Sociology of Energy

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Introduction

Sociologists have long investigated the roots, meanings, and consequences of modernity and socio-technical change, yet energy remains an underdeveloped area of inquiry. This is not for lack of trying—scholars have repeatedly called for the development of a formal sociology of energy (Lutzenhiser, 1994; Rosa et al., 1988; Ryan et al., 2014). Nor is this due to a lack of importance. Indeed, our current period is deeply shaped by climate crises; conflicts over the nature, type, and scale of energy production; questions regarding democratic access to affordable energy; and the considerable potential socio-ecological outcomes of dependence upon finite natural resources.

The lack of a coherent sociology of energy is paradoxical, given energy's central role in people's lives. While many energy-related threads weave through the environmental sociology literature, they do not yet tie together. In this chapter, we begin to bring together the various ways that social scientists have applied a sociological lens to studies of energy systems. Throughout, we pay particular attention to analyses focusing on issues of power and inequality. In so doing, we endeavor to present a more unified and theoretically consistent overview of the sociology of energy.

Our review includes studies of fossil fuel and nuclear energy production systems, as well as renewables. Fossil fuels such as coal, oil, and natural gas have played historically powerful roles in industrialization, its globalization, and continued dependence on these heavily polluting industries, even as the impacts of climate change intensify. Centralized, risky, and expensive technologies such as nuclear power have further consolidated and privatized ownership and control over energy production and development. Human societies' current reliance on fossil fuels and nuclear energy means that related industries and elite players within them have had extraordinary power and influence over the shape and substance of our societies, political systems, economic structures, norms, and the planet. These industries cause harms that manifest unequally, disproportionately burdening those who are already marginalized and suffering from other environmental harms. These industries now also deeply shape ongoing conflicts and discourses over appropriate responses to global climate change. Renewable energy systems, such as

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wind and solar, are intended to be more sustainable alternatives to fossil fuels and nuclear energy but, as we will show, present their own share of injustices and ecological impacts.

Due to space constraints, we cannot include every study related to energy and its socio-environmental dynamics. We look predominantly at studies based in the U.S., though we do link our observations to global processes. The U.S. has been the historical epicenter of the extractive industries we examine, shaping global energy development trajectories as other nations industrialized according to U.S. development ideals. We do not delve deeply into the literature of energy efficiency, given our more macro- and meso-level foci on systems and structures of power and inequity; nor do we review the literature on attitudes and behaviors related to energy consumption and technologies. *Instead, we address the relationships between power and structural inequality in energy production, with a concerted focus on the impacts of energy production systems on their host communities.* We conclude by discussing emergent perspectives about transitions to more sustainable, equitable, democratic, and otherwise just energy systems. As we show, scale matters. And political economic transformation may provide the most sustainable solutions for embedding globalized energy markets in their socio-environmental contexts.

Progress toward a Sociology of Energy

> All social scientists—especially environmental sociologists—must take energy seriously, since it is fundamental to social organization and a central factor in society-environment interactions (Lutzenhiser et al., 2002: 223).

Rosa et al. (1988) and Lutzenhiser et al. (2002) recognized the discipline's need for a formal sub-field around the sociology of energy to nurture productive dialogues, debates, and theoretical developments. Early ethnographic fieldwork, though limited in scope, offered more detailed portraits of energy consumption (Wilhite Jr & Wilk, 1987), uncovering people's perceptions of their energy use versus actual consumption (Kempton and Montgomery, 1982), as well as a deep-rooted sense of social obligation in conserving energy resources (Kempton, 1993). While some of the more voluminous attitudinal literature on environmental issues examined people's perceptions of energy sources such as nuclear power (e.g., Rosa and Dunlap, 1994), much survey-based work tended to be disconnected from sociological theory, especially related to multi-scalar political economic perspectives.

To encourage formalization of this sub-field, Lutzenhiser and Hackett (1993) and Lutzenhiser et al. (2002) argued for a *political-economic model* that accounts for impacts of social structural variables on levels of support for various energy systems. Importantly, this nascent sub-field *has* started to emerge. In this chapter, we highlight valuable research that documents the people and communities affected by energy production; the ways in which firms, government agencies, and other powerful actors exert substantial, undemocratic influence on energy policy trajectories and discourses; and the multi-scalar ways in which these dynamics can produce and exacerbate environmental injustices. We highlight these three foci as important threads in energy research in each section below.

In the following chapter, we examine research on extraction's sociological dynamics, especially aspects of power and structural, environmental inequity. We interrogate these dynamics first through the sociological literatures on energy boomtowns and natural resource dependence, focusing on structural inequities—since this was some of the initial research systematically examining resource- and energy-related outcomes. We then take a deeper dive into scholarship on these three empirical domains described above, by focusing on specific energy systems and highlighting issues of inequality within each. To that end, below we examine socio-environmental and EJ dynamics at various sites of extraction for three of the most significant sources of energy in the modern industrial era: coal, (unconventional) oil and gas, and nuclear power. We also examine outcomes at sites of energy production, such as refineries and power plants. Subsequently, we

address EJ issues that have emerged in the context of renewable energy development. We conclude by outlining the ways sociology of energy can progress and more systematically examine the sociological dynamics of extraction, energy production, and access.

Historical Perspectives on Energy from Fossil Fuels: Power, Poverty, and Reproduction of Structural Inequality

This section of the chapter maps out two strands of research that engage with questions of power, inequality, and social change occurring with changes in energy systems. These literatures provided some of the foundations for environmental sociology and sociology of energy, as these studies examined how extractive systems for energy production often related to structural changes in communities and structural drivers of poverty, including the marked impacts of extra-local firms. This work provided important foundations for environmental sociology's examination of power and inequities in the contexts of energy extraction and production.

Energy Boomtowns and Social Disruption

The 1973 oil crisis set in motion a scramble for more sources of domestic oil production in the U. S., subsequently increasing exploration for fossil fuels, particularly in the western states. Rural sociologists and scholars conducted a series of studies to understand the 'boomtown' dynamics that occur when isolated, seemingly idyllic rural communities find themselves undergoing rapid change because of an energy boom.

In a widely cited conference paper, Kohrs (1974) argued that energy development upended the quiet rural life of Gillette, Wyoming, as workers from other parts of the nation flooded the town and social ills like prostitution, domestic violence, divorce, and a general perceived loss of control became widespread. Subsequent analyses largely confirmed Kohrs' initial claims about energy boomtowns (e.g., Bacigalupi & Freudenberg, 1983; Brown & Swanson, 2004; Cortese & Jones, 1977; England & Albrecht, 1984). Importantly, scholars began to identify phases in boomtown development, wherein crime and general social dislocation often spiked during early stages of a boom (Brown et al., 1989, 2005; Freudenburg, 1992), though some communities were resilient over time (Smith et al., 2001).

Although these early studies provided novel insights into the social dynamics of energy boomtowns, critics soon pointed out questionable methodological choices (e.g., Summers & Branch, 1984; Wilkinson & Thompson, 1982) and simplistic assumptions about the "roughneck" nature of energy workers. For instance, Smith (2008) conducted interviews in Gillette, Wyoming, and found that many miners were older, family men with little interest in wild parties and a stereotypical roughneck lifestyle. Indeed, many of her informants hoped to stay in Gillette for the remainder of their careers, contrary to early claims about the transient nature of energy workers. After a flurry of papers on energy boomtowns in the late 1970s and early 1980s, interest in energy boomtowns faded until the 2000s (e.g., Luthra et al., 2007).

The mid-2000s boom in domestic oil and gas production engendered renewed interest in the classic boomtown scholarship (e.g., Jacquet, 2014; Jacquet & Stedman, 2011; Stedman et al., 2012). Jacquet and Kay (2014) caution that the classic boomtown model rests on several assumptions that are not necessarily tenable for the current boom in unconventional oil and gas development. Chief among these is the idea that booms are sudden, dramatic upswings in extractive activity; instead, current technologies are more likely to create short booms and busts, often on a small spatial scale. Further, classic boomtown research focused almost exclusively on bucolic, isolated rural communities, yet technological changes have brought energy production in much closer proximity to peri-urban and even suburban areas (Fry, 2013; Fry et al., 2015).

Socio-Economic Natural Resource Dependence and Poverty

Although we might expect that regions rich in natural resources would experience economic prosperity, a long tradition of research identifies a 'resource curse' or 'paradox of plenty'—in which nations or regions endowed with significant natural resources (e.g., fossil fuels) often have heightened poverty and unstable or authoritarian governments (Papyrakis & Gerlagh, 2004; Ross, 1999, 2015). A related tradition rooted in rural sociology identifies structural natural resource dependence, particularly dependence upon fossil fuel extraction, as a significant driver of persistent poverty and economic malaise in rural regions within countries like the U.S. and Canada (Humphrey et al., 1993; Peluso et al., 1994).

Natural resource dependence describes communities' socio-economic and cultural reliance on one (or perhaps a few) extractive sectors, with little to no economic diversity. Because extractive industries are susceptible to the volatility associated with commodities markets, natural resource dependent communities often experience severe boom and bust cycles and occasionally a final bust, such as the closing of a mine, which hollows out the local economy (Krannich & Luloff, 1991; Malin, 2015; Stedman et al., 2004). Freudenburg (1992) theorized that, while natural resource dependent communities often seem to have economic diversity, many industries are tightly coupled to the main extractive industry and thus suffer from boom and bust cycles. Freudenburg and Gramling (1998) further illustrated the tight economic linkages among industries that appear to be only indirectly linked to the main extractive or production activity by showing how, in the context of Louisiana oil production, even indirectly linked sectors such as retail trades, housing, restaurants, and hotels were deeply affected when the oil industry busted. Across contexts, natural resource dependent communities are structurally vulnerable to rapid economic and social change wrought by their over-reliance on extractive industries (e.g., Flint & Luloff, 2005; Freudenburg, 1992; Freudenburg & Gramling, 1994, 1998; Stedman et al., 2004).

This can engender other processes that exacerbate rural poverty and other social problems. Extractive industries can crowd out other types of economic development. For instance, researchers have documented how the decaying wreckage of extractive infrastructure can act as a spatial blight on a region, creating a place-based stigma that inhibits new business formation or investment because the area is viewed as permanently damaged (Colocousis, 2012; Ellerbusch, 2006; Thomas, 2016).

Natural resource dependent communities may engage in "developmental channelization" (Gramling & Freudenburg, 1996) or "cognitive lock-in" (Hudson, 2005: 532), whereby communities and their leadership are seemingly unable to imagine an economic future that does not center on a once dominant extractive industry. Industries that were a historical part of the community may now be perceived as part of the local social fabric (Malin, 2015). Thus, in some situations, communities do not diversify their economies or transition to new models of economic development because of strong familial, community, and contemporary cultural ties to a given extractive industry (Freudenburg, 1992; Malin, 2015). This has been repeatedly observed in U.S. coal mining communities (Bell, 2016; Bell & York, 2010; Blaacker et al., 2012; Dicks, 2008; Lewin, 2017) and in uranium communities (Malin, 2015). In the next section, we turn to literature that attends to ways industrial-scale, centralized, and fossil fuel-based energy development shapes inequities for host communities, utilizing an environmental justice lens.

Inequality, Injustice, & Extractive Energy Development

While the political-economic lenses utilized above allow us to better understand structural drivers and outcomes of energy extraction and production, environmental justice (EJ) perspectives allow researchers to see other important consequences of energy production. An

EJ lens illuminates structural violence (Farmer, 2004) that can occur when marginalized communities act as internal colonies or sacrifice zones (Gaventa, 1982; Kuletz, 1998; Lerner, 2010) to supply often wealthier urban population centers with energy and other raw materials. As we detail below, fossil and nuclear fuels utilized for energy production have well-documented histories of creating and amplifying environmental inequities, such that low-income communities, communities of color and particularly Native American, Indigenous, and Tribal communities, and other marginalized groups bear a disproportionate burden of hazardous industrial activity (Ard, 2015, 2016; Campbell et al., 2010; Clark et al., 2014; Downey & Hawkins, 2008; Faber & Krieg, 2002; Grant et al., 2010; Liévanos, 2015; Mohai & Saha, 2015; Mohai et al., 2009a, b, 2011; Pastor et al., 2001; Taylor, 2014). Sociologists have been at the forefront of this scholarship.

Dynamics producing the inequitable outcomes we describe below are complex. U.S. environmental regulations are typically not designed to track or reduce environmental inequalities, but instead to improve environmental conditions measured at large spatial scales and for the population overall. Further, environmental regulatory agencies have long been subject to 'capture' by the industries they are charged with regulating (Harrison, 2014). Industry actors use their massive financial power to pressure local, state, and federal regulatory authorities to relax environmental regulations, limit regulatory enforcement, and allow facilities to continue to operate despite regulatory violations and expired permits (Davidson & Frickel, 2004; Faber, 2008; Freudenburg & Gramling, 1994; Gould et al., 2015). Additionally, in low-income communities where residents struggle to make ends meet, they lack the free time, scientific support, credibility, and other resources needed to fight powerful industries. Their elected officials feel compelled to welcome industrial development in exchange for jobs and tax revenues, despite the accompanying hazards, and workers feel reluctant to report or challenge environmental problems for fear of retaliation. These dynamics, and potentially lower property values, make such communities attractive to those industries seeking to locate or expand their hazardous facilities or willing to violate existing laws (Mohai & Saha, 2015). When these debates are framed as zero-sum 'jobs versus environment' scenarios and when operators promise local jobs, it becomes difficult to oppose these short-term potentially profitable activities over longer-term sustainability concerns (Freudenburg, 2005). These structural dynamics can turn communities into sites of acceptance for risky industrial activity (Malin, 2015).

The clustering of environmental problems in communities of color showcases an enduring legacy of centuries of industrial practices and government policies that have produced residential segregation, while systematically affording material resources—from wealth to clean air—disproportionately to whites (Lipsitz, 1995; Mascarenhas, 2016; Mohai & Saha, 2015; Morello-Frosch, 2002; Pulido, 1996, 2017; Taylor, 2014). In the U.S., these practices and policies have been structured through centuries of settler colonial practices (Whyte, 2018) and also include explicitly racist institutions of forced removal and relocation of thousands of Native people, slavery, Jim Crow laws, and 'redlining' practices through which banks and other actors refuse mortgages and other services to people in majority-minority neighborhoods. Racist hiring practices have also allowed employers to allocate the best paying and 'cleanest' professional-sector jobs to whites. Since the 1950s, U.S. federal highway development projects and government urban 'renewal' programs have destroyed entire communities (often of color), even as sovereignty of Indigenous and Tribal nations have been consistently violated through state-sanctioned violence and treaty violations. Finally, weak environmental law and uneven enforcement of existing laws further concentrate the environmental 'bads' from energy production into marginalized communities (Mohai et al., 2009a, b).

Below, we examine socio-environmental dynamics related to these historical and contemporary inequities at various sites of extraction.

We focus on three of the most significant sources of energy in the modern industrial era: coal, unconventional oil and gas, and nuclear power.

Coal's Socio-Environmental Impacts

Sociological research on coal extraction and production has highlighted persistent structural inequities and environmental injustices related to this industry. As Bell and York observe, "coal may be responsible for more environmental harm than any other energy source" (2012: 359). Coal produces more than 40% of energy around the world annually (International Energy Agency, 2012), fueling over 500 coal-fired power plants in the United States alone (American Lung Association, 2011, cf. Bell and York, 2012; EIA, 2021). Global production is projected to increase over the next 40 years (Energy Information Administration (EIA) 2017), as export-oriented manufacturing drives increased coal consumption in the Global South, where much of the Global North's production activities have been outsourced.

This comes at a cost, as burning coal for energy generates about 45% of global carbon dioxide emissions (EIA, 2021)—and leads to significant methane emissions (US EPA, 2012), mercury contamination, and sulfur dioxide, nitrous oxides, and small particle pollution (Bell & York, 2012). In the U.S. alone, coal-fired power plant pollution is linked to tens of thousands of additional premature deaths, heart attacks, asthma attacks, hospitalizations, and emergency room visits each year (Physicians for Social Responsibility, 2009). Coal-fired power plants, as well as coal mining and processing, engender a host of additional environmental problems, including toxic coal waste ponds that can breach their earthen dams, dust-coated communities near coalmines, valleys filled with debris, and watersheds permanently damaged by mountaintop removal and other mining practices (Bell, 2016). Public health impacts include increased rates of mortality, birth defects, respiratory, and cardiovascular ailments in coal mining areas like Appalachia (Ahern et al., 2011; Hendryx, 2015).

The harms of the coal industry play out along lines of social inequality. Hendryx (2010) found that people living in areas of mountaintop-removal coal mining experience higher rates of both poverty and mortality. Similarly, Greenberg (2017) and Liévanos et al. (2018) found that new coal waste impoundments are disproportionately proximate to socioeconomically disadvantaged communities. Moreover, Liévanos et al. (2018) show that the hazardous impacts of coal mining persist long after the mines themselves close, as the authors found that coal waste impoundments were disproportionately located in communities with *past* (rather than current) coal mining activity.

Coal communities often suffer multiple intersecting environmental and economic injustices and experience persistent structural inequities that can disrupt people's daily lives. Coal communities have been depicted as internal colonies dependent upon coal extraction (Bell, 2009; Fox, 1999). Indeed, coal companies can cause serious socio-environmental devastation in these places, which can irreparably harm community social fabrics (Erikson, 1976). Moreover, these problems persist as communities come to identify with and defend the industry. Lewin (2017), Bell (2016), and Bell and York (2010) have shown that the economic and cultural domination of large coal companies in coal mining communities can create such strong economic identification with the industry that citizens harmed by coal extraction while gaining little from it still support the industry, political leaders align with it, and residents and leaders alike idealize its eventual resurgence. As Blaacker et al. (2012) compellingly show, residents of coal mining regions can significantly overestimate the positive impacts of the coal industry in their region. Because of these misperceptions, people may become more willing to overlook environmental and social costs of coal extraction and production. For instance, Scott et al. (2016) examined the aftermath of a massive coal slurry spill in Martin County, Kentucky, where more than 300 million gallons of waste leaked from

an impoundment. Though it devastated watersheds, ecosystems, and nearby communities, the authors found that many residents regained trust in the responsible company within ten years.

Studies indicate that coal heightens local poverty and provides few economic development opportunities. For instance, Perdue and Pavela (2012) have analyzed the economic impact of coal mining on West Virginia communities and found that counties with higher rates of coal production also has higher rates of poverty. However, the effect of coal mining may vary across time and region, with some positive effects in recent years and in certain regions (Betz et al., 2015; Lobao et al., 2016; Partridge et al., 2013).

Despite the economic, social, and cultural power of coal companies, activists have mobilized against local environmental, social, and economic injustices associated with coal production. Women have been at the forefront of this activism in Appalachia (Bell & Braun, 2010; Bell, 2008, 2016; Burns, 2007)—in part because they are less likely than men to be directly employed by, and thus dependent upon, the industry. It also stems from ways dominant gender norms make it socially acceptable for women to become political active when protecting their families' health (Bell, 2008; Bell & Braun, 2010). Gendered outcomes can have different patterns when more women are employed in the industry, however, as demonstrated in Smith's (2008) study of Wyoming's Powder River Basin.

Internationally, coal mining has created similar environmental injustices and upheavals, often experienced by the most marginalized or poorest members of these societies. While we regrettably do not have the space to review this all here, important patterns emerge around structural inequity and environmental injustice. In China, with its staggering increases in most forms of energy production as it quickly becomes a global superpower, coal has been found to generate massive environmental inequities. For instance, ethnic minorities, such as Inner Mongolians, have protested coal mining's detrimental outcomes and its comparatively small benefits for ethnically marginalized communities providing most of the labor (Liu et al., 2014). In South America, environmental inequities have resulted from coal mining, as marginalized members of the public (such as smallholder ranchers) are excluded from decision-making processes surrounding coal mining (Bustos et al., 2017).

Unconventional Oil and Gas Production's Socio-Environmental Impacts

Unconventional oil and gas production has developed rapidly and widely in the U.S. – accompanied by various environmental injustices and economic outcomes that can affect populations unevenly (Mayer et al., 2018), often privatizing profit and nationalizing risks such as public health, social, and environmental costs (Faber, 2008). The United States has recently emerged as the top global producer of hydrocarbons. This is largely due to its increased use of unconventional technologies such as hydraulic fracturing to tap previously inaccessible oil and natural gas in shale layers scattered around the country (EIA, 2021). The federal deregulation of the industry since the 1970s—and especially through the 2005 Energy Policy Act—accelerated unconventional drilling as well (Malin et al., 2017; Warner & Shapiro, 2013).

Conflict and tension over the pace and scale of unconventional oil and gas (UOG) production have characterized the recent boom. Supporters of UOG production laud the potential for economic growth, job creation, and the energy independence it may offer (Ceresola & Crowe, 2015; Silva & Crowe, 2015). Others oppose the industry's rapid development, concerned over public health and environmental risks, economic instability of boom-bust prone industries, and communities' lack of political power over decisions about drilling (Malin, 2014; Mayer et al., 2017; Ryder, 2017, 2018). Communities' lack of power in such decisions stands in stark contrast to the meta-power—or ability to control the rules of the game—exercised by operators at

most phases of UOG production (Hall, 1997; Malin et al., 2019).

UOG production poses various environmental and public health risks. These include exposure to hazardous chemicals used in fracturing fluid, which is associated with adverse human health outcomes (Colborn et al., 2011), including higher rates of birth defects (McKenzie et al., 2014) and childhood cancer (McKenzie et al., 2017) in populations living in close proximity to UOG production in Colorado (see also Adgate et al., 2014; McKenzie et al., 2012). Studies have shown that the industry fails to report oil spills, and that UOG production contributes to water contamination (Rozell & Reaven, 2012), air pollution (Ahmadov et al., 2015), industrial accidents (Blair et al., 2017; Haley et al., 2016), induced seismic activity (Keranen et al., 2014), and other hazards to human health (Adgate et al., 2014; Rabinowitz et al., 2015).

Although increased UOG production has helped decrease energy costs (unless we start counting subsidies for fossil fuel industries), its consequences for host communities are murkier. Kinnaman (2011) reviewed several early industry-funded studies, finding that they tended to overstate the economic benefits of UOG production. Jobs often go to workers from outside host communities (Wrenn et al., 2015). Haggerty et al. (2014) studied the U.S. West and found that long-run specialization in oil and gas development is associated with lower incomes, heightened crime, and reduced educational attainment. Munasib and Rickman (2015) found marked employment growth in North Dakota but no effects in Arkansas. Other studies find that unconventional oil and/or natural gas extraction is associated with modest wage and employment growth (Lee, 2015; Tunstall, 2015; Weber, 2012), but these gains may be short-lived and mostly concentrated within the oil and gas sector, suggesting limited multiplier effects (Cosgrove et al., 2015; Komarek, 2016). The job growth and tax revenues provided by UOG can be offset by increased strain on local infrastructure from heavy equipment traffic, elevated water usage, noise and light pollution, and negative impacts on air and water quality (Anderson & Theodori, 2009; Brasier et al., 2011; Gullion, 2015; Jacquet, 2012; Jacquet & Stedman, 2011; Ladd, 2013, 2014; Schafft et al., 2013; Theodori, 2009; Willow, 2016). Perry's work in Pennsylvania has shown how rural communities can experience collective trauma amid rapid and widespread UOG production, as social and community fabrics and livelihoods are disrupted (2012). Malin and DeMaster (2016) showed that when small- and medium-sized farming operations in Pennsylvania lease their property for UOG production, they can implicate their rural livelihoods in dual systems of natural resource dependence. Further, Willow (2014) found that deregulated UOG production can create barriers to more sustainable energy development.

Evidence continues to accumulate that UOG production has complicated environmental justice outcomes (Clough, 2018), especially in the communities where extraction takes place. Concerning distributive justice, there are a disproportionate number of wells in poorer regions of Pennsylvania (Bienkowski, 2015; Ogneva-Himmelberger & Huang, 2015). Wylie and Willow (2014) compiled multiple instances of environmental injustice in their special issue examining the political ecology of UOG production, including inequitable access to technology and information possessed by the industry as compared to members of the public.

The massive power inequities between oil and gas companies and the communities hosting drilling sites also create significant procedural injustices. In these contexts, members of the public often have fewer resources, less access to information, and fewer opportunities for meaningful participation in making decisions about UOG production near homes, schools, or on public lands (Malin et al., 2019; Wylie, 2018; Wylie & Willow, 2014). Wylie and Albright (2014) demonstrated how UOG operators can hold comparatively massive power in the face of community or grassroots efforts to gain information or share and record their experiences with the industry by creating publicly accessible databases regarding leases and other industry actions. Malin (2014) has shown how Pennsylvania farmers often feel compelled to sign leases with

UOG producers, and that they need substantial financial resources to hire the legal counsel needed to ensure more equitable lease terms. Gullion (2015) has demonstrated the ways in which Texas homeowners mobilized to combat their lack of control over the zoning and regulation of UOG production in their neighborhoods.

In U.S. states like Colorado, the state has thwarted local efforts to regulate or ban UOG production (Davis, 2014; Ryder, 2017; Ryder & Hall, 2017). Concerned members of affected communities may also find the convoluted regulatory system blunts their ability to engage with siting decisions, hampering procedural equity. Further, in many U.S. states, mineral rights ownership is severed from surface rights ownership. In such scenarios, people who live on a property may have little to no input about UOG development, as state laws typically privilege mineral owners over surface owners (Mayer & Malin, 2018).

In the United Kingdom, similar environmental inequities have emerged around the use of UOG production methods, as members of the public lack the ability to meaningfully influence policy decisions related to UOG production (Cotton, 2017). In eastern Australia, coal-seam gas extraction and production have generated similar controversy, and the public has mobilized to demand the recognition of a social contract between host communities and oil and gas operators (Lacey & Lamont, 2014). Yet, the environmental injustices that result—from environmental health impacts such as asthma and cancer clusters to increased risk of toxic contamination among vulnerable and rural populations (White, 2013)—compete with the mining sector's economic power and dependence of Australia upon its, which now accounts for over 15% of the nation's economic activity (Cleary, 2012: xi). This can limit the ability of members of the public to have a seat the table when making relevant policy decisions (Mercer et al., 2014).

Although current evidence suggests that UOG production may provide communities with some economic benefits in terms of job creation and wage growth and can generate localized support (Mayer & Malin, 2018; Malin et al., 2017), these same benefits can generate their own secondary problems if rents, property values, and the cost of other necessities increase in tandem. UOG production may also generate significant tax revenue, but this revenue is typically moved upstream into state coffers and not always redistributed back to local host communities, potentially exacerbating the infrastructure strains created by local development (Newell & Raimi, 2018a, b). As a further complication, UOG production does not appear to address the seemingly intractable problem of persistent rural poverty, and does not seem to stop or slow human capital flight from rural areas (Mayer et al., 2017, 2018; Rickman et al., 2017). Indeed, UOG production might reduce much-needed human capital in rural places (Mayer et al., 2018). Finally, scholars have shown that, in some areas, civic science water monitoring projects conducted by residents concerned about fracking pollution are not located in the areas of greatest environmental injustice, and often are not coordinated with government datasets (or other citizen science data collection projects) nor in compliance with agencies' strict quality control standards (Kinchy et al., 2016). Additionally, such projects are designed and discussed in ways that constrain participants' democratic sensibilities, notably by focusing on preparedness for disaster rather than pollution prevention and by using data government agencies already deem valid rather than residents' experiential knowledge (Kinchy, 2017).

Environmental inequalities—from the distributive to the procedural—emerge for individuals and communities touched by UOG extraction. While the industry is still relatively young, researchers increasingly demonstrate its socio-environmental implications and related injustices.

Socio-Environmental Impacts of Uranium Extraction & Nuclear Waste

Uranium production and nuclear technology propelled the U.S. to its status as a global superpower, but also generated a host of socio-environmental problems, including legacies of environmental injustice, nuclear sacrifice zones,

and environmental health outcomes still contested by the state.

Nuclear power has enormous decarbonization potential, and is framed by some as the most viable low-carbon energy source (International Atomic Energy Agency, 2016). Nuclear power currently supplies about 20% of the electricity in the U.S. (EIA, 2021) and about 11% globally (IAEA, 2017), with global demand projected to increase by about 1.6% annually, making it the second-fastest growing sector after renewables (US EIA IEO, 2017). While this climate-friendly framing has put a new shine on a controversial and risky technology, the industry remains plagued by serious environmental justice considerations at the beginning and end of the nuclear fuel cycle. Cleaner materials such as thorium are increasingly used for nuclear power generation, but uranium extraction and production continue to play central roles in nuclear power production. When extracted, milled, and enriched, uranium can propel a nuclear reaction for atomic weapons or energy production.

Uranium's public and environmental health consequences are well-documented and have been fought by communities seeking stronger regulatory protections as well as cancer screening and treatment (Brugge & Buchner, 2011; Malin, 2015; Shuey, 2007). After the rush of uranium's first two booms (Ringholz, 2002), uranium communities were often left with substantial legacies of environmental contamination, busted economies, and public health problems—such as cancer clusters, childhood leukemia, birth defects, and ongoing fears over residual contamination and its potential effects (Malin, 2015; Malin & Petrzelka, 2011). However, these inequities do not figure prominently in contemporary policy discussions about nuclear's sustainability, and government actors have claimed that that individual behaviors like smoking, rather than environmental uranium exposure, led to disease clusters (Malin & Petrzelka, 2010).

Poor, predominantly white communities such as Monticello, Utah, have dealt with these injustices. But the worst and most persistent environmental injustices were experienced by Native, Tribal, and Indigenous nation communities (Kuletz, 1998, 2001), forcibly removed and relocated—then often dismissed and actively disempowered through treaty rights violations and other injustices within settler colonies (Whyte, 2018). For instance, the Navajo (or Diné) reservation had numerous uranium reserves and currently has over 500 abandoned uranium mines. Residents experience lingering health impacts from exposure to contamination through their air, water, and hogans (spiritual spaces) and homes that were in some cases built with uranium tailings (waste) (Brugge & Goble, 2002; Brugge & Buchner, 2011; Brugge et al. 2007a; Johnston et al., 2010). The Church Rock spill, where the United Nuclear Corporation's uranium tailings pond experienced a dam breach and released 94 million gallons of radioactive sludge into the Puerco River, stands as the worst nuclear disaster in U.S. history (Brugge et al., 2007a, b). But the spill's location on Native nation land and its impacts to mostly Native populations rendered it all but invisible. Indeed, these ongoing environmental health disasters have led to deep psycho-social stress and reductions in quality of life in Tribal and Native communities still impacted by uranium (Johnston et al., 2010; Madsen et al., 1996)—part of the motivation for on-going activism against further uranium production, including the Diné Nation's moratorium on production.

Kuletz (1998) argues that the U.S. government-funded nuclear industrial complex is a form of internal colonialism, where Native nations and peoples have been particularly exploited and disregarded for the benefit of 'the nation'. At the same time, popular narratives about the desert as a wasteland frame these spaces of sacrifice as expendable and ignorable, justifying their "relentless plunder" (p. 13) and the dumping of waste. Even today, the only operational uranium mill in the U.S., the White Mesa Mill in predominantly white Blanding, Utah, has created environmental injustices for the Ute Mountain Ute, from increased exposure to environmental toxicants to destruction of sacred burial sites (Natori, 2013). In New Mexico, the Laguna Pueblo contends with ongoing water contamination concerns related to the Jackpile Mine. And in

northern Arizona, as uranium production renews on the Colorado Plateau, Tribal populations like the Havasupai fight to protect their sacred lands, sovereignty, and tribal water rights amid renewed uranium mining.

These outcomes have occurred globally, where uranium production had similarly concentrated impacts on Native populations. For instance, Keeling (2010) shows how Canadian uranium mining and milling took on the same feverish pitch and was accompanied by the same socio-environmental impact as in the US, including environmental health outcomes and inequitable risk exposure for marginalized groups, particularly First Nations peoples and communities. In Australian uranium mining operations, Aboriginal peoples were unequally exposed to the socio-environmental and public health risks of uranium production (Banerjee, 2000; White, 2013).

The other end of the nuclear fuel cycle is plagued by similar power disparities and environmental inequities. Nuclear waste storage debates have sparked significant activism (Masterson-Allen & Brown, 1990). Intergenerational justice figures prominently in this discussion (Shrader-Frechette, 2002), yet different worldviews and orientations to the natural world are frequently dismissed in favor of Western, technocratic views of nuclear waste storage problems. Yucca Mountain has been frequently identified as the most promising site for a permanent and centralized repository for US nuclear waste. Significant concerns about the integrity of the site are ignored, and 'nuclear colonialism' (Kuletz, 1998) has been allowed to continue, as the sacredness of Yucca Mountain for Native groups has not been authentically considered in policy and media discussions about the site (Endres, 2013).

Not all communities respond to the siting of nuclear facilities or renewed nuclear production for power generation with fear or opposition. Recent work has identified 'sites of acceptance' in the context of nuclear power and renewed uranium production (Malin, 2015; Malin & Alexis-Martin, 2020). In these communities, people do not necessarily mobilize against uranium extraction but instead embrace the industry's renewal due to a complex intersection of persistent poverty, natural resource dependence, cultural and community ties to the industry, and spatial isolation (Malin, 2014, 2015). Internalization of neoliberal norms encourages these sites of acceptance, as people privilege free markets, laud de- and re-regulation (especially of environmental rules), and trust corporations to regulate their own behavior.

Importantly, though, these outcomes are impacted by environmental racism, specifically as it affects procedural equity and sovereignty. For instance, in the cases where Native or Indigenous groups *approved* of nuclear waste storage, they were not allowed to store nuclear waste on their sovereign land. Specifically, in Skull Valley, Utah, the state of Utah prevented the Goshute tribe from storing radioactive waste on their sovereign land, despite being surrounded by the chemical, radioactive, and other hazardous wastes stored and incinerated in Utah's west desert (Ishiyama, 2003). In another case, the Mescalero Apache in New Mexico were treated with similar paternalism when they lobbied to store radioactive waste on their land (Sachs, 1996). Yet, the predominantly white communities that have supported the continued operation of the White Mesa Mill in Blanding, Utah, or permits for constructing the only new uranium mill in the U.S. since the end of the Cold War, have been supported by the state when considering inviting in these industries (Malin, 2015).

Nuclear power generation facilities pose pernicious existential risks to host communities (Beck, 1992), given their extraordinary capacity to generate catastrophic harm (Brugge et al., 2007a, b). Perrow (1984) demonstrated that, because of the extraordinary complexity of nuclear power generation and other highly complex technological systems, failures are inevitable. Moreover, he demonstrates how typical engineering approaches to mitigating risk actually exacerbate the chances of major accidents. Some of the worst technological accidents have involved radioactive releases from nuclear power plants, including Three Mile Island in the U.S., Chernobyl's record-setting release of radioactivity in 1986, and the 2011 Fukushima-Daiichi

disaster in Japan (Alexis-Martin, 2019; Hasegawa, 2012). Still, in some social settings, dominant social norms can mitigate against residents' abilities to effectively mobilize in the face of these risks. For example, Kimura shows that women concerned about radiation-contaminated food following the Fukushima nuclear disaster were labeled irrational and challenged for not complying with dominant, gendered norms of neoliberal responsible citizenship (2016).

Across the nuclear fuel cycle, from uranium mining and milling to nuclear waste storage and power generation, social scientists have documented the structural inequalities and persistent environmental injustices that accompany atomic technologies. When considering nuclear power's potential role in producing low-carbon energy, then, we can see how these inequities limit nuclear power's socio-environmental sustainability.

Socio-Environmental Impacts of Refineries and Fossil Fuel Power Plants

Environmental sociologists have documented numerous environmental justice (EJ) issues at refineries and fossil fuel power plants. These are often disproportionately clustered in lower income, immigrant, black, Latinx, Native American, Indigenous, or other marginalized communities. Consequently, these populations bear the greatest burden of the hazards associated with such facilities—explosions, toxic emissions, polluted water, truck traffic, odors, and noise, which harm human health, cause suffering, impair educational attainment, and cause other problems. The poverty, racism, food insecurity, lack of access to health care, and other social stressors that characterize life in these communities render their residents disproportionately vulnerable to the effects of exposure to such hazards (Morello-Frosch et al., 2011).

Community-based, qualitative studies of the communities along the Mississippi River oil and chemical corridor—dubbed "Cancer Alley", with over one hundred oil refineries and petrochemical facilities—have provided striking insights into the hazards these communities endure (Allen, 2003; Kurtz, 2007; Lerner, 2005; Ottinger, 2013a; Taylor, 2014; Wright, 2005). Low-income African Americans suffer the greatest harm from these facilities, yet have been largely excluded from facility jobs and other economic benefits. At the same time, state officials and industry experts routinely dismiss residents' concerns as unsubstantiated and uninformed. In numerous cases, residents outraged about facility explosions and toxic air emissions have organized to fight for stronger environmental regulations, greater regulatory enforcement, research on the toxic impacts of these facilities, and, in some cases, paid relocation of residents out of their neighborhoods (Allen, 2003; Kurtz, 2007; Lerner, 2005; Taylor, 2014; Wright, 2005). Such studies show that industry and government actors undermine community concerns by downplaying risks inherent to complex energy-producing facilities.

Ottinger (2013a) shows why other residents who are harmed by these facilities do not mobilize against them. She demonstrates that industry engineers defined public debate about facility safety in terms of individual, responsible choice—framing themselves as *responsible*, enterprising individuals who *choose* to live and work near the plants, and framing other residents' health in terms of irresponsible individual behaviors like smoking, dietary choices, and exercise. This obscured the scientific uncertainties about plant safety and the well-documented hazards from these facilities. At the same time, neoliberal rollback of environmental and labor regulations and declining funds for basic social services created among residents a "need to be entrepreneurial" (p. 95)—a need to seek industry investments into basic community development projects and to make their neighborhoods attractive to upwardly mobile prospective home buyers. Many residents thus pushed for a friendly partnership with industry to fund neighborhood beautification projects and rejected EJ activists' assertions that their town was "unlivable" and should be relocated.

Pipelines move raw materials such as liquefied natural gas and petroleum from sites of extraction to refineries, power plants, and ports. While we do not have the room here to exhaustively review related research, social scientists continue to examine EJ aspects of pipeline siting and community responses—and focus on the growing public activism against pipeline proliferation amid increased UOG production. Some of the most high-profile EJ activism of this century has centered around pipelines, from the Standing Rock Sioux coalition for water protection (Whyte, 2018) to the on-going protests related to the Enbridge Line 3 (Black et al., 2014) and Keystone XL Pipelines (Bradshaw, 2015). In the context of UOG production, FracTracker Alliance (2016-present) continues to capture pipelines' EJ outcomes on the ground, as the oil and gas industry increasingly relies upon mechanisms such as eminent domain to claim land from members of the public for pipeline construction (Chalk & Harrison-Fincher, 2009). Broadly, activism along pipeline routes that cut through communities is increasingly well-documented (Boudet & Ortolano, 2010; Veltmeyer & Bowles, 2014), and First Nations People and Native and Indigenous nations have been at the forefront of public resistance (Gilio-Whitaker, 2015). At the same time, the media frames debates over energy development, like other industries, in terms of either jobs or environmental concerns, as Kojola (2017) found in the case of the XL pipeline controversy—which can create the same zero-sum 'jobs versus environment' dynamic discussed previously in the context of UOG production.

Socio-Environmental Impacts of Renewable Energy

Given the tremendous socio-environmental and political problems inherent in fossil fuel and nuclear energy, many actors have advocated for an energy transition to renewable energy sources such as wind and solar. There is broad public support for renewable energy, but considerable community opposition to specific renewable energy projects (Wolsink, 2007), for reasons we review below. Moreover, while planners and state actors often deride community opposition to renewable energy projects as a selfish and parochial "NIMBY" (Not In My Back Yard) mentality, many scholars have shown communities' concerns are not so simplistic. Indeed, the forms of renewable energy development most likely to flourish have been shown to contribute similar environmental injustices as their carbon-based predecessors (Bailey, 2016; Bailey & Darkal, 2018; Devine-Wright, 2012; Ottinger, 2013b). Importantly, though, many of these concerns relate to scale and procedural inequity rather than stark socio-environmental and broader sustainability concerns presented by fossil fuel-based energy sources.

Scholars raise concerns about the inequitable distribution of costs and benefits from *industrial-scale* renewable energy projects. In these instances, host communities bear the greatest burdens in several significant regards. While the social benefits of utility/industrial-scale renewable energy projects are widely dispersed, the hazards they create are concentrated around the sites of production (Ottinger, 2013b). The mining of rare earth minerals essential for producing renewable energy technologies (e.g., solar panels), the manufacturing of renewable energy infrastructure, and exposure to toxic chemicals at waste sites where old renewable energy infrastructure is discarded all pose health risks to workers and communities, just as in fossil fuel production (Newell & Mulvaney, 2013; Phadke, 2018). Biofuels have also impacted global agricultural markets in ways that exacerbate inequity for developing nations and peasant populations (Borras Jr. et al., 2010). Many of those most affected are Indigenous and Tribal nations already harmed by air and water pollution, poverty, food insecurity, and flooded global markets.

Residents and researchers also point to public health and environmental impacts of wind turbine installations, whose low-frequency vibrations, noise, and flickering light can cause headaches, nausea, and other health problems for residents and perhaps wildlife (Ottinger, 2013b; Phadke, 2013). Additionally, industrial-scale renewable

energy projects on public lands have been found to appropriate and exploit land, water, minerals, and other resources without adequately compensating local people (Mulvaney, 2013, 2017; Newell & Mulvaney, 2013; Rignall, 2016). Renewable energy projects have damaged Native American tribal nations' sacred cultural resources, including burial sites, wild rice production, wildlife, and water quality (Lipschutz & Mulvaney, 2013; Mulvaney, 2013, 2017).

At the same time, given centralized, large-scale sites of production, corporate renewable energy project developers reap the projects' greatest benefits. Some "big solar" projects and rare earth mines used to harvest materials needed for producing solar and wind technologies are owned by some of the largest multinational corporations in the world, many of which are responsible for human rights violations internationally (Mulvaney, 2017: 18; Newell & Mulvaney, 2013; Phadke, 2018). These corporations use narratives of 'responsible' mining, manufacturing, and energy production to pressure communities and agencies to accept their projects. Phadke (2018) points out that developers' discursive focus on their new, "socially responsible" forms of mining "naturalize[s] the assumption that we need more and more raw metals to drive the production and consumption of clean energy technologies" and precludes conversation about alternatives such as "extended producer responsibility and economy wide materials recycling and recovery programs" (p. 172).

Additionally, scholars have highlighted the extensive neglect of basic elements of procedural justice during large-scale renewable energy planning and development. Key public participation practices have been abandoned in some renewable energy projects, such that residents feel that they have not been given a chance to help shape decisions about projects that affect their lives (Bailey & Darkal, 2018; Gross, 2007; Mulvaney, 2013, 2017; Newell & Mulvaney, 2013; Ottinger, 2013b; Ottinger et al., 2014; Phadke, 2013; Wolsink, 2007). Officials and other renewable energy proponents disregard lay knowledge about harms (Ottinger, 2013b). In many cases, regulators have not conducted thorough impact analyses required by law (Mulvaney, 2017). In the context of post-colonial nations in the global South, states' pursuit of renewable energy projects can violate communities' rights or aspirations for land and self-sovereignty (Rignall, 2016).

Again, scale and land ethics matter. The social outcomes of renewable projects are often a function of scale and private, consolidated ownership. Centralized renewable energy projects (e.g., utility scale solar) are often imposed upon communities by investors and utilities, raising concerns of procedural and representative equity (Mulvaney, 2013, 2017). Renewables, especially solar installations, can be deployed at a highly granular scale—as in the case of rooftop solar–and is also amenable to alternative models of ownership, such as community-owned solar gardens (Chan et al., 2017; Schelly, 2017). Although these sorts of projects represent only a niche of the U.S.'s current energy portfolio, appropriately scaled renewables can perhaps create spaces for more fulsome public participation and procedural equity.

Conclusions: Emerging Trends & Steps toward a Unified Sociology of Energy

Globally, energy systems are always shifting. In recent years, increasing scientific evidence and public concern about climate change, as well as climate justice activism, have motivated calls to phase out fossil fuel-based energy production and put greater investment into renewable energy (Klein, 2014, Roberts & Parks, 2009). Visionary perspectives on building distributive and regenerative systems that (re-)embed economies in their socio-environmental contexts are vital and inspiring (Raworth, 2017)—but also need to be complemented by action and insight from environmental sociologists. Sociology of Energy can play an important role in capturing and analyzing these transformations and possible futures, identifying their implications for equity and other elements of justice, and helping inform energy policy measures at all scales of government.

As these transitions occur, social scientists have utilized numerous conceptual approaches to examine these shifting spaces and relationships attending to just sustainabilities (Agyeman, et al. 2003). For example, 'climate justice' scholarship foregrounds the inequitable dimensions of anthropogenic climate change (Ciplet et al., 2015; Schlosberg & Collins, 2014). Climate justice scholars demonstrate how those who contribute most to climate change bear the least of its harms, while the world's most vulnerable people are and will continue to be most harmed by the droughts, floods, forced migration, and other consequences of global warming. Studies have emphasized these injustices at various scales, such as between the global North and global South, and across and within nations. They showcase the work of climate justice activists, who fight for national and international policies that, among other things, mandate democratizing decision-making about energy systems, phasing out fossil fuel-based energy systems that make the greatest contributions to cliamte crises, and developing sustainable and smaller-scale renewable energy systems that help do the work of embedding economies in their social and environmental contexts. Many climate justice scholars and activists also insist that these energy transitions must hold industrialized countries to higher standards for greenhouse gas reductions and honor the rights of countries in the global South to profitably industrialize and develop as those in the global north have done.

Other scholars have taken on this task through the frame of 'just transitions'. The term emerged from labor justice activists in the U.S. and Australia committed to protecting the needs of energy and chemical sector workers and 'frontline' communities affected by industrial restructuring stemming from sustainability policy (Stevis & Felli, 2015). Scholars have used the just transitions concept to advocate for sustainability agreements in the U.S. and internationally that attend to economic and community development, equity, and other justice concerns that include and extend beyond the needs of chemical and energy sector workers (Ciplet & Harrison, 2019; Newell & Mulvaney, 2013; Olsen, 2010; Rosemberg, 2010; Stevis & Felli, 2015; Swilling et al., 2015).

Social scientists have also begun to discuss these issues of power, equity, and access from the perspective of 'energy justice'—an especially vibrant and promising area of inquiry. These scholars examine ways in which issues of equity, fairness, access, and other aspects of social justice are realized—or not—within current systems of energy policy decisions, energy production systems, and energy system transitions (Baker, 2016; Jenkins et al., 2016; Sovacool et al., 2017). Researchers also examine inequities experienced by households that must spend more than 10% of their (non-discretionary) income on heating and electricity services, creating much greater risk of staying in economic hardship or poverty (Bohr & McCreery, 2019). This work, which began about a decade ago, specifically focuses on equity in processes of decarbonization, responses to global climate change, and the energy transitions that have been occurring, especially toward appropriately scaled renewables accompanied by just transitions (Goldthau & Sovacool, 2012; Jenkins et al., 2017; Newell & Mulvaney, 2013; Sovacool, 2014; Sovacool & Dworkin, 2015; Sovacool et al., 2017). Energy justice scholars have proposed the idea of cosmopolitanism—or that each person is a citizen of the world and a stakeholder in these decisions about how we shape just energy systems (Sovacool & Dworkin, 2014). Yet, this work on energy justice does not fully engage with the decades of EJ research, much of it centrally focused the substantial and intersectional ways in which this participation can be limited by significant structural and historical barriers (e.g., Mohai et al., 2009a, b; Roberts & Parks, 2006; Pellow & Brehm, 2013). As such, the energy justice literature would benefit from drawing on EJ's rich body of empirical and theoretical work in order to more effectively identify structural drivers of the energy injustices and who

bears responsibility for remedying them (Jenkins et al., 2017).

Steps Forward

How do we help shape this wealth of research, where studies often talk past or across one another, into a unified Sociology of Energy that attends to socio-environmental sustainability and justice? First, we can better use our sociological imaginations to help identify and analyze the hidden and invisible aspects of energy systems and transitions. The metabolic rift (Foster, 1999) between energy production and consumption may be due in no small way to the centralized and large-scale aspects of production and distribution of contemporary energy systems, which can contribute to people's separation from the energy they consume, its origins, and its socio-environmental impacts. As sociologists, we can both uncover these hidden dynamics and explore how smaller-scale energy production approaches or larger closed-loop systems, for instance, may reduce metabolic rift. Second, we encourage scholars to be in greater conversation with each other and with environmental justice scholarship. As we have shown above, energy systems—conventional and renewable alike—may exacerbate inequalities and disproportionately burden working class and poor communities, communities of color, Indigenous peoples, and other marginalized and environmentally overburdened groups.

The research reviewed here on centralized, industrialized, fossil fuel-based systems of extractive energy production highlights multiple intersecting and systemic environmental injustices they help generate. Sociologists of energy can utilize this knowledge to facilitate more unified, multi-scalar, and rigorous foci on power and inequity tied to extractive energy production. Sociologists of energy can help envision the next energy and economic systems—which can transform from neoliberal capitalism to systems that are distributive and regenerative by design (Raworth, 2017), where thick democracies, closed-loop systems, and community or communal resource management become the norm. And we can, perhaps must, move beyond the academy and translate our work for members of the public. We possess the skills to help design systems and policies that (re-)embed extractive energy systems and markets in their socio-environmental contexts, opposing attempts to dis-embed markets through de- and re-regulation, privatization, and other neoliberal approaches.

We suggest that the following are promising paths ahead for sociologists of energy:

1. Doing more public sociology and publicly accessible work. Sociologists of energy can help assess what environmental justice within energy systems and markets looks like. We can counter the tendencies of policy, especially over the last 40 years, to dis-embed markets from socio-environmental contexts, by reconsidering 'externalities'. This means working more meaningfully with communities by sharing knowledge, conducting participatory research when appropriate, and building long-term, genuine relationships with practitioners and members of the public—especially communities with environmental injustices. In doing this deep work, sociologists of energy can help illustrate how to build new, distributive, regenerative systems in the face of urgent pressures from the climate crisis.
2. Conceptualizing and leading interdisciplinary assessments of the environmental justice and health implications of fossil fuel-based industrial systems. This can begin as comprehensive meta-analyses of the hundreds of studies that already examine social disparities in health, pollution's impacts on marginalized populations, and their links to fossil fuel emissions and pollution. After the state of the field is assessed through these kinds of analyses, then more empirical research can ask questions specifically targeted to these EJ and environmental health components of fossil fuel production, linking sociology of energy to these well-developed literatures.
3. Offering more comprehensive assessments of the global/international, macro-level, political economic, and governance aspects of fossil

fuel production, and, in particular, conducting comparative studies of the sociological outcomes of energy systems across the world. Such research could include meta-analyses of existing studies to identify cross-national outcomes, comparisons of large-scale versus smaller-scale transitions to more renewable energy systems, and analyses of the political-economic impacts of the Paris Accord and the US's ambivalent role in it.

4. Drawing on a more robust set of theoretical traditions when analyzing energy issues. Environmental sociologists specializing in energy should draw not only on theoretical frameworks widely used in the sub-field, such as Treadmill of Production, but also other theoretical frameworks that contribute valuable insights into issues of inequality and power, such as those by and stemming from Polanyi, Foucault, and Bourdieu, among others. These can help sociologists of energy analyze power inequalities and potentials for liberatory transformation in novel ways. Bringing in 'renegade' and environmental economists and collaborating with other visionary social scientists will lead to richer, more engaged research.
5. Conducting spatial, multi-scalar, and intersectional EJ analyses, linking sociology more carefully to critical human geography. Energy systems center on multiple phases of production that impact communities in different ways, but those relationships are often not explored in depth by researchers.
6. Identifying and analyzing links to energy consumption and access, effects of scales of energy production and distribution, the role of private ownership versus public management, and, perhaps most importantly, aspects of energy poverty and barriers to access. As research on energy poverty and just transitions continues to develop, sociology of energy should more formally interrogate the ways in which various groups have access to affordable energy, the types and scales available, and multi-scalar environmental justice outcomes—and how equity can be realized through more distributive, regenerative energy (and economic) systems.
7. We acknowledge the need for additional, rigorous impact assessment and related empirical research to inform policy-making. However, we note that some of the community impacts of energy production, such as stress and the loss of sense of place, are not captured in traditional means of quantitative risk assessment. Further, we concur with Evensen (2016) and Cotton (2017) that moral and ethical reasoning is also necessary to understand the equity and other justice implications of any energy production. The climate crisis and all other inequities we examined above demand transformative, ethical solutions. Sociology of Energy can work to actively inform policy and conduct applied and community-based work, even as we push to have traditional quantitatively oriented risk assessments also capture quality of life impacts for individuals and communities over time.

Research on the sociology of energy has contributed valuable insights into the people and communities affected by energy production, the ways powerful actors and firms exert substantial influence on energy policy trajectories and discourses, and the multi-scalar ways in which these dynamics can shape, and be shaped by, environmental injustices. A distinct and robust Sociology of Energy would more coherently unify these three foci, systematically identifying how power plays out within the context of resource extraction and production in ways that contribute to environmental harm and injustices. With this knowledge in hand—and more publicly accessible—we can help build more equitable, distributive, and regenerative set of energy and economic systems.

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