, and future technological relations can and should be simultaneously imagined. Wajcman [134: 11–12] cautions that "command of the very latest technology signifies a greater involvement in, if not power over, the future," and exhorts us to disrupt the association between (hegemonic) masculinity and technology. Importantly, this is not a recommendation to simply switch out the gender identities of those at the top of energy-technology hierarchies. It is, rather, an invitation to imagine and design such systems from an alternative value system.

4. Conclusion: engendering feminist energy

The practice of "gender mainstreaming," in which so-called women's concerns are centered by urban planners, both hits and misses the mark of feminist energy projects. That is, attending to the needs of pedestrians pushing strollers—a category that often includes but cannot be reduced to women/mothers—can (and typically does) include other social groups, including anyone with needs that differ from those of the imagined city resident (i.e. an able-bodied, economically secure person who feels safe in public). But conflating women with mothers, and using this category to exclude the non-gender specific needs of other marginalized populations is antithetical to feminist imaginaries. And so while we understand that feminist energy systems will have the greatest impact when and if they are deployed within broader feminist sociopolitical systems, we do not believe that gender mainstreaming represents that goal, nor do we believe it necessary to await alternative systems in their entirety in order to move forward [150]. Applying the principles outlined in this essay can allow us to enact a differently configured society, one that requires no more work to structure than does the maintenance of our current inequitable one. We do not dismiss the importance of articulating utopian visions, but we simultaneously recognize the ways that uncritical utopias can reproduce existing social relations [151, 11].

Indeed, it is vital that we reconcile feminist energy systems with techno-utopian projects in which "technology" liberates humans from specific forms of labor and subjection. In contrast, feminists retain but redefine the concept of work: centering activities in which humans and non-humans can engage with pleasure and without subordination and violence [36, 99]. Feminist energy systems acknowledge that energy production and exchange are effort-full activities; rather than wishing away this labor, we strive to distribute it equitably across a community, maximizing rather than titrating accessibility. Ahmed [152: 50] argues that "queer and feminist worlds are built through the effort to support those who are not supported because of who they are, what they want, what they do."

As technologies, feminist energy systems are world-making projects. Technological fantasies that liberate humans from "dull, dirty, and dangerous" forms of labor perpetuate the fiction of an autonomous subject "whose freedom is in actuality only possible because of the invisible … workers who perform this racialized and gendered labor" [151] on their behalf. Feminist energy systems may be utopic in scale and vision, but they reject progress narratives generated from white technomasculine perspectives [153] as illusions built on the routine dismissal of care work and socially reproductive labor. Holding together "creative possibility and critical accountability" [11; see also 143], feminists refuse universalizing solutions to complex problems and are pragmatic in their reckoning of risk and reward.

Dismantling violent energy systems and building feminist ones will not be easy, and may not always – or even often – succeed, but difficulty should not permit us to relinquish hope. As Ahmed [152: 2] observes, "hope is not at the expense of struggle but animates a struggle; hope gives us a sense that there is a point to working things out, working things through." Feminist energy may sound like a "killjoy" to ecomodernists, oil companies, the agents of "world-destroying machines," and

even some energy scholars who cling too tightly to growth and profit. But for many Earthlings, both human and not, feminist energy brings hope, insisting that new and better worlds of energy are possible.

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The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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