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Disrupting the grid: Encountering fire and smoke through energy infrastuctures

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ABSTRACT: Experiences of fires are mediated by energy infrastructures and refracted through social inequality and difference. In California, a state marked by increasingly intense and frequent wildfires, the grid is a source of fire risk, with historically marginalized groups bearing the brunt of exposures to wildfire smoke. Drawing on research conducted by one of the co-authors in collaboration with California's Karuk Tribe and Blue Lake Rancheria Tribes, this empirically grounded review article expands our understanding of grids. Extant scholarship presents the grid as a networked infrastructure mediating access to energy and one's relationship to a collective and the state. We extend this analysis by highlighting the diverse and unevenly distributed forms of risk entangled with the electric grid, focusing on those related to fire and smoke. We conclude by considering alternative infrastructural arrangements entailing different relationships to the grid with potential for more just futures in the context of climate change.

KEYWORDS: California, electricity, energy, fire, grid, infrastructure, risk, smoke

Writing from the vantage of California, the intersection of fire, smoke, electricity infrastructure, and risk is readily apparent. Always an ecologically variable, fire-adapted landscape, the combination of an aging electric grid, extended droughts, land management decisions criminalizing Indigenous uses of fire on the land, and climate change has produced unprecedented, extensive, and frequent destructive blazes across the state in recent years. But a key point is sometimes lost amid headlines focused on acreage singed and tragic death tolls: these events shape lives well beyond the borders of a burn. As we will elaborate through a case study in Northern California, the air pollution from fires escapes the boundaries of the fires themselves, and frequent power outages (planned and unplanned) are intricately linked to the risk of wildfires, leading to consequences including the inability to use air filters during fire season, difficulty running life-sustaining medical systems, negative impacts on food storage, and the incapacity to maintain telecommunications networks. Using the electricity grid as our anchor, this empirically grounded review article considers the more diffuse forms of hazard associated with fires, and the broader role of networked infrastructures in shaping uneven experiences of risk.

Like other networked infrastructures, the electricity grid illuminates and structures a wide range of material and political relations. In this article, we make four distinct contributions to critical scholarship on the electric grid as connective energy infrastructure. First, we draw on scholarship in the disciplines of geography and anthropology to examine how the electric grid is experienced unevenly across the landscape, both socially and spatially, forged as it is in colonial

and capitalist logics. Second, we highlight the opportunities engendered by the electric grid for energy access, connectivity, and citizenship (and the converse, their withholding). Third, drawing on one co-author's research in collaboration with Indigenous communities in Humboldt County, California, and engaging with critical scholarship from Native American studies and case studies in the Global South, we extend theorization of the grid as not only bringing electricity and connectivity, but as also producing vulnerability to wildfires and smoke. And finally, our empirical case study and literature review allows us to consider possible alternatives to the grid as currently configured. We conclude by analyzing the potential for these sociotechnical imaginations of new formations of electricity infrastructure to engender more progressive and liberatory arrangements.

Critical scholarship from anthropology, geography, and Indigenous studies has attended to networked energy infrastructures with varying loci of focus based in their discipline's intellectual genealogies. We believe that considering networked energy infrastructures through the critical perspectives offered by these disciplines offers new ways to understand connection, vulnerability, and the possibility for liberatory futures. The structure of the article is as follows: we begin with a brief literature review describing scholarship in anthropology and geography about networked energy infrastructures. Next, we provide the reader with historical context for the grid in California amid its incendiary landscape. Then, we discuss the risks associated with connecting to an electric grid. An empirical case study follows, based on collaborative research conducted by one of the authors in Humboldt County, California to illuminate our theoretical interventions around the vulnerability produced by the grid-as-is, and possibilities for alternative grid arrangements, which we examine in the section immediately following. We conclude with reflections on the potential for new infrastructural arrangements of electricity production and transmission to create more just energy futures.

Networked Electricity across Anthropology and Geography

Experiences of electricity grids vary wildly, often along lines of social and spatial difference (Braier 2020; Love and Garwood 2013; Nucho 2022; Winther 2008). Focusing on the networked distribution infrastructure of the grid, we diverge from the orientation of much of the critical social science literature on energy. Within energy geographies, a fast-growing body of scholarship that foregrounds the spatial dimensions of energy production, distribution, and consumption, recent reviews have emphasized the field's disproportionate focus on energy production at the expense of attention to its distribution and (to a lesser degree) consumption phases (Baka and Vaishnava 2020; Huber 2015). In a recent comprehensive review of the energy geographies literature, Jennifer Baka and Saumya Vaishnava (2020) identify this lacuna in stark numeric terms, finding that works on the distributive phase (or, as those authors categorize it, the energy infrastructures and transmission phase) represent only 3 percent of all the articles in energy geography. However, while only a small subset of the literature, we found that geographical works attending carefully to the grid offer conceptual and methodological insights with the potential to advance anthropological accounts of the grid's mediating role in the production of power relations and political subjectivities (e.g., Baptista 2015, 2018; Braier 2020; Harrison 2013, 2016). Including these works in our review helps to clarify how a deeper engagement with spatiality might sharpen anthropological accounts of energy.

Like energy geographies, the anthropology of energy has expanded dramatically since the start of the twenty-first century. This efflorescence builds on several earlier waves of interest in energy in anthropology, starting with Leslie White (1943) who theorized the relationship

between energy and culture, and Laura Nader (1981) who explored questions of power through the study of energy experts from the late 1970s onward. Anthropological engagement with the topic of energy accelerated in the 2010s, as demonstrated by a series of special issues or sections on the topic in disciplinary journals including *Cultural Anthropology* (2015), *Economic Anthropology* (2016), and the *Journal of the Royal Anthropological Institute* (2019), which emerged alongside a profusion of stand-alone articles, monographs (e.g., Adunbi 2015; Appel 2019; Barry 2013; Boyer 2019; Coleman 2017; Howe 2019; D. Hughes 2017; Kale 2014; Kikon 2019; Powell 2018; Rogers 2016) and edited volumes (e.g., Kumar et al. 2021; Loloum et al. 2021; Nader 2010; Strauss et al. 2013) addressing energy-related topics. Through such work, anthropologists have argued that understanding energy is central to understanding neoliberalism (Sawyer 2004), modern forms of power and power relations (Boyer 2014), the creation of ethical worlds (High and Smith 2019), and development in the Global South (Cross 2019), among other topics.

While far from a universal focus, electricity as an energy service and the electric grid in particular have gotten considerable attention within this body of scholarship. This focus has largely been grounded in anthropologists' recognition of the grid's imbrication with political and economic formations and state power. As a promised infrastructure linked with imaginaries of modernity, the grid has been approached as a terrain for considering collective responsibility and the relationship between individuals, communities, and the state (Anand et al. 2018; Boyer 2015; Chatterjee 2020). As Dominic Boyer puts it: "Grid helps to groove political efficacy, subjectivity, and affiliation; it is not just a state instrument, in other words, a tool invented to accomplish a governmental agenda. Rather, grid must be understood as the organization of enabling power that allows any invention of statecraft to occur in the first place" (Boyer 2015: 533). Aligned with other writings from the discipline's so-called infrastructural turn of the 2010s (Anand 2017; Larkin 2013; Von Schnitzler 2016), many have emphasized the symbolic and communicative dimensions and state-connective functions of electricity infrastructures, particularly in the Global South (Badami 2021; Cross 2019; Mains 2012; Phillips 2022) and in the Indigenous geographies of the Global North (Curley 2019; Manning 2018; Powell 2015, 2018).

Our reading and fieldwork suggest that this rich and growing literature can be productively extended through a deeper engagement with the grid itself and its role in shaping arrangements and relations of risk and vulnerability. As an assemblage of energy infrastructures embedded in the landscape, the grid both reflects spatial inequalities (and peripheries) and helps to create them. As a networked infrastructure mediating connection to resources physically, financially, and institutionally, the grid shapes access to energy service and a range of electricity-dependent resources. And as we detail below, as failing or dangerous infrastructure, the grid directly structures the spatial distribution of fire risk, creating the potential for fires and exacerbating local smoke exposure and other hazards when parts of it are de-energized. By looking critically at the grid, we heed anthropologist Joanne Nucho's call to remember that "[t]he grid is not an innocent infrastructure, and the grid never did what was promised or purported, at least not for everyone" (Nucho 2022: 285).

The Grid amid Incendiary Risks in California

Following geographer Gregory Simon (2017), we understand the California landscape as incendiary rather than flammable, its blazes produced through long-term processes of Native dispossession and capitalist accumulation, in addition to the state's more-discussed biogeographical conditions. Grounded in a case study of the 1991 Oakland Tunnel Fire, Simon's political ecology

of fire helps to clarify the historically contingent, socially constructed nature of fire-related hazards within the California landscape. His call to expand the ontology of vulnerability, thinking of it as a dynamic process and not a static condition of households, communities, and regions, is also salient when considering how the electrical grid itself mediates risk, which we explore in the section below. Here we offer a brief summary of how the grid interfaces with fire in California's landscape.

The electricity grid can be productively approached as part of the bundle of supposedly universally accessible networked infrastructures that service spaces understood to conform with the "modern infrastructural ideal" that dominated urban imaginaries from the late nineteenth century onward (Graham and Marvin 2001). Over the years, scholars from a range of disciplines have elaborated the new social norms, bodily practices, and expectations of the public space and the state that emerged in tandem with these provision networks (Gandy 1999; T. Hughes [1983] 1993; Kaika and Swyngedouw 2000; Nye 1990). As Stephen Graham and Simon Marvin (2001) demonstrate, despite an early efflorescence in private provision, for much of the first half of the twentieth century this "ideal" was widely understood to be one achieved and maintained by public entities. While initially associated with urbanized areas, over time, expectations for the realization of this networked paradigm extended ever-further into the countryside.

In the context of electricity provision in the United States, electricity began as a luxury good for urban consumption that, during the post–World War II era, came to be understood as an assumed universal element of domestic life (Bakke 2016). Though privately held utilities played a substantive role in some contexts (Hirsh 2018), during the first half of the twentieth century, much of the realization of such rural encroachment of the grid was government driven, accelerated by New Deal policies, and frequently connected to publicly funded programs of dam development (Bauer 2020; Spinak 2020). Driven in part by the systematic creation of markets for electricity over the past fifty years (Özden-Schilling 2021), today investor-owned utilities and other private companies play a significant role in electricity provision, pricing, and distribution across the nation.

These national patterns largely held within California, which has long been serviced by a mix of publicly and privately held utilities (T. Hughes [1983] 1993; J. Williams 1997). In the early decades of the twentieth century, big, public water projects sited in rural areas—such as the Los Angeles Aqueduct and the Hoover Dam—often provided the electricity necessary to power the streetlights that signaled California and other Western cities' status as properly modern spaces (Needham 2014; Piper 2006). Rural electrification projects followed, but their development was uneven, shaped by proximity to hydroelectric production sites along the Sierra Nevada and the lopsided distribution of wealth across the countryside (J. Williams 1997). As in many other areas of the United States (Needham 2013; Powell 2015, 2018), Native reservations within California were frequently excluded from state and federally funded programs of grid expansion (Sandoval 2018). Following legal scholar Catherine Sandoval's argument, such exclusions from networked energy can be read as forms of energy injustice, since "energy access is a predicate to energy justice" (2018: 166; see also Nadesan and Pasqualetti 2016; Sovacool and Dworkin 2014).

This uneven pattern of grid development was established in the context of a fire-prone landscape. In California, fire risk is best approached as a condition dynamically produced by multiple factors that interact with and amplify each other, risks with biogeographical, technical, and political dimensions that are exacerbated by climate change. While much of the state's land can be characterized as fire dependent or fire adapted, decades of fire suppression and exclusion have led to an accumulation of flammable materials in the landscape (Pyne 2016). These prohibitions are a direct result of the criminalization of Indigenous land management practices (since the year 1850), which include using fire as a tool for a variety of socio-ecological purposes (Tripp

2020). California has been and remains an important battleground for the debate between fire suppression (like a city's fire service extinguishing fires in the landscape) and fire restoration, propelled, in part, by back-to-the-land movements that imagined a nature untouched by human activities (Pyne 2016) and efforts by Tribes to put controlled fire back on the land as part of a larger set of actions related to reclaiming sovereignty (Adlam et al. 2022; Tripp 2020).

Always variable, the characteristic swings of California's hydrological regime are being intensified by climate change, increasing wildfire risks during the extended drought periods (Mann and Gleick 2015). These recurrent stretches of aridity have been correlated with a growth in fire extent within the state. Since 1972, the state has seen a fivefold increase annually in the area burned by fires (A. Williams et al. 2019). Analyses have shown that the number of autumn days with extreme fire weather has more than doubled since the 1980s (Goss et al. 2020).

In addition to burned acreage and loss of life, catastrophic wildfires produce exposure to high levels of air pollution causing harm to public health. In recent years, parts of Northern California have seen spikes in air pollution associated with wildfire events, leading to sometimes having the worst air quality in the world (Mull 2018). Modeling analysis of the Humboldt region of Northern California has shown that status quo wildfire smoke risk is the highest in the continental United States (based on typical burning and smoke exposure) (Ford et al. 2018). The health impacts of the exposure to wildfire smoke over several seasons are still being studied, but it is already known that even short-term exposures can cause acute and chronic respiratory and cardiovascular effects, including premature mortality (USEPA 2022).

Risky Infrastructures: Exclusions, Unreliability, and the Uneven Politics of the Grid

Even in wealthy, well-resourced contexts commonly associated with the idealized version of universal access to networked infrastructures (like California), gaps and limits to access endure. Anthropologists and geographers of the electricity grid have been attentive to such limitations, foregrounding the persistent forms of exclusion and unreliability characteristic of these sociotechnical systems. Reading across these works, an individual's ability to access electricity flows via the grid at a particular place and time emerges as a highly contingent achievement, mediated by institutions, infrastructures, policies, climatic events, and local practices, and shaped by structural and spatial patterns of social difference.

The variability of local environments can play a powerful role in disrupting the capacity to produce electricity for and distribute it within the grid. Events like fires, hurricanes, cyclones, tornadoes, blizzards, ice storms, droughts, and earthquakes can all lead to outages. However, as the literature demonstrates, while so-called natural disasters (slow or fast) may be the proximate cause of such shutdowns, these events are best read within longer trajectories of grid development and management (Mains 2012; Nucho 2022; Yang et al. 2018). Accounts of protracted power outages across Puerto Rico following the 2017 landfall of Hurricane Maria emphasize the years-long patterns of underinvestment in and deferred maintenance of the island's grid that left it so extraordinarily vulnerable to the storm's impacts (Bonilla 2020; Llorens 2018; Smith-Nonini 2020). The contrast between the recovery trajectory of Puerto Rico's grid following Hurricane Maria and the far faster restoration of service in Houston after Hurricane Harvey's impact the same autumn underlines this point. As such, grid outages associated with "natural" disasters are best approached alongside those caused by human conflict (Nucho 2016) or more quotidian system mismanagement (Phillips 2022), deeply structured by people's decision-making.

In many contexts—and, indeed, many that suffer from frequent grid outages—electricity access is also constrained by limits to the spatial reach of the grid. In rich and poor countries alike, a subset of homes, businesses, settlements, villages, and reservations remain disconnected from networked electricity transmission infrastructures. Such exclusions frequently map onto other forms of social, economic, and spatial marginalization. Geographer Conor Harrison's (2016) study of the survey data used to guide the prioritization of target areas for grid expansion in rural North Carolina under the New Deal era's Rural Electrification Agency provides a stark example of how white supremacy can shape such processes. Under the rules of the survey, Black households were deprioritized for grid access by an explicitly race-based algorithm, highlighting the structuring role of anti-Black racism in the development of infrastructure in the United States. Harrison's careful methodology, cross-referencing survey data and guides and maps, enables a grounded, particular rendering of how such spatial differentiation via the grid comes to be, in specific locales. The exclusion of American Indian reservations—including, ironically, many mined by settler companies to provide fossil fuels to power the grid—from universal electric connections should be also be read as the intentional production of race-based spatial differentiation in the US context (Needham 2014; Sandoval 2018). In other settings, scholars have demonstrated how the uneven process of electricity service extension mediates state-society relationships and can serve to reinforce state power by keeping communities engaged in state processes within remote areas (Phillips 2022; Power and Krishner 2019; van den Bold 2021). In some instances, this form of inequity leads the grid to become a straightforward object of state-directed politics, as communities mobilize to demand the extension of electricity service to their areas (Braier 2020; Cao and Frigo 2021).

Sometimes grid-related inequities emerge in unexpected ways. Gökçe Günel (2021) sheds light on new vulnerabilities produced by what are ostensibly grid improvements from an energy security and decarbonization viewpoint. Günel draws on research in Ghana to show how efforts to make the grid more dependable resulted in making electricity more expensive for everybody relying on the network. The unreliability of the national grid led wealthy Ghanaian customers to install solar panels on their properties to protect themselves from fluctuating electricity access. In Günel's analysis, far from providing energy access to hitherto underserved populations, rooftop solar is a "status symbol, like owning a luxury car" (2021: 167). Second, to solve the problem of intermittent power, the Electricity Company of Ghana signed multiple power purchase agreements in a desperate attempt to quickly solve the electricity crisis. This led to a much larger installed power generation capacity (compared to peak demand in Ghana), which made the Electricity Company of Ghana increase rates. Thus, efforts by individuals and the Electricity Company to improve electricity access (whether by installing solar panels on an individual scale or creating more power generation capacity at the utility scale) lead to increased electricity rates for everyone else (the not-so-wealthy) who need to remain on the grid. Here Günel joins other anthropologists (Boyer 2019; Howe 2019) in critically analyzing the ways expansion of the grid capacity and renewable energy technologies might give rise (or not) to positive social change and upend entrenched hierarchies (see also Ahmann 2019; Alonso Serna 2022; Baker 2021; Desbiens 2004; Kelly and Negroni 2021; Lennon 2017; Rignall 2016).

Across the anthropology of energy and energy geographies, the ability to access electricity via the grid is generally treated as desirable, a condition eminently worth fighting (or cheating) for, given the need for electricity embedded in so many contemporary technologies and daily practices. Sometimes, access to electricity is linked with direct economic development and social gains, but there are many other divergent, even unanticipated (and not necessarily desired) impacts that electricity connections can create for households and communities (Badami 2021; Bose 1993; Jacobson 2007; Winther 2008; Winther and Wilhite 2015). In many contexts, the

inability to connect with the grid is approached as a matter of (in)justice (see especially Braier 2020; Cao and Frigo 2021; Sandoval 2018). However, the scholarship also shows that the grid (as imagined and materialized today) can bring several forms of localized risk in addition to the valued connection.

Near the end of *Landscapes of Power* (2018), Dana Powell describes the homes of her Diné interlocutors Angie and Adella. Located on remote summer camp land in the woods, neither dwelling was connected to the grid. While both women had previously lived in one of the reservation's grid-linked Navajo Housing Authority's developments, both had chosen to decamp for more remote, less connected homes. Though Adella also maintained a fully serviced apartment in a nearby town, she valued her house in the woods, inconsistently powered by rooftop solar panels, as a site of independence from those networked infrastructures. Here, the choice to live off grid (at least part of the time) is presented as one grounded in a desire to avoid certain entanglements. Powell foregrounds the economic register of this freedom, noting that power lines convey more than just electricity: "They also deliver economic expense, creating a constraint for families" (2018: 234).

Such economic burdens are also foregrounded in accounts of urban dwellers who seek out cheaper, illegal access to the grid or contest excessive costs of legally obtained electric service, which emphasize the untenable financial stresses that official access to the network can entail (Degani 2013, 2017; Luke 2021). Setting up a formal account with a utility might bring light (for a time), but it can also carry the promise of a long-term debt relation with that entity (Baptista 2015, 2018). The pursuit of unauthorized connections can bring its own sorts of financial dangers and benefits. Akhil Gupta (2015) demonstrates this in the context of informal settlements in Indian cities, where formal electricity connections function as a mechanism to convert unauthorized homes into legal tenure of contested urban land. Power companies refuse to allow grid connections in such communities, but tacitly allow residents to tap into power lines without formal connections. While these informal connections to the grid are not metered in the way formal connections are, customers end up paying for the electricity through bribes to politicians, police, and bureaucrats to keep the electricity flowing (Gupta 2015). As such examples show, tapping into the grid—whether formally or not—creates new forms of connection and obligation (see also Naqvi 2018).

Notably, for many marginalized communities, direct engagements with the state can also carry severe risks, complicating efforts to access electricity via the grid. For instance, for immigrant Latinx communities in Texas who experience a spectrum of legality and documentation, making demands on the state exposes them to the risk of increased visibility and scrutiny from the state, which can lead to deportation. This is well illustrated in Michal Braier's work (2020) on collective action for public lighting in the spatial thresholds of *colonias*, underserviced and unincorporated areas at the peri urban fringes of cities in Texas near the United States–Mexico border. Braier describes how county officials initially responded to demands for lighting by piloting solar lanterns (decentralized energy infrastructures) that did not necessitate a connection to the city's electrical grid. As the campaign for lighting progressed, residents of *colonias* began to see the solar lantern as a metaphor for political isolation and invisibility, and access to the grid infrastructure as being symbolic of political belonging, something worth fighting for despite its attendant risks.

For Indigenous communities, infrastructurally mediated state entanglements have a well-established destructive legacy. As Powell's (2015, 2018) accounts of the diverse forms of energy development in Navajo Nation attests, it can be fruitful to consider the electric grid in the context of broader programs of energy development enacted on Indigenous lands. Anthropologists, geographers, and Indigenous studies scholars have provided wide-ranging accounts of the envi-

ronmental, economic, and cultural destruction wrought by the state-led development of large-scale energy infrastructures within Indigenous homelands, particularly oil and gas pipelines and hydropower dams (e.g., Baviskar 1995; Estes 2019; Spice 2018). Among the most exciting developments in this vein of scholarship on energy are the intellectual connections and political solidarities being forged across Indigenous contexts in the Global North and South to imagine decolonial futures (see, for example, Gergan and Curley 2023). In the context of California, the state's infrastructural incursions into Native lands have caused severe disruptions to Indigenous life-worlds, including the destruction of sacred sites via inundation by megadams. As Beth Rose Middleton Manning (2018) has shown in her study of hydropower on California's Powder River, the institutionalized exclusion of Indigenous peoples from environmental decision-making processes, including those related to conservation (such as the creation of national parks) or development (such as the State Water Project) is predicated on a selective amnesia of Indigenous rights to the land.

Cognizant of these risks, many Indigenous communities have fiercely resisted the establishment of energy infrastructures on their homelands, interpreting them as technologies that reinscribe and deepen the settler colonial process on the landscape (Kinder 2021; Spice 2018). But a story of universal uncomplicated resistance by Indigenous communities to new energy projects because of the risks posed by them is simplistic. There are instances of partial or patchy strategic alignment to ensure that the benefits of energy infrastructures also flow to Indigenous communities who often bear the brunt of the negative consequences. For example, Suzana Sawyer (2004) has complicated such universalizing narratives of Indigenous responses to the coming of a big bad oil company to town, through a case study of Chevron/Texaco's efforts to acquire land and extract crude oil in Ecuador. Sawyer describes the deep contestations between Indigenous groups who want to resist the oil company and those who want to work with the company to make claims on them. And Powell's account of contested energy development on Navajo Nation lands contends that energy development there is best approached as "a forum for politics, including negotiations over indigeneity, sovereignty and the place of social movements in affecting tribal and federal environmental policy and public culture" (Powell 2018: 4). Furthermore, she argues that conventional binaries of "cultural adaptation *or* resistance" (emphasis original) are inadequate to explain contemporary energy politics in the Navajo Nation. Instead, Powell suggests we view the complicated relationship of various Navajo members to energy in the context of both long-standing critiques of colonialism and concerns over sustainability.

Case Study: Emergent Forms of Energy Sovereignty in Humboldt County

We now turn to a case study based on collaborative research conducted by one of the authors, to illustrate how these debates are actively unfolding in the context of a region characterized by high (and growing) fire risk. This case study was informed by a larger collaborative project called Smoke, Air, Fire, Energy (SAFE) in Rural California co-led by faculty in engineering and the critical social sciences at Cal Poly Humboldt, the Schatz Energy Research Center, the Karuk Tribe, and Blue Lake Rancheria Tribe, funded by the Strategic Growth Council of California.

On 8 October 2019, much of Humboldt County, California, went dark. With only a few hours of notice, Pacific Gas & Electric (PG&E) elected to de-energize the two main transmission lines into Humboldt. This shutoff was part of a Public Safety Power Shutoff (PSPS) that affected 738,000 customers across 35 counties, powering down a large area of the state for several days. PSPS events are driven by a concern that gusty wind conditions, dry weather, plenty of flam-

mable materials in the landscape, and energized and aging power lines crisscrossing California create a perfect constellation of factors for uncontrollable wildfires.

In Humboldt's coastal towns, batteries, matchsticks, candles, and flashlights ran quickly out of stock in the local supermarkets. When the sun set, a few lucky residents were able to use wood fires, gas boilers, and gas stoves to keep their homes warm and light. But most people were plunged into chilly darkness as the nighttime temperatures dipped close to freezing. To soften the blow, local governments set up charging centers powered by diesel generators where people could connect to the internet and charge their devices. Cal Poly Humboldt, the local state university, did the same. But for some, these makeshift arrangements could not meet their urgent needs. Residents with medical or mobility needs for electricity had to scramble and make alternate arrangements on short notice. Some drove north, seeking hotel rooms in towns connected to a different electrical utility, while others headed south, assuming major metropolitan areas near the Bay Area would be prioritized for returning power.

Responding to the dayslong disruption, one particularly disgruntled county resident took to the comments section of the local newspaper to compare California to a "Third World Country" in the light of PSPS events, drawing a straight line from what makes a country "First World": the expectation that electricity access from the grid is continuous, ever present, and unremarkable. But as we have discussed, the ideal of the continuous and uninterrupted grid has never been a reality for everyone in California. An hour's drive inland from the coast, where many Native residents from the Hoopa and Karuk Tribes live alongside rural settlers, residents took this PSPS in stride. Protracted power outages were nothing new for these communities. This time was unusual only because everyone else connected to the network also lacked energy access.

Power shutoffs both announced and unannounced are a frequent occurrence across the inland Humboldt region. Residents of the Karuk ancestral territories have dealt with frequent outages over the years, and in some areas have lacked steady electricity access during many snowy winter holidays. Due to these persistent gaps in service from the grid, many Native and settler families inhabiting inland sections of Humboldt rely on generators, propane gas tanks, and wood stoves to keep their lives powered, bolstering the state's unreliable energy infrastructure with personal additions. Put differently: their experience of the region's grid is one of a tenuous, unreliable network.

The Northern California grid power down of October 2019 was the first of several such shutoffs over PG&E's service area over the next two years, driven by the utility's assessment of heightened fire risks. During the same period, the established patterns of rural shutdowns have become even more frequent, due to concerns about exceptional fire danger in these areas. However, as we describe above, flames are not the only hazardous element of a fire. Driven by the combustion of forests and homes, Northern California has seen extreme air pollution levels in recent years, conditions that have been especially concentrated in rural inland areas. An increasing number of Tribal residents rely on masks and air filters to protect themselves from dangerous smoke levels when, despite grid shutdowns and other precautions, the region burns. Unfortunately, power shutoffs often coincide with the time that air filters are needed the most: when conditions are ripe for uncontrollable wildfires. The electric grid clearly mediates risks associated not only with fire, but also with smoke, cold, darkness, water supply, telecommunications and internet, and the general capacity to access the power necessary for most household devices (including medically essential ones). As this case study attests, here it serves to concentrate a wide range of hazards within vulnerable communities.

Energy infrastructures, when conceptualized in certain ways, can be foundational to Tribal sovereignty. The Karuk Tribe has identified critical infrastructure in the form of the electric grid, roads, water systems, phones, and internet as being "essential for asserting tribal manage-

ment authority and highly relevant for tribal sovereignty" (Karuk Tribe 2019: 161). The Tribe's climate adaptation plan clearly articulates the issues related to the expansion of state infrastructure in the context of climate change (Karuk Tribe 2019). Karuk communities have historically not been prioritized by state or federal entities for infrastructure expansion and maintenance including roads, power lines, and communications infrastructures, so calling attention to their uneven provision has been a central aspect of recent advocacy. The inequalities in historic infrastructure development currently make it difficult for Karuk communities to reliably connect to the grid, power their air filters during high smoke events, and access information about ongoing wildfire events to keep themselves safe.

Expansion of energy infrastructure to strengthen climate resilience of Karuk communities might involve setting up new electrical grids separate from the utility grid that currently exists, or expanding the current grid in certain ways. As we have shown, there is no "natural" outcome of energy infrastructure expansion; setting up of new energy infrastructures could be carried out in a manner that either undermines or enhances Tribal sovereignty. Karuk communities assert that in order to not reinscribe injustices it is important to recognize Tribal sovereignty as a cornerstone of climate resilience in the present moment and to plan energy infrastructure accordingly. As such, the Tribe's adaptation plan describes the threats to jurisdictional recognition and sovereignty that are put at increased risk due to climate change. As a sovereign government and as per the Karuk constitution, the Karuk Tribe claims jurisdiction over its membership, lands, water, air, including its right to practice landscape management using fire as a tool in line with expertise held by the Tribe. Prescribed fire on the landscape enhances Tribal sovereignty by not only reducing the flammable fuels, but also enhancing the quality of culturally relevant materials for traditional foods and basketry. Up to three-quarters of culturally important species for the Karuk Tribe are enhanced by fires (Norgaard 2014). As wildfire season expands in its duration (number of fire days) and area, the ability of the Karuk Tribe to practice intentional fires to enhance cultural resources are curtailed.

The political project of expanding energy infrastructure or creating new forms of infrastructures can advance progressive goals, upending historic inequalities, or serve to further stockpile power in the hands of the already elite (as discussed earlier in the case of the solar islands of wealthy Ghanaians). Here it is instructive to discuss the example of a solar microgrid doing the former in rural Northern California. The microgrid is owned and operated by the Blue Lake Rancheria, a federally recognized Native American Tribe about 300 miles north of the San Francisco Bay Area. In contrast to the rest of the county, which went dark during the October 2019 PSPS, this localized electricity generation infrastructure provided emergency energy services to local communities, serving as a lifesaving refuge for those with urgent medical needs. The local Department of Public Health estimates that four lives were saved in the region because of their operational microgrid during the shutdown caused by wildfire risk. This small-scale electricity network also kept the local newspaper running and powered the only functioning gas station in the region during the shutoff period.

Driven by a deep desire to contribute to climate resilience in the region, and shaped by the experience of being an institution that local residents turned to for help in the case of an emergency in 2011 (tsunami warnings caused by the Tohoku earthquake, which caused the Fukushima Daichii nuclear disaster), the Blue Lake Rancheria Tribe decided to implement microgrids to advance the twin goals of decarbonizing the grid and providing emergency power in the time of shutoffs.[1]

Jana Ganion, the sustainability director with the Blue Lake Rancheria Tribe described their motivations as "being resilient in that place, and also for that place."[2] Since many Tribal nations face tenuous power access as it is, and several are spatially located at the peripheries of the

utility-run electric grid, they are more vulnerable to power shutoffs and variable quality electricity access. There is increasing recognition in California that microgrids developed for and owned by Tribal governments may be part of increasing efforts to strengthen climate resilience and Tribal sovereignty.

The October 2019 PSPS event created a rupture in the ideal of the reliable grid for a larger-than-usual swathe of the region's population. Between September 2017 and December 2020, data from the California Public Utilities Commission (CPUC) estimates that 3.2 million customers (households) lost power due to PSPSs (Wong et al. 2022). As our research suggests, these events are extending the periodic exclusions from access that have long characterized the state's grid, a shift with particularly significant stakes for residents of remote, fire-prone areas of inland California. PG&E's Northern California grid shutdowns suggest the complex relations between environmental risks and network unreliability. While the proximate cause of the PSPS was the weather event that created conditions ripe for wildfires, these conditions were risky only because of the specific way the grid infrastructure wove its network through the landscape with overhead lines, and because decades of fire suppression had left a high volume of flammable fuels in the landscape. Layered on top of these factors was the recent history of the utility being held legally responsible for fires caused by its infrastructure (Blunt 2022).

In this article we attend carefully not only to the risks as described in earlier sections but also to a related and growing interest—articulated by interlocutors from Tribal communities and documented in other contexts within California (Nucho 2022)—in the pursuit of new electricity provision arrangements beyond the centralized grid. This focus allows us to consider the growing range of relations that more distributed electricity infrastructures serve to produce and mediate, an area that recent anthropological scholarship has begun to explore (Günel 2021; Cross and Neumark 2021). In the following section, we turn to these alternative configurations and their potential for engendering more just energy futures.

Leaving the Big Grid

As our case study attests, in recent years the connections between energy access and fire risk within California have become increasingly visible and fraught, particularly when the utility that owns and operates the grid chooses to manage fire risk by shutting down the grid. These contentious decisions by electric utilities play out in the context of dynamic efforts by Tribal governments to improve energy access, strengthen climate resilience, and increase political sovereignty for Tribes. In many cases, pursuing these aims leads Tribal governments to create new energy infrastructures to better serve their communities.

We have described how questions of access and risk are socially and infrastructurally mediated and historically and politically constructed. In this section, we analyze alternative arrangements and other relationships to the grid. These arrangements do not necessarily have a pre-defined or progressive social impact. In some cases, decentralized energy systems can reproduce or exacerbate inequalities, while in other cases, especially when careful attention has been paid to questions of ownership and operation, these systems can align with more power and sovereignty for marginalized groups. We look at electricity access that is not a connection to the traditional grid, ways in which people leave the traditional grid, or attempt to become less reliant on it while still connected to it. These arrangements are sometimes categorized as "off-grid" or "microgrid" energy and include in various contexts small portable lighting devices and charging devices for mobile phones, home-level solar power systems, or community level microgrids that power several hundred homes at once. Discourse of development in the Global

South, sustainable energy for all, or discourse around energy transitions for climate change mitigation tempt us to think of decentralized energy solutions and renewable energy solutions in glowing terms. We argue that rather than being *a priori* desirable or damaging technical assemblages, such alternative energy infrastructures are, just like the traditional grid itself, better understood within their socio-political contexts and the practices that bring them into being and sustain them.

The work of Jamie Cross and Tom Neumark (2021) provides an example of small-scale renewable energy systems being unhelpful to the most marginalized groups. Drawing on ethnographic fieldwork conducted across East Africa's off grid solar industry, Cross and Neumark (2021) ask what off-grid energy companies do, to what ends, and for what motives. They describe how national governments in East Africa focused on building utility-scale regional electric grids, while smaller electrical infrastructures (home or community scale) were installed and operated as "developmental gifts" by non-governmental organizations, often from the Global North.[3] Focusing on the latter, Cross and Neumark argue that the physical infrastructures of solar power depend on "invisible social, financial, social and power relations" (2021: 921). Analyzing the ethical dimensions of enforcing payments in situations where customers could not afford to or were unwilling to pay for a variety of reasons, and where seizing the installed infrastructures provided little financial benefit to the companies, the authors argue that off-grid energy infrastructures in East Africa contribute to the production of specific kinds of financial subjects, exposing low income families to new forms of financial and social discipline.[4] The authors describe the process of "repossession"—taking back the gift of electricity—unplugging customers by literally ripping out wires from electrical devices in the home when they were unable or unwilling to keep up with payments.

Such practices highlight the similarities in problems of access between these smaller, more local forms of infrastructures and the larger grids, as described in the previous sections, underlining the point that social vulnerabilities are not automatically addressed simply by changing the size or scale of the grid. Cross and Neumark argue that loan officers who go around repossessing solar systems for non-payment treat impoverished customers as rational economic actors (also see Özden-Schilling 2016, 2019), whereas a more grounded approach would view of unpaid debts as the result of complex obligations and social relationships. The authors also argue that the term "reliability" in the context of microgrids in rural Tanzania entails more than the consistent flow of electrons to homes (which is the UN definition): it is about "whether energy systems can be depended upon to produce long-term socioeconomic outcomes at a community and national scale" (Cross and Neumark 2021: 917). In other words, the notion of reliability in this context is understood by users as connected to questions of whether the energy system will advance developmental aims. This definition of reliability is grounded in the longer history of governmental modernization efforts in postcolonial East Africa to provide electricity as a public good, for the welfare and economic and social development of the rural poor.

While Cross and Neumark (2021) demonstrate how small-scale solar systems can reinscribe inequalities by imagining communities of electricity consumers that are fiscally responsible in specific ways, Ankit Kumar and Gerald Taylor Aiken (2021) show how different forms of communities may accrete around energy projects. Drawing on case studies in Scotland and Bihar and analyzing them through the lens of postcolonial studies, Kumar and Aiken describe community in this context as "fluid bonds of solidarity," always emergent, that align and realign around different purposes. On the other end of the spectrum is the case described below, where it seems like the idea of community is forsaken at the altar of individual resilience.

Reliability in the context of California is about whether there will be electricity at home when large sections of the grid need to be de-energized during PSPS events. Motivated by a desire to

buffer themselves from the ups and downs of being connected with the grid, and therefore being exposed to the vulnerabilities of losing power during PSPSs as described above, Nucho (2022) examines how wealthy Californians create home-scale energy islands by purchasing solar panels and lithium-ion battery arrays. In addition to improving energy resilience at the household level and buffering households against the risk of losing power during wildfire events, these installations are understood to increase the value of a home and channel wealth from everyone on the grid (which is a wider socioeconomic swath of society) to the relatively wealthy few who can install solar panels at home. This is for two reasons: first, when solar panels are subsidized by the utility, they are effectively being paid for by everyone who pays their electric bills, and second, by retreating from the grid and paying less to the utility, wealthier customers put less and less money into the collective pot for future infrastructure improvements. Nucho draws a comparison with her research in urban Lebanon, where the long-standing experience of an unreliable electric grid has led to most residents relying on diesel-powered microgrids. In thinking about ways in which patchwork solutions commonly associated with the Global South, which were hitherto seen as a sign of a failure of the state to provide modern infrastructural access to everyone, and are revived in wealthy states like California, Nucho foregrounds the experience of many people around the world, in different contexts, where there is a turn away from expecting infrastructure to be a public good toward a "post-grid imaginary." Nucho argues that grids do more than physically transport electricity (although they certainly do that); they also "shape an understanding of oneself in relation to others" (Nucho 2022: 269). In turning to a post-grid imaginary in the way Nucho articulates it, people become less accountable to each other, undermining prospects for reciprocity or redistribution: "That call to be responsible not only for oneself but also for unknown others connected through shared infrastructure is part of what is at stake when the grid imaginary is replaced by something else" (Nucho 2022: 271).

Nucho highlights the political and social imaginaries in which microgrids appear as feasible and desirable solutions to the current constellation of energy infrastructure challenges. Having an interconnected and large-scale grid that covered everybody has long been understood as the idealized infrastructural arrangement, a hallmark of modernity. Here Nucho also draws on the work of Canay Özden-Schilling, who traces the shift from treating a customer on the grid as a citizen with access to a public good, to a consumer, a self-interested individual navigating the electricity market in the context of deregulation and private ownership of electricity infrastructure (Özden-Schilling 2016, 2021). Nucho reminds us that "creating a microgrid is a political project" (2022: 272). As discussed earlier, the political project of developing a microgrid can serve to upend historic inequalities and strengthen Tribal sovereignty, or to retrench power in the hands of an established elite.

Conclusion: Contextualizing Alternative Electricity Infrastructures

From the vantage of Northern California, we have used the example of fire to develop an account of the electricity grid's role in mediating differentiated experiences of risk and hazard. As the case of the October 2019 PSPS demonstrates, in this context a functioning grid can exacerbate fire risks, while a powered down grid during wildfires can intensify localized environmental hazards of smoke exposure from the fires. And as the experiences of the Karuk and Blue Lake Rancheria Tribes help to clarify, the contemporary distribution of such dangers is grounded in more than a century of exclusionary development based on settler colonial dispossession, an ongoing process that has made the Golden State an ever-more incendiary landscape.

While we have addressed the particularities of Northern California, we have done so to illuminate the grid's more general role in mediating the experience of environmental hazards—and the connections between those forms of risk and a broader category of dangers that can be grounded in these networks. As recent years have demonstrated, the grid shapes acute and long-term effects of hurricanes, floods, and freezes on communities, often in ways that reinscribe established social inequalities. Given the likelihood that such events will recur with ever-greater frequency in a wide range of contexts throughout the decades ahead, we aim to direct scholars' attention to the role of networked infrastructures in structuring differentiated experiences of such hazards.

We also hope to incite further scholarly attention to alternative electricity provision arrangements. Through our review of the literature, we have explored how conditions of both access to and exclusion from a centralized grid can entail a range of risks for individuals and communities. But we have also sought to highlight a small-but-growing engagement with the pursuit of electricity access beyond-the-big-grid, with an eye to the potential of these arrangements to reshape power relations and political formations—in addition to the experience of fire, smoke, and other hazards.

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NOTES

1. The Blue Lake Rancheria Tribe was one of 16 communities recognized by the Obama White House for climate leadership. "FACT SHEET: 16 U.S. Communities Recognized as Climate Action Champions for Leadership on Climate Change." *The White House: President Barack Obama*, 3 De0 cember 2014. https://obamawhitehouse.archives.gov/the-press-office/2014/12/03/fact-sheet-16-us-communities-recognized-climate-action-champions-leaders.
2. Interview with Jana Ganion on 21 October 2022 in California in the context of the SAFE project.
3. In Kenya, however, for over two decades there has been a flourishing rural market for home solar systems (Jacobson 2007).
4. Here Cross and Neumark draw on the extensive scholarship on microfinance which has documented this. See, for example, Elyachar (2005).

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