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Movements shaping climate futures: A systematic mapping of protests against fossil fuel and low-carbon energy projects

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Abstract

In this article we undertake a systematic mapping of 649 cases of resistance movements to both fossil fuel (FF) and low carbon energy (LCE) projects, providing the most comprehensive overview of such place-based energy-related mobilizations to date. We find that (1) Place-based resistance movements are succeeding in curbing both fossil-fuel and low-carbon energy projects. Over a quarter of projects encountering social resistance have been cancelled, suspended or delayed. (2) The evidence highlights that low carbon, renewable energy and mitigation projects are as conflictive as FF projects, and that both disproportionately impact vulnerable groups such as rural communities and Indigenous peoples. Amongst LCE projects, hydropower was found to have the highest number of conflicts with concerns over social and environmental damages. (3) Repression and violence against protesters and land defenders was rife in almost all activities, with 10% of all cases analysed involving assassination of activists. Violence was particularly common in relation to hydropower, biomass, pipelines and coal extraction. Wind, solar and other renewables were the least conflictive and entailed lower levels of repression than other projects. The results caution that decarbonization of the economy is by no means inherently environmentally innocuous or socially inclusive. We find that conflicts and collective action are driven by multiple concerns through which community mobilization seeks to reshape the energy regime and its impacts. These include claims for localization, democratic participation, shorter energy chains, anti-racism, climate-justice-focused governance, and Indigenous leadership. Climate and energy policymakers need to pay closer attention to the demands and preferences of these collective movements pointing to transformative pathways to decarbonization.

1. Introduction

The most ambitious 1.5 °C goal for responding to climate change calls for a rapid phaseout of fossil fuels (FFs) and mass deployment of renewables to supply 70%–85% of electricity by 2050. As the most recent Intergovernmental Panel on Climate Change (IPCC) report acknowledges, this transition will require 'rapid, far-reaching and unprecedented changes in all aspects of society' (IPCC 2018) leading to distributional impacts, trade-offs, and consequent social conflicts over the distribution of costs and benefits amongst populations. The challenge, according to the IPCC, is how to navigate inclusive and socially acceptable pathways towards low carbon futures and which deliberation processes to employ 'to negotiate societal values, well-being, risks and resilience and to determine what is desirable and fair, and to whom.' (IPCC 2018, P22).

To understand and meet these challenges, social scientists have begun to examine in greater detail the social dimensions of pathways towards deep decarbonization (Patterson *et al* 2017; O´Brien 2016). While some of this work focuses on socio-technical

transitions and how they can be managed and accelerated (Kemp *et al* 1998, Geels 2002, de Haan and Rotmans 2011), scholars from the fields of political ecology and environmental justice have examined how the use of contention, the challenging of power interests, and non-institutional forms of political participation (Mcadam 1982) can help spur the disruptive, creative, and systemic-structural socio-energy transformations needed to address climate change (Scoones *et al* 2016, Temper *et al* 2018, Scheidel *et al* 2018).

This work lends increased attention to questions of justice and the fair distribution of social and environmental risks related to the extraction, production and consumption of both FFs and low carbon energy (LCE)[6]. Further, it cautions against the adoption of a post-political and consensual view of climate change (Swyngedouw 2013) and highlights the profoundly political nature of energy transitions, enquiring into issues of power, distribution, access to resources, and winners and losers as energy systems are transformed (Newell and Mulvaney 2013, Barry and Healy 2017).

Actors engaging in disruptive interventions to shape climate futures from the bottom-up (Leach and Scoones 2016) include social movements for climate and energy justice (Sovacool *et al* 2017). These movements emphasize the ethical and human rights dimensions of climate change, disproportionate burdens of energy costs and accessibility, and the impacts of energy extraction, refining, and manufacturing on vulnerable communities. They promote strategies such as divestment (Barry and Healy 2017), anti-FF norms (Green 2018) and leaving oil in the soil (Temper *et al* 2015). Prominent actors within these movements include formal organizations such as 350.org, loose coalitions such as the Fridays for Future student strikes and Extinction Rebellion, as well as a diverse array of place-based mobilizations contesting and stopping FF projects along the entire project life cycle chain, from extraction to processing, transport and combustion. Termed *blockadia* by Klein (2014), these interwoven spaces of resistance include protests and direct action against coal power plants, fracktivists protesting natural gas extraction in their backyards and communities blockading the paths of pipelines (Temper 2019). Recently, these groups have been joined by emergent movements contesting the territorial dispossessions, social disruptions, and large-scale environmental changes triggered by low-carbon energy projects and 'green' investments (Del Bene *et al* 2018, Avila 2018). This includes communities resisting large-scale energy developments (biofuels, solar, wind, hydropower and geothermal facilities), as well as plantation and forestry projects linked to the Clean Development Mechanism (CDM) and Reducing Emissions from Deforestation and Forest Degradation (REDD+) program.

The widely dispersed nature of these place-based movements, their diversity, and the sheer number of conflicts have hindered comprehensive empirical analysis of their characteristics beyond isolated case studies. To date the state of current evidence on the composition, scope and breadth of these movements is still unclear. What energy projects are triggering citizen mobilizations and what concerns are being expressed? How are different groups impacted? What are the outcomes of such mobilizations and how do governments and companies respond to such protests? Are movements successful at stopping and changing damaging unwanted energy projects (and reducing emissions)? And how may they support or hinder a just transition towards deep decarbonization? Until now, no comparative global study on these questions exists. Further, the bulk of the reviewed research on public opposition to renewables, for example, tends to be Northern-based (see Rand and Hoen 2017 for North America and Bruns and Olhurst 2011 for Europe) and little is known about countries in other geographical areas and cultural-social-political contexts.

Furthermore, LCE and FF mobilizations are often studied in isolation, limiting comparative analysis on the social and environmental impacts of different energy projects, social acceptance by communities, and the distributive consequences among them. To address this gap, this paper reviews and analyses 649 cases of resistance movements to FF investments and LCE projects, drawing from a systematic map of the Global Atlas of Environmental Justice database, an online inventory of ecological conflicts based on scholar and activist knowledge (Temper *et al* 2015). The identification and location of these frictions serves to inform policies and governance pathways to achieve more justice, less social conflict, and to minimize exclusion and inequality in low-carbon transitions.

Our findings illustrate how both FF and low-carbon energy projects provoke a large range of local impacts (violation of human rights, social and environmental disruptions), leading to intense social conflicts and community contestation. Both FF and LCE projects disproportionately impact vulnerable groups such as rural communities and Indigenous peoples. Repression and violence against protesters is high in almost all activities we analyse, and particularly in those involving hydropower, biomass, pipelines and coal extraction, with 10% of all cases analysed involving assassination of activists. The evidence shows that place-based movements are contributing to curbing FF production, with a quarter of projects either stopped, delayed or suspended. At the

[6] The link between local opposition to fossil fuel extraction and climate change was first made by social movements from the South before 1997, from Nigeria and Ecuador, with the slogan 'leave oil in the soil' and Oilwatch's proposals in Kyoto for a moratoria on oil exploration in sensitive social and ecological landscapes.

same time, a similar proportion of low carbon projects studied have also been delayed, cancelled or suspended.

The following section explains how greater attention to contentious politics can better inform climate policy and supplement approaches from other social sciences in shaping demand-side solutions. We then introduce our methodology and present results, firstly for eight types of energy projects and then comparative results across the entire sample, focusing on questions related to distribution, impacts and outcomes. In the discussion we delve into the claims of movements for addressing injustices and outline possible policy responses that make space for contestation and antagonistic social processes over energy futures and the meaningful involvement of impacted communities. The results caution that decarbonization of the economy is by no means inherently less environmentally damaging and more socially inclusive than a fossil-fueled status quo. The review of these energy-related movements and conflicts highlights the social and environmental concerns of the FF economy, with guidance on how to transition away from it equitably, as well as those of low-carbon energies, outlining a vision for a just energy transition.

1.1. Supply and demand and place-based resistances

This special issue focuses on demand-side solutions to climate change and seeks to understand how norms, values, preferences and structural factors shape energy demand and GHG emissions (Creutzig *et al* 2018) with a view to informing an upcoming chapter on social aspects of mitigation in the sixth assessment report of the IPCC. This focus on demand from a social science perspective hopes to complement technological supply-side approaches with strategies targeting technology choices, consumption, behaviour, lifestyles, social norms and well-being.

The study of movements contesting energy projects, even though they are often considered 'supply side movements' (Le Billon and Kristoffersen 2019), provides key information for understanding well-being, the evolution of social norms, and possible models of production-consumption infrastructures and systems that citizens would welcome.

Currently, citizen preferences regarding climate policy are mainly assessed through rational choice and consumer utility functions (Fremstad *et al* 2019). However, such standard economic approaches and methods are limited in understanding value formation and capturing the diversity of human behaviour (Sagoff 1988, Kosoy and Corbera 2010). Environmental policymaking must treat human beings as more than rational economic actors whose behaviour is guided solely by economic incentives.

If we understand demand-side solutions broadly as those based on the inter-relationship between consumption and the collective choices that structure possibilities for action (Creutzig *et al* 2016), and acknowledge the need for radical transformations to address climate change, it follows that engagement with social movements can illuminate structural transformative pathways to deep decarbonization that are not apparent through examination of individual consumer actions.

Firstly, social mobilizations provide a window into the political demands and concerns of the most marginalized communities, who are often sidelined in decision-making (Hanna *et al* 2016) due to their limited capacity to express preferences via the market and political consumerism (Stolle and Micheletti 2013). Secondly, citizen mobilizations express demands and preferences that *cannot* be reduced to monetary terms, including for common resources, environmental health, land, climate stability, clean water, Indigenous demands for land and political sovereignty, and collective autonomy and control over energy, technology and food production. Thirdly, mobilizations serve to represent collective rather than individual preferences. In this way they represent more than an aggregation of individual preferences expressed in isolation through dollars or votes (and potentially leading to feelings of powerlessness). They are manifestations of collective agency, an emergent force which can propel new ideas, energy, and creative approaches to the climate crisis. In this way, social movements can provide signals to governments about citizen preferences, desires, capacities and broader visions for *collective existence*, beyond an individual choice perspective.

A systematic review of place-based resistances[7] over carbon futures can also inform on how demand-side and supply side climate policy can work together dialectically. Scholars from sustainability science, drawing from social movement theorists, have documented how contentious social movements alter norms and push policy change on climate change, overcoming political inertia (Angel 2017, Piggot 2018, Cheon 2020). Social movement theory insights on how movements create frames, mobilize resources and take advantage of political opportunity structures have enriched understanding on movement successes (Piggot 2018). For example, activism and social movements can help overcome the limited adoption of supply-side policies due to the resistance of powerful interests (Lazarus and van Asselt 2018, Green and Dennis 2018). Further, social movements play an important role in creating new norms that have pushed climate policies of all kinds. For example, Green (2018) finds empirical evidence that

[7] Place based resistance is based on geographically rooted identities and a sense of belonging to a particular place. Such activism often centers on defence of the local and associated way of life against the delocalizing effects of global capital (Escobar 2001).

suggests that anti- FF norms have high awareness-raising potential and are more resonant than generic climate change frames. Piggot (2018) shows how the diverse strategies of such movements, including media advocacy, lawsuits, awareness and alliance-building, sit-ins, blockades and demonstrations, have influenced the social acceptance of technologies, and created new organizational models. Outcomes include undermining the financial viability of industries (Franks *et al* 2014), shifting investment flows, and directly stopping projects, leading to supply-side transformations (Piggot 2018). In this way, place-based movements tackle the problem of 'carbon lock-in' through overinvestment in FF infrastructure (Erickson *et al* 2015), as well as the perverse side-effects of demand-side action such as the green paradox whereby owners of FF resources accelerate production in anticipation of climate policies to come (Sinn 2012). Our review further contributes to appraising the role of place-based movements in creating norms and pushing climate policies by surveying empirical evidence from the largest existing dataset on ecological conflicts in order to explore and understand the collective agency and potentialities of such movements.

2. Methods

This study assesses the state of knowledge on social mobilizations and community resistance over FF projects and LCE/mitigation projects, drawing from a systematic geo-located database of cases of ecological conflicts and protests documented in the Global Atlas of Environmental Justice—henceforth called the EJAtlas (Temper *et al* 2015, 2018). We have undertaken a systematic mapping of energy-related conflicts included in the EJAtlas.

Systematic mapping[8] (Berrang-Ford *et al* 2015, James *et al* 2016) is an evidence synthesis method that aims to describe the state of knowledge about a question or topic. Systematic mapping does not answer a specific question as does a systematic review, but instead collates, describes and catalogues available evidence relating to a topic of interest (Bates *et al* 2007). The included studies can be used to develop a greater understanding of concepts, and to identify evidence for policy-relevant questions, knowledge gaps that would benefit from primary research, and knowledge clusters (Gough *et al* 2012).

2.1. Identification

The EJAtlas was created in 2011 to close knowledge gaps about, and to foster more systematic research on, environmental conflicts. The EJAtlas database documents cases of social conflict related to claims against perceived negative social or environmental impacts with the following criteria:

(a) Economic activity or legislation with actual or potential negative environmental and social outcomes;
(b) Claims and mobilization by informal or formal groups that such harm occurred or is likely to occur as a result of that activity;
(c) Reporting of the conflict in media stories.

The unique approach of the EJAtlas is that data collection relies on a collaborative process and on grounded knowledge that has thus far involved more than 500 individuals and organizations worldwide over 10 years (Temper *et al* 2015, Temper and Del Bene 2016; see Supplementary Information for further information on the EJAtlas (available online at https://stacks.iop.org/ERL/15/123004/mmedia)). Each case study is entered by a scholar/activist[9] and later reviewed by one or more moderators for quality and accuracy. Each case draws on multiple references including academic literature, grey literature, press reports, and movement knowledge, and is entered online in a form following a pre-established coding system, with over 100 data fields, including spatial, quantitative and qualitative data (see appendix 2 for relevant definitions). By relying on sources and documenting cases not included in academic literature, the EJAtlas addresses key biases in the academic literature, which tends to be predominantly in English and focuses on a small number of developed countries (Althor & Witt 2020, Earl *et al* 2004). The EJAtlas represents the most extensive publicly available collection of information on environmental conflicts, with over 3200 cases documented by September 2020 (https://www.ejatlas.org). The online database has been Accessed to date by over 2.75 million users and stakeholders as an evidence base.

2.2. Screening

This article analyses only a subset of the EJAtlas systematic database which documents conflicts over 50 subcategories of economic activities, including mining, industrial activities, wetlands management, etc. For this article, the database (cases registered up to December 2019, $N = 2909$) was screened according to the following criteria.

- Cases where the conflict was sparked after 1997 inclusive (the year of adoption of Kyoto Protocol) and was registered in the EJAtlas by December 2019, when we began our analysis ($n = 2048$).

[8] The Methodology for systematic mapping was developed by the Evidence for Policy and Practice Information and Co-ordinating Centre (EPPI-Centre, see Peersman 1996, Oakley *et al* 2005).

[9] The term scholar/activist refers to an approach to academic production based on the idea that knowledge creation can and should explicitly contribute to social change. For further details on the methodological approach of the EJAtlas building from activist knowledge see Temper *et al* (2015).

AND EITHER

- **Cases of conflicts related to fossil fuel energy and related infrastructures (here abbreviated FF):** Cases coded in the EJAtlas with the following characteristics: Coal extraction and processing OR gas flaring OR shale gas fracking OR oil and gas exploration and extraction OR transport infrastructure networks (roads, railways, canals and pipelines) OR oil and gas refining OR thermal power plants. This filter yielded 542 cases.

OR

- **Cases of conflicts related to low-carbon energy projects and mitigation (here abbreviated LCE):** Cases coded in the EJAtlas with the following characteristics: Agrofuels and biomass plants OR nuclear power plants OR CC related conflicts (glaciers, small islands) OR mega solar projects OR geothermal energy installations OR windmills OR [dams and water distribution (2nd level) AND electricity (commodity)]. This filter yielded 327 cases.

2.3. Eligibility and results

This screening process thus yielded a total of 869 cases. After joint analysis and appraisal, these were grouped according to eight sub-categories. Then teams of two reviewers assigned to a subcategory independently screened titles and full texts of the identified cases for scope, relevance, and completeness according to the inclusion criteria. Results were compared between them and differences in opinion were resolved through subsequent discussion. This led to exclusion of a further 211 cases (See details of the systematic review process, in the Prisma diagram in appendix 1)

Our systematic mapping yielded 649 cases of conflicts from 1997 to 2019, 371 related to FF and 278 related to LCE conflicts and mitigation (LCE). For FF, conflicts were sub-categorized according to those related to oil and gas extraction and refining ($n = 160$), shale gas hydraulic fracturing ($n = 35$), pipelines and fossil fuel infrastructure ($n = 38$), coal mining and thermal power plants ($n = 138$). LCE cases were further categorized and classified under biomass and land ($n = 57$), hydropower ($n = 160$), nuclear energy ($n = 22$) and other renewables ($n = 39$) (This subcategory breakdown of the conflicts included is shown in Graph 1). Following this case selection and categorization, both meta-data and qualitative data were analysed by the systematic mapping team. The data table with links for each case to the systematic map can be consulted in appendix 3.

2.4. Critical appraisal, study limitations

There are several limitations to this study. First, not all cases of mobilization against energy projects are reported in the EJAtlas, so our findings are thus only valid for our sample. The database cannot be considered to have statistical representativeness according to geographic distribution or economic activity (see appendix). Second, the study does not consider the entire universe of energy projects, but only those facing resistance. There is thus a 'positive bias' in our approach toward projects which face resistance, and the study does not assess what proportion of all FF and LCE projects face opposition. Third, the study covers place-based mobilizations targeting specific energy projects, and not more general climate movements, such as the Fridays for Future or campaigns by Oilwatch since 1997 for 'leaving oil in the soil' and for repayment of the 'climate debt'. Such movements are also involved in changing norms, social priorities, and climate policy influences. Finally, a focus on conflict and resistance does not clearly trace how movements have positively contributed to a transition to just climate futures, including 'anti-FF norms' (Green 2018), 'stranded assets' shaping future investment decisions (Carbon Tracker 2013, Franks *et al* 2014, Dietz *et al* 2016), and fewer negative impacts on local communities as a result of project cancellations and 'cleaner' and just production processes. More investigation of all these points would help provide a broader picture of dynamic collective contributions to the energy transition; our study is only a start.

The following section describes the available evidence for the different categories of conflict and resistance. Issues we discuss for each category include an *overview, characteristics of analysed conflicts and conflict triggers, movement demands and outcomes.* This is followed by overall results and an identification of major trends.

3. Results and discussion

Table 1 summarizes the results discussed in this section.

3.1. FF projects

3.1.1. Coal mining and thermal power plants

3.1.1.1. Overview

As it is the most carbon intensive FF, a phase-out of coal is integral to reducing carbon emissions (Edwards 2019). This need to 'keep coal in the hole' has compounded aversion to an industry already widely opposed for its negative impacts on health, e.g. black lung disease and premature mortality (Guttikunda and Goel 2013, Guttikunda and Jawahar 2014, Leonard *et al* 2020) and local ecologies (Arsel *et al* 2015, Cardoso 2015). Concern about the global climate change impacts of coal, in addition to the local impacts, has increased the trans-national and networked character of mobilizations against new coal mining and combustion projects (Tyfield 2014) in India (Lahiri-Dutt 2016; Roy and Martinez-Alier 2019), Bangladesh (Kotikalapudi

Table 1. Fossil fuel and low carbon energy projects summary: conflicts, claims and outcomes.

Category	Conflict type	Sample size (*n*)	Sample distribution (countries and/or income areas)[a]	Main socio-environmental claims expressed by mobilizing communities	Main outcomes (nr of cases/%)
Fossil Fuel Projects	**Coal mining and thermal power plants**	138	40 countries HI: 31 (22%) UMI: 29 (21%) LMI: 77 (56%) LI: 1 (1%)	Loss of land, Loss of livelihood, Pollution concerns (air, water and land due to emissions, fly ash, dump sites etc), Climate justice concerns	Compensation: 55 (40%), Under negotiation: 42 (30%), Criminalization 24 (17%), Activist death 18(13%), Environmental improvements 26 (19%), Judicial victory for mobilizers 25(18%), Displacement 16 (12%), New legislation 19(14%), Repression 31 (23%), New EIA 37 (27%) Project cancelled 15 (11%), Withdrawal of investment 13 (9%), Project temporarily suspended 24 (17%)
	Oil and gas extraction and refining	160	46 countries HI: 22, 14% UMI: 54 (34%) LMI: 72 (45%) LI: 11 (7%) Unknown 1 (1%)	Biodiversity loss, Loss of livelihoods, Oil spills, contamination of water soil, Loss of land, Violations of human rights, Loss of traditions, and displacement	Under negotiations: 60 (38%). Displacement: 32 (20%), Criminalization 28 (18%), Activist death 14 (9%), Environmental improvements 12 (7.5%), Judicial victory for mobilizers 20 (12.5%), Displacement 32 (20%), New legislation 14 (9%), Repression 26 (16%), New EIA 16 (10%) Project cancelled 13 (8%), Withdrawal of investment 11 (7%), Project temporarily suspended 20 (13%)
	Shale gas fracking	35	17 countries HI: 18 (51%) UMI: 14 (40%) LMI: 3 (8%) LI: 0 (0%)	Groundwater pollution or depletion, soil contamination, surface water pollution, air pollution exposure to unknown or uncertain complex risks, loss of landscape sense of place, loss of livelihood, global warming, accidents, land dispossession	New legislation: 10 (29%), Criminalization: 9 (26%), Repression 7 (20%) Moratoria 3 (9%), Project canceled 4 (11.4%), Withdrawal of investment 2 (6%), Project temporarily suspended 4 (11%)
	Pipelines and transport infrastructure	33	17 countries HI: 16 (48%) UMI: 10 (30%) LMI: 5 (15%) LI: 2 (6%)	Impacts to water, loss of landscape/aesthetic degradation and loss of sense of place, loss of traditional knowledge, practices and cultures, displacement, global warming	Repression: 14 (45%), Application of existing regulations 11(29%), New EIA 7 (18%), Project cancelled 5 (13%) Withdrawal of investment 4 (11%), Project temporarily suspended 8(21%)

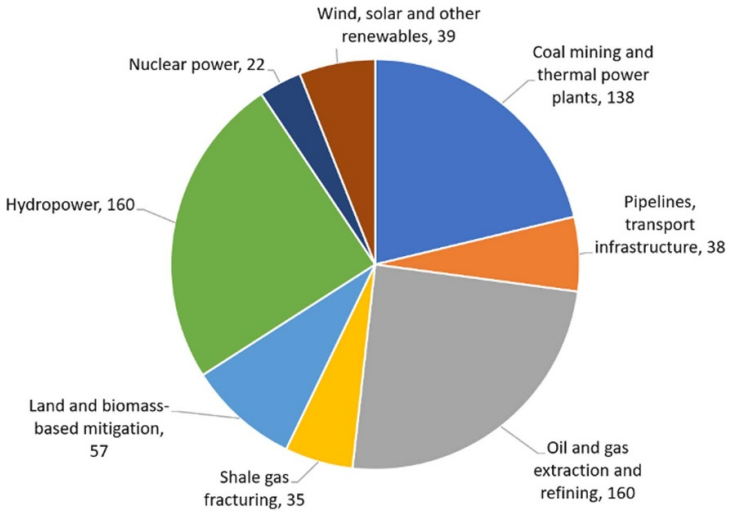
Table 1. continued.

Category	Conflict type	Sample size (n)	Sample distribution (countries and/or income areas)[a]	Main socio-environmental claims expressed by mobilizing communities	Main outcomes (nr of cases/%)
	Land and biomass-based mitigation activities	57	28 countries HI: 3 (5%) UMI:13 (23%) LMI: 12 (21%) LI: 28 (49%) Unknown: $n = 1$ (2%)	Visible livelihood loss, land dispossession, protesters voice problems in almost all cases over inadequate project implementation, including lack of transparency, communication, involvement of marginalized groups in decision-making processes, transparent project benefits distribution (i.e. for REDD + cases), flawed SEIAs. Concerns over mitigation effectiveness of proposed projects	Compensation: 18 (32%), Criminalization 13 (23%), Activist death 7 (12%), Judicial victory for mobilizers 5(9%), Displacement 18 (32%), Repression 18 (32%), Application of existing regulations 12 (21%), Project canceled 8 (14%), Withdrawal of investment 6 (11%), Project temporarily suspended 4 (7%)
	Hydropower	160	43 countries HI: 4 (3%) UMI: 74 (46%) LMI: 68 (43%) LI:14 (9%)	Impacts on the ecosystems far larger than expected or stated in official documents, displacement (often under physical threat), loss of means of livelihood, alternatives to large hydro remain understudied or underassessed, monetary compensation is not considered satisfactory, consultation has been poorly conducted, not done according to the law, or not done at all, misrecognition of human rights (e.g. Indigenous rights).	Under negotiation: 45 (28%), Displacement 43 (27%), Repression: 40 (25%), Violent targeting of activists: 35 (22%), Compensation: 34 (21%), Criminalization: 32 (20%), Activist death 21 (13%), Judicial victory for mobilizers 17(11%), Project canceled 21 (13%), Withdrawal of investment 14 (9%), Project temporarily suspended 28 (18%)

Table 1. continued.

Category	Conflict type	Sample size (*n*)	Sample distribution (countries and/or income areas)[a]	Main socio-environmental claims expressed by mobilizing communities	Main outcomes (nr of cases/%)
Low Carbon Energies	**Wind, solar and other renewable energies**	39	23 countries HI: 12 (31%) UMI: 16 (41%) LMI: 8 (20%) LI: 3 (8%)	Wind and solar power plants: biodiversity loss, loss of landscape, sense of place and livelihood, land dispossession, deforestation, displacement, reduced ecological connectivity, increase in corruption, and noise pollution (wind power). Solar panel manufacturers: exposure to unknown risks, mental problems, loss of livelihood and landscape/sense of place, violations of human rights, food insecurity, soil contamination and erosion, surface and groundwater pollution, waste overflow. Geothermal power plants: exposure to unknown risk, air and noise pollution, biodiversity loss, food insecurity, loss of landscape, soil contamination, deforestation, surface and groundwater pollution/depletion, disturbance of hydrological systems and of ecological connectivity.	Under negotiation: 8 (21%), Judicial victory for mobilizers 7(18%), Activist death 0 (0%), Repression 6 (15%), Project canceled 4 (10%), Withdrawal of investment 0, Project temporarily suspended: 8 (21%),
	Nuclear power	23	14 countries HI: 10, (43%) UMI: 5 (22%) LMI: 0 LI: 8 (35%)	Risks that this activity and the waste it generates poses to human health, livelihoods, the environment and landscape (radioactivity, pollution of water, soil and biodiversity). Land dispossession. Impacts of waste overgeneration and management. Corruption. Violation of human rights.	Under negotiation 8 (35%), Compensation 7 (30%), Criminalization 0, Activist death 0, Project canceled 5 (18%), withdrawal of investment 0, project temporarily suspended 2 (9%)
Total		649 cases	106 countries	NA	NA

[a] HI: High income, LI: Low income, UMI: Upper middle income, LMI: Lower middle income



Graph 1. Number of cases per project type analysed ($n = 649$).

2016, Kuchler and Bridge 2018), Colombia and Turkey (Cardoso and Turhan 2018).

3.1.1.2. Characteristics of analysed conflicts and conflict triggers

We analyse 138 conflict cases in 40 countries, roughly one third over coal mining and processing ($n = 46$) and two thirds involving coal power plants ($n = 96$) (see table 1). Protests are motivated by land use and pollution concerns, livelihood defense, Indigenous rights; health impacts (air pollution from coal dust and fly ash, toxic metal exposure, water contamination, etc.). Climate change is rarely a driving factor, however climate change discourses are employed instrumentally to press other claims and to create alliances with trans-national activist organizations (Brown and Spiegel 2019). Movements motivated directly by climate justice include cases in Germany (4), United Kingdom (4), Australia (6), and the US (3) as well as in Chile (1), Kenya (1), Philippines (3) and Bangladesh (2). Mobilizations around climate justice vary significantly across regions and communities. For example, climate justice movements in cities have been found to focus on distributive justice, and in the Global South the emphasis is on procedural justice and collective rights (Bulkeley *et al* 2013). Increasingly, anti-coal movements are creating alliances with national and international climate justice movements. For example, the Philippine Movement for Climate Justice has anti-coal activism as its central platform, including campaigns against a plant and coal stockpiling in Mariveles (Case 2559). One emblematic climate justice anti-coal movement in the North is the Ende Gelände civil disobedience movement, which uses direct action to blockade lignite coal mines, railways, ports and companies in Germany (the 4th largest consumer of coal globally) and beyond, under the banner #deCOALonize (Ende Gelände 2016; Case 2595).

Fifty cases are documented in India, the world´s second largest coal producer and importer (IEA 2018), where coal accounted for 74% of electricity generated in 2017 (IEA 2019). Pollution and health problems, poor labour conditions in the mines, and appropriation of land, water affecting livelihoods, as well as climate concerns drive opposition (Kohli and Menon 2016, Oskarsson and Bedi 2018). Many conflicts date from the early 2000s, but resistance has been further enlivened by recent legislation including new protections for Indigenous and environmental rights (such as the Forest Rights Act and the National Green Tribunal (Ghosh 2016, Gill 2016, Talukdar 2016, Roy 2018, Roy and Schaffartzik 2021). However, these protections have not succeeded in stemming violence and repression against protesters from the state and what Goyal (2018) terms the 'coal mafia' . The killing of Sister Valsa John, who was defending the tribal Santhal people against displacement by a coal mine in Jharkhand in 2011, is one example (Case 911). Violent repression of activists occurred in 22% of the cases surveyed.

3.1.1.3. Movement demands and outcomes

While monetary compensation for land displacement or pollution is common (37.5% of cases), numerous projects have also been cancelled ($n = 19$, 12%) or delayed ($n = 25$, 16%). For example, after 8 years of mobilization and the deaths of 3 protesters, the people of Phulbari, Bangladesh, succeeded in stopping an open-pit mine and power plant that would have displaced 50 000 people (Case 1747).

3.1.2. Oil and gas extraction and refining

3.1.2.1. Overview

Socio-environmental concerns and conflicts affect all parts of the oil and gas sector, from exploration to drilling, transportation, and refining (Watts 2005, Bridge and Le Billon 2017). Generating vast

revenues and comprising 54% of the global energy mix, oil and gas is actively pursued by companies and governments, but also resisted by many Indigenous groups, local communities, climate movements, and citizens denouncing corruption, authoritarianism, foreign resource grabs, and poor development outcomes (Sawyer 2004, Mcadam *et al* 2010, Ross 2013, Cheon and Urpelainen 2018).

3.1.2.2. Characteristics of analysed conflicts and conflict triggers

Our mapping reports 160 cases of mobilization in 46 countries against oil and gas extraction, refining or liquefaction (see table 1). Few cases are reported in the Middle East and North Africa. This may be attributed to limits on political and civil liberties, as rich oil-funded autocracies often pre-empt or crush mobilization through subsidies and repression (Girod *et al* 2018, Fails 2019). Mobilization increases with low oil revenues per capita, severe (potential) environmental impacts (oil spills and gas flaring and surface water, air, and soil pollution) and the presence of minority populations. Closely fitting this profile, Nigeria accounts for 29% ($n = 46$) of all cases. Whereas oil generates 65% of Nigerian government income, revenues are low (US$92 per capita in 2016), and their distribution bitterly contested. The oil-producing Niger Delta region has experienced decades of chronic environmental pollution, strong state violence including the execution of environmental and land defenders, ineffective regulations, poor corporate practices, underinvestment, sabotage and oil theft resulting in deep socio-environmental grievances and mobilization taking forms ranging from peaceful demonstrations to armed rebellions (Watts 2005, Temper *et al* 2013; Obi and Oriola 2018). Mobilizations are more frequent within emerging oil and gas producing countries, where populations often seek the cancellation of oil and gas projects, than in traditional and already oil-dependent producing areas, where conflicts tend to relate to labour issues, the comprehensiveness of Environmental Impact Assessments, or enquiries into major accidents. About two-thirds of cases are high or medium intensity, reflecting the high stakes at play for governments, corporations, and populations. Governments respond with harsh repression in nearly all cases involving mass mobilization,[10] and only 4 out of 34 high intensity conflicts were successful (two to prevent project implementation and two to seek reparations).

3.1.2.3. Movement demands and outcomes

Protests frequently seek the outright cancellation of projects (e.g. new oil drilling licenses in the Barents Sea, case 3207[11]), but also compensation and environmental remediation for socio-environmental impacts, and more thorough environmental impact assessments, community consultations and enquiries into accidents. Some movements make specific demands on oil and gas companies or governments, including clean water provision, electricity, jobs, benefits agreements, greater transparency, or an end to militarization. Mobilization was reported to be successful in accomplishing protesters' aims in 18% of all cases.

3.1.3. Shale gas fracturing

3.1.3.1. Overview

Within fossil resources, natural gas is often promoted as a 'bridging' fuel to help societies move from dirty to clean energy (Howarth 2015, Cheon and Urpelainen 2018). Increased use of natural gas has also been driven by technological advances including unconventional drilling techniques such as hydraulic fracturing—*fracking* (Cheon and Urpelainen 2018). The novelty and uncertainty regarding this technology and related regulatory regimes amidst concerns about increased seismic activity and contamination of underground water sources have led to divisiveness regarding its use, particularly at the local level.

3.1.3.2. Characteristics of analysed conflicts and conflict triggers

Our mapping yielded 35 shale gas fracking cases across 17 countries (See table 1). No cases are reported in low-income countries due to limited hydraulic fracturing activities there. Nine per cent of cases involved Indigenous communities. Widespread resistance to shale gas fracking is driven by concerns such as increased water scarcity and the potential for toxic chemicals to leak into and pollute groundwater and aquifer reserves, with concerns being especially acute in regions suffering from droughts. Other concerns include soil contamination, loss of landscape, accidents, exposure to unknown risks, land dispossession, and loss of livelihood. Earthquakes are impacts of primary concern, and examples include the Cuadrilla site near Blackpool, UK in 2011 (Case 55), the town of Las Enrambas, Mexico where an earthquake destroyed over 45 homes after Halliburton and Schlumberger drilled wells in the area (Case 1706) and Rong County, Sichuan, China, where a shale gas project was suspended after three earthquakes occurred in two days (case 4051). Climate change was a concern expressed in campaigns in two-thirds of cases. While proponents argue that natural gas emits less

[10] For a discussion of factors influencing government responses across sectors as well as the interplay between resistance, repression and other forms of (re)action, see for example (Dunlap 2020, Prause and Le Billon 2020).

[11] https://ejatlas.org/conflict/the-people-versus-arctic-oil

carbon dioxide than other FFs per unit of heat energy, difficult-to-track emissions of methane mean that shale gas may lead to higher GHG emissions than conventional natural gas, coal, and oil (Howarth 2015).

3.1.3.3. Movement demands and conflict outcomes

Movements demand the cessation of existing projects, the development of renewable energies and sustainable energy systems. They fight for rights of local communities to have a say, for Indigenous rights to be respected, and for accountability. A common demand for a moratorium on fracking has been made from Egypt, to Mexico, to the UK, Canada, and South Africa. Moratoriums have been passed in France, Algeria, Scotland, Uruguay, and the Canadian provinces of Nova Scotia and Quebec, among other jurisdictions. Projects have also been halted due to drops in gas prices rather than due to movement pressure, as in Ain Salah, Algeria.

In 26% of cases ($n = 9$), the projects were stopped, either as a result of new legislation, moratoria or company withdrawal. These projects involved over a billion dollars of investment. Thus, community opposition, as evidenced by the 35 cases, has had considerable positive climate impacts, keeping gas from being fracked and methane from being released, leading to new legislation and withdrawal of company investments.

3.1.4. Pipelines and transport infrastructure

3.1.4.1. Overview

Despite emission reduction commitments, an economic 'carbon lock-in' continues through new FF infrastructure and the refitting of aging ones such as pipelines (Shahriar *et al* 2012, Erickson *et al* 2015, IEA 2017). As vast geographic infrastructures, pipelines have been a key focus of environmental conflicts and a critical target for climate activists opposing FFs. We identified 38 cases of oil and gas infrastructure conflicts since 1997 across 17 countries, 31 related to pipelines and 7 related to other FF transport infrastructures such as export terminals (See table 1).

3.1.4.2. Characteristics of analyzed conflicts and conflict triggers

Pipeline conflicts are sparked by concerns about construction impacts, leaks and oil spills, and poor public consultation, as well as intergenerational and climate injustice implications, with two-thirds of cases, mostly in the Global North, driven by climate change concerns (e.g. opponents of the Kinder Morgan pipeline twinning project in Canada (Case 1596) arguing that 'Climate Leaders do not Build Pipelines'). Since pipelines distribute pollution from extraction sits to refineries (Scott 2013), they mobilize resistance movements along their routes (e.g. the Standing Rock NODAPL mobilization (Case 2668), focusing on Indigenous territorial rights and potential water pollution—'Water is Life'), and create deeper connections, including between Indigenous, agrarian and climate justice struggles (e.g. the Keystone XL project (Case 3161[12])).

3.1.4.3. Movement demands and conflict outcomes

Demands include no new FF infrastructure and a rapid transition away from FF-based energy systems and towards renewable energies. These demands are sometimes expressed through the building of *alternatives as resistance* in the paths of the proposed pipelines, as in the installation of solar panels in the pathways of the US Keystone XL project (Case 3161); the building of solar-equipped Tiny Homes along the route of the Trans Mountain pipeline in Canada (Case 1596), and the revival of traditional cultural and Indigenous governance practices at the Makwa camp blocking Enbridge´s Line 3 pipeline in Minnesota (Case 3285[13]). In only a few cases do the demands include the re-location of the infrastructure project elsewhere. In 15% of 38 cases, the project was stopped ($n = 3$, involving at least 10 billion dollars in investment), suspended ($n = 8$) or investment was withdrawn ($n = 4$). Repressive responses were common, with criminalization of activists in 40% of cases ($n = 15$), as well as violence against activists ($n = 7$). In 4 cases, protesters were killed. Many cases are ongoing and the outcomes are yet unknown.

3.2. LCE and mitigation

3.2.1. Land and biomass-based mitigation initiatives

3.2.1.1. Overview

Biofuels, bioenergy, forest conservation and reforestation projects are commonly proposed to reduce and sequester carbon emissions. However, several studies report conflicts and social mobilizations by customary users against such projects due to livelihood concerns (e.g. Griffiths 2008, Fairhead *et al* 2012, Hunsberger *et al* 2017, Scheidel and Work 2018, Corbera *et al* 2019, Franco and Borras 2019). Also, their sustainability and true mitigation potential has been subject to debates (Giampietro and Mayumi 2009, Richards and Lyons 2016, Scheidel 2018, Gingrich *et al* 2019).

3.2.1.2. Characteristics of analyzed conflicts and conflict triggers

We find that resistances against land- and biomass-based mitigation projects arise mainly over distributive and procedural injustices, and in a few cases, protesters also question the mitigation effectiveness of these projects. Large-scale flex-crop[14] plantations,

[12] https://ejatlas.org/conflict/keystone-xl-in-nebraska

[13] https://www.ejatlas.org/conflict/makwa-initiative-frontline-resistance-against-enbridges-line-3-replacement-project

[14] Flex crops are crops such as corn, sugarcane or cassava with multiple uses such as fuels, feed, food or fiber. The study of conflicts resulting from biofuels policies requires attention to related changes in demand over flex crops and their production patterns (Borras *et al* 2015).

including palm-oil, sugarcane, jatropha, maize and cassava cultivations, with potential (37% of cases) or explicit (32%) use for biofuels production, are the most common conflict types. These are followed by forestry initiatives (26%) including REDD + projects, forest plantations for carbon sequestration, conservation and agroforestry projects. Only three conflicts over biomass energy plants and wood-fuel production are reported (See table 1).

3.2.1.3. Movement demands and conflict outcomes

Grassroots movements protesting land- and biomass-based mitigation initiatives frequently demand a wide range of measures to establish socially more just and/or effective climate change mitigation. Demands for improved project implementation include, for instance, adequate community involvement in benefits and decision-making processes, and in 28% of conflicts (16 cases), strengthened participation was achieved. Also, enhanced impact assessments are demanded, and achieved in 18% (10 cases) of conflicts. For flex-crop plantations, workers frequently demand better labour conditions, including higher wages and less working hours. However, many groups also call for project cancellation, which was achieved in 14% (8 cases) of conflicts. While some argue that less conflictive siting and scales should be pursued (e.g. limited size of land concessions for biofuel crops), others call for the support of customary resource use practices with proven mitigation benefits (e.g. Indigenous forest uses and protection), as well as for overall reduction in global resource use to tackle FF emissions at their sources.

3.2.2. Hydropower

3.2.2.1. Overview

Hydropower is a key source of renewable energy and has been seen as a key component of the energy matrix in the post-fossil energy transition (World Bank 2009, Cole *et al* 2014, IHA 2019a, 2019b). Hydropower is also a major recipient of CDM credits (Pottinger 2008, Erlewein and Nüsser 2011, Haya and Payal 2011). The recent boom in hydropower investment includes refurbishing of old projects as well as greenfield projects, especially in Mexico, the Balkan countries, the Brazilian Amazon, the Yangtze basin in China, the Andes, Sub-Saharan Africa, Turkey, and the Mekong and Ganges–Brahmaputra basins, (Zarfl *et al* 2014). Smaller rivers are also targeted, especially under 'run-of-river' schemes, i.e. a series of hydropower plants interconnected through tunnels and water discharges along the same river and its tributaries.

3.2.2.2. Characteristics of analyzed conflicts and conflict triggers

Our mapping included 160 cases of conflictive hydropower plants in 43 countries. Almost 85% of the cases are high or medium intensity. Indigenous peoples are particularly badly hit, involved in over 58% of cases (See table 1). These conflicts register a particularly high level of repression, criminalization, and assassination of social leaders (see also Del Bene *et al* 2018).

Loss of livelihoods, forced displacement, lack of compensation, and flawed impact assessments are the most reported reasons for opposition and mobilization against hydropower projects. In more than 78% of cases, compensation was not received or deemed insufficient. Impacted people also voice concerns related to procedural injustices, such as lack of community consultation.

3.2.2.3. Movement demands and conflict outcomes

Opponents question the sustainability of hydropower projects and denounce severe impacts on livelihoods and local ecologies. Demands include recognition of rights enshrined in current national and international law, and more accurate EIA studies. More radical demands include the adoption of alternative management and economic plans for the region, comprehensive studies of alternatives to hydropower for energy generation, and the ultimate cancellation, moratoria, or dismantling of the existing plants.

3.2.3. Wind, solar and other renewable energies

3.2.3.1. Overview

In addition to hydropower, mitigation strategies in the energy sector are increasingly relying on the implementation of technologies to harness wind, solar, bio, ocean and geothermal resources. For a fourth consecutive year, global net capacity additions for renewable power, supported by an increased articulation of stable policy frameworks and targets at national scales, were higher than for FFs and nuclear combined (REN21 2019). Renewable energies, however, face an increasing number of conflicts, raising key concerns for achieving just climate futures. These include aspects of spatial and environmental justice along production and consumption chains, as well as issues on democracy and participation in shaping just transitions (Scheidel and Sorman 2012, Newell and Mulvaney 2013, Yenneti *et al* 2016, Avila-Calero 2017, Avila 2018, Mccarthy and Thatcher 2019). The EJAtlas database includes 39 cases of conflicts related to wind, solar and geothermal power industries (table 1).

3.2.3.2. Characteristics of analyzed conflicts and conflict triggers

Wind, solar and renewable energy conflicts are emerging across countries with different development trajectories. Agrarian, rural and Indigenous communities are the most impacted in our sample. Conflict triggers depend on the technology and resource at stake. Movements resisting geothermal power plants, for example, are concerned with risks from local pollution and seismic disruptions. In such cases, geothermal is equated to fracking industries and questioned as a viable and just climate

solution. Appliance of the precautionary principle in projects involving new technologies is a key demand. Mobilizations against solar panel manufacturers denounce mismanagement of toxic waste and consequent river pollution. Protesters highlight the disconnection between impacted local ecosystems and livelihoods and the profits of solar panel production overseas.

Wind and solar power conflicts are often triggered by claims of land-grabbing and irregular land acquisitions of large-scale facilities stemming from a lack of recognition and proper consultation of communities who materially or culturally depend on those lands. Mobilizers condemn a lack of integral planning, deployment and management despite livelihood and biodiversity impacts wrought by these spatially intensive facilities. This commonly refers to the structural exclusion of local communities, scientists and environmental justice groups in the overall decision-making processes. Such claims for democratic participation accompany distributional claims. In particular, mobilizing groups denounce that large-scale and centralized facilities reinforce an unequal distribution of economic gains, in favour of large corporations, and the uneven consumption of electricity produced, benefitting urban or industrial sectors.

3.2.3.3. Movements demands and conflict outcomes

Conflicts related to renewables tend to be of low intensity (61.5% of cases), involving less violence and repression in comparison with other energy-related conflicts (See table 1). In a similar vein, the perception of what is a successful outcome in renewable energy conflicts is different from other instances of environmental injustice. Whereas the cancelation of projects is often sought in oil, gas or nuclear energy conflicts, in the case of renewables the emphasis tends to be on the institutional, technological or political alternatives that these conflicts bring forward (Avila 2018)

The existence of these mobilizations sheds light on emergent injustices to be prevented in shaping just climate futures. Conflicts also illustrate the need for more effective implementation of consultations and environmental impact assessments in renewable energy industries. This includes the push towards democratic decision-making processes (case 1606[15]), risk assessment with multiple actors (case 1302).[16] Going further, some cases exemplify the articulation of new narratives and practices towards just energy futures. These include concepts such as energy sovereignty, autonomy and decentralization, and a range of initiatives for developing medium-scale facilities (case 1683[17]), cooperative schemes (case 2108[18]), and democratic participation to re-design and downscale energy systems (case 2525[19]). Within this range of debates, movements ultimately highlight the socio-environmental issues that renewables might trigger if technologies are not accompanied by changes in energy demand, all of which require economic and social transformations (Fauset 2010, Trainer 2014).

3.2.4. Nuclear power

3.2.4.1. Overview

Nuclear energy has historically been a controversial activity (Diaz-Maurin and Kovacic 2015), and its inclusion as a low-carbon energy source to address climate change and energy security remains highly contested (Bickerstaff *et al* 2008). Furthermore, the 2011 Fukushima nuclear disaster in Japan enlivened anti-nuclear movements and led to the shutting down of nuclear power plants in Germany (17 reactors with a pledged to close the rest by the end of 2022), Italy, Switzerland, Belgium, France and Spain, as well as bans on expansion in other countries (Younghwan *et al* 2013).

3.2.4.2. Characteristics of analyzed conflicts and conflict triggers

The EJAtlas includes 118 nuclear cases worldwide, mostly located in high income countries. However, our analysis includes 23 conflicts initiated after 1997 across 14 countries related to existing and planned nuclear energy facilities and nuclear development. Sixty percent of these occurred in low-middle income countries (See table 1). Conflicts occurred in countries with both long-standing (e.g. India, Japan, Russia, France) and recent (e.g. Sri Lanka, Taiwan, Egypt, UEA, Czech Republic) incursions in nuclear energy generation. Most struggles (74%) were preventive and of high intensity (83%). For instance, in ten cases blockades were used as a disruptive tactic by mobilizing groups.

3.2.4.3. Movements demands and conflict outcomes

Resistance to nuclear energy generation is motivated by the risks that this activity and the waste it generates poses to human health, livelihoods and the environment. In some cases, activists point to verifiable impacts of waste generation and management ($n = 6$). A central argument of actors promoting nuclear activities is the need to decrease carbon emissions and gain independence. This is the case of Finland ($n = 2$) where nuclear is supported as a path to national carbon neutrality (Teräväinen *et al* 2011) but where the construction of two plants has been subject to long delays. In India ($n = 7$), nuclear is

[15] https://ejatlas.org/conflict/meiningen-deep-geothermal-energy

[16] (https://ejatlas.org/conflict/enel-geothermal-plants-in-mt-amiata-italy).

[17] https://ejatlas.org/conflict/movement-against-industrial-renewable-energy-resources-res-in-chios

[18] (https://ejatlas.org/conflict/communal-members-of-ixtepec-contending-to-develop-a-wind-farm-cooperative)

[19] (https://ejatlas.org/conflict/tribal-opposition-against-cape-wind-farm)

framed by the President as a key strategy to address climate change (Kaur 2011). However, recent studies signal that this energy option is more expensive and slower to implement than other energy alternatives,[20] limiting its effectiveness (WNSIR 2019). There are numerous cases of post-Fukushima mobilizations in old nuclear areas (as in France and India) where local citizens are concerned with public control capacity and the extension of the life of old nuclear plants, however they have not been analyzed here as the conflicts began before 1997 (Ramana 2012).[21] In 6 cases in our sample, projects were canceled or temporarily suspended.

3.3. Comparative results and analysis

3.3.1. Distribution

Groups mobilize to raise concerns about distributive inequities of project harms and benefits. Graph 2 shows the frequency of involvement of key actors in mobilizations across project types. Cases are also coded according to whether they are located in an urban, rural or semi-urban location. Our review shows that conflicts over both FF and low carbon energies impact certain populations disproportionately, with some differences depending on the specific activity and sector.

The first group is rural communities, including those dependent on rural livelihoods such as farmers, peasants and fishers. Most power plants, mines, gas drilling sites, wind turbines and dams are in rural areas, as are the farms and forests that provide the materials for biomass production. Roughly 71% ($n = 459$) of cases are located rurally, with this rising close to 90% for biomass ($n = 51$) and hydropower ($n = 143$), and from 60%–80% for oil and gas extraction (66%, $n = 79$), FF and pipeline infrastructure (68%, $n = 26$) and coal extraction (76%, $n = 35$) and other renewables (79%, $n = 31$). Only 6.4% ($n = 41$) of cases are deemed urban and 5% unclassified. The conflicts that tend to be least rural include oil and gas refining, nuclear and coal power plants and fracking, located primarily in semi-urban/suburban areas. While the local impacts for both carbon intensive FF extraction and renewables are located in rural areas, most energy consumption occurs in urban areas.

Secondly, Indigenous communities and ethnic minorities are disproportionately involved in such conflicts. Indigenous peoples constitute 3% of the global population and are impacted in no less than 50% ($n = 322$) of cases examined.[22] Their representation ranges from 67% ($n = 80$) in oil and gas extraction projects, to almost 60% in hydropower ($n = 93$), biomass ($n = 33$) and pipeline projects ($n = 22$), and 50% ($n = 20$) in other renewables (see graph 2). In contrast they are only involved in 9% ($n = 3$) of fracking conflicts. The overrepresentation of Indigenous communities in both FF (46%) and LCE (55%) suggests that ongoing dispossession and displacement of Indigenous peoples is increasingly being justified on climate grounds with the same extractivist logic of the carbon economy. In fact, new commodity frontiers created by the green energy political economy such as lithium mining (which we have not studied here[23]), wind corridors, and geothermal power plants serve as new threats to Indigenous sovereignty and well-being (Avila-Calero 2017).

Graph 2 also shows mobilization involvement of supporting actors such as international human rights and environmental organizations, and local governments. International organizations appear more frequently in alliance with local movements in conflicts over biomass and pipelines. This is explained by the existence of well-articulated trans-national agrarian and climate justice movements (Claeys and Delgado Pugley 2017). Local governments were most likely to be active supporters in struggles over coal infrastructure, shale gas and nuclear power. The opposition of governments at local levels may be a contributing factor in the higher incidence of cancellation of coal and nuclear projects (see below).

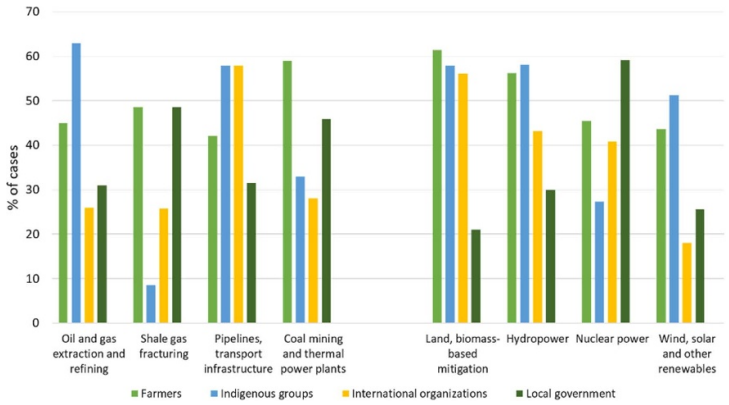
Distribution of conflicts according to country income groups (based on Gross National Income per

[20] While levelized cost estimates for utility-scale solar dropped by 88% and wind by 69% over the last decade, nuclear increased by 23% (WNSIR 2019).

[21] Examples include Tihange in Belgium, which has three reactors, often malfunctioning with concerns about their safety expressed by the official agency for nuclear security as well as neighbouring countries. Similarly in Aslmaraz, neighbouring Portugal has voiced concerns. In France there are instances of successful shutting down nuclear power plants because of 'old age' and increasing risks of accidents such as Fessenheim, built in 1977, and ordered to be closed down in 2020.

[22] Numerous factors contribute to increased exposure of Indigenous communities to risks from energy projects, including increased dependency on the natural resource base for their cultural and production practices suffering from habitat destruction, large areas of traditional lands which have not been exploited to date and their close attachment to these ancestral territories, difficulty of project promoters in understanding and protecting intangible cultural heritage (UN 2003), increased vulnerability to being disadvantaged in the development process due to poverty and political marginalization (Permanent Forum on Indigenous Issues, United Nations 2009), among many other reasons. Further, they are more likely to resist top-down development due to cultural and spiritual values. For example, Calder *et al* (2016) found that all 22 Canadian hydroelectric facilities being considered for near-term development are located within 100 km of Indigenous communities and that the traditional diets of Indigenous people in the Arctic and Subarctic which are rich in fish, birds, seal, and whale also bio-magnify environmental contaminants from dams such as Methylmercury exposure.

[23] For low-carbon energies rare-earth minerals, lithium and cobalt mining, crucial for solar panel and wind turbine production and power storage technologies, and e-waste disposal, entail significant impacts across the commodity chain of renewable energies that require further analysis. Such conflicts are included in the systematic map of the EJAtlas but have not been analyzed here. For recent analysis see: Sovacool *et al* (2020).



Graph 2. Frequency of key mobilizing actors.

capita, as defined by the World Bank) was as follows: High income ($n = 119$), Upper Middle Income ($n = 217$), Lower middle ($n = 240$) and Low income ($n = 78$). Whereas both FF and LCE had from 65%–70% of their cases in middle income countries, FF cases occurred more in high income countries (24.3%), and a higher proportion of the LCE cases were located in low income countries (16.5%), with only 10% in high income countries (See graph 3). This is firstly attributed to a boom in dam construction, nuclear and carbon offset programs in the Global South due to more existing installed capacity in the North. Proponents' rationale for carbon offsets is that paying for greenhouse reductions elsewhere is cheaper and easier than domestic reductions. Yet activists, NGOs and academics have decried offsets as 'carbon colonialism' (Bumpus and Liverman 2011), pointing to controversial local impacts and dubious claims regarding mitigation and additionality. Our findings support caution about displacement of the social and environmental costs of decarbonization from North to South and towards the peripheries of industrialized countries. Improved regulatory regimes and more secure land tenure in developed economies are another reason for the reduced conflictivity of LCE projects in higher income countries, as land grabbing and displacement is a prime driver of conflict in these projects in low income countries.

3.3.2. Impacts and intensity

Cases are coded for conflict intensity based on the level of mobilization (whether there is mass mobilization) as well as incidences of violence and repression. We refer to this as the level of conflictivity evidenced in each case. Contrary to expectations that FF conflicts would spur higher intensity conflicts (due to a rich body of work on the 'resource curse' and poor governance and the relations between hydro-carbons, violence, conflict and antidemocratic politics (see Watts 2001, 2005, Sachs and Warner 2001);[24] we observe no significant difference in intensity between the two categories (30.3% of FF are high intensity and 26% of LCE are high intensity). Activities with higher intensity conflicts include nuclear, pipelines, fracking, coal extraction and power plants and hydropower. Oil and gas extraction and refining and biomass conflicts had lower levels of intensity. Wind, solar and other renewables had the lowest level of intensity.

Regarding impacts, both conflict categories show similarly high levels of either concern or evidence of social impacts at the local level, including loss of livelihood, land dispossession and displacement. Differences between groups concerning environmental impacts show greater variation. Air pollution is a major concern for FF projects (69.5%), compared to only 20% of LCE cases, as is soil contamination and surface and groundwater pollution. Concern for global impacts such as C02 emissions are a concern in 53% of FF cases v. 19.5% of LCE projects. In contrast deforestation and reduced ecological connectivity are expressed as more significant concerns regarding low carbon energies, particularly hydro projects.

3.3.3. Outcomes

Of the 649 cases studied, a total of 104 (16%) were either canceled, suspended or had their investment withdrawn, accounting for 15% ($n = 55$) of FF projects and 17.6% ($n = 49$) of LCE projects. A further 77 projects (12%), which had not yet been shelved,

[24] Resource curse theorizing emphasizes how the emphasis on foreign trade over national productive sectors weakens the need for governments to pursue popular legitimacy and how elite power from export driven commodity sectors diminishes the role of popular consent paving the way for violations of human and environmental rights to secure resource extraction. The operations of the oil complex and the petro-state in particular have generated a substantial body of work examining the relations between oil, violence, conflict, and antidemocratic politics. For example, Watts describes how in Nigeria the petroleum industry is militarized as a national security sector and how the ruling coalition uses state power to accumulate oil wealth (Watts 2001).

had been or were still (temporarily) suspended. Thus, more than one in four projects in each category incurred significant costs and/or delays. Meanwhile, 17% of FF ($n = 63$) and 13% of LCE B ($n = 37$) had to revise initial environmental impact assessments.

Regarding outcomes by project type, oil and gas extraction and refining and coal mining are the activities least reported to be canceled or temporarily suspended, pointing to the strong geopolitical and economic interests at stake. Meanwhile, nuclear and coal power plants are more frequently canceled (See table 1). This may be because such projects can be more easily displaced to other locations when facing resistance compared to geologically fixed projects such as dams, mines and oil-wells. Further research is needed to examine this hypothesis. Wind, solar and other renewables are more likely to be temporarily suspended than canceled. Moratoria have been most successfully achieved in fracking cases.

One third of cases included responses such as repression, criminalization[25] of dissent and violent targeting and assassinations of activists. Repression was documented with the highest frequency in conflicts over biomass ($n = 16/32\%$), pipelines ($n = 12/32\%$), hydropower ($n = 52/28\%$) and coal extraction ($n = 14/30\%$) (See graph 4). These activities are those which are also most closely associated with displacement of populations and those with the highest intensity conflicts. Of the total cases, 65 (10%) witnessed at least one assassination of an environmental defender, with the highest occurrence in these activities.

4. Discussion: contention and justice in the energy transition

Our systematic mapping examined 649 cases of resistance movements to FF investments as well as to LCE and mitigation projects. These movements are driven primarily by opposition to the negative local social and environmental impacts of these activities and by their desire for control over land use and their livelihoods. The evidence presented here points to take-aways for policy and future research centering around three broad issues: distribution, impacts and outcomes.

4.1. An environmentally just energy transition

Place-based mobilizations point the way towards responding to the climate crisis while tackling underlying societal problems such as racism, gender inequality, and colonial and class-based patterns of exploitation and historical injustices. The mobilizations we examined unearth existing socio-economic disparities and vulnerabilities such as the disproportionate impacts of energy projects on peripheral countries and regions, including rural areas; and on marginalized groups such as Indigenous Peoples, minorities, and those who depend on nature for their livelihoods and suggest how a truly just transition can move society towards greater equity.

Through their activism, movements suggest how such inequities can be addressed based on their own specific contexts. For example, The Ende Gelände movement's fight to stop the sale of a German coal mine by Swedish company Vatenfall asks why the richest countries in the world, claiming to be dedicated to stemming climate change, need to continue to produce and burn the dirtiest fuel on the planet. Ende Gelände reignited debates in the German parliament about the sale. While Vattenfall initially expected to sell for 2–3 billion Euro, the company eventually had to pay the buyer, the Czech company EPH, 1,7 billion euros for assuming the mine's ecological liabilities in the region.[26] Germany´s planned coal exit was likely hastened by pressure from the Ende Gelände movement.

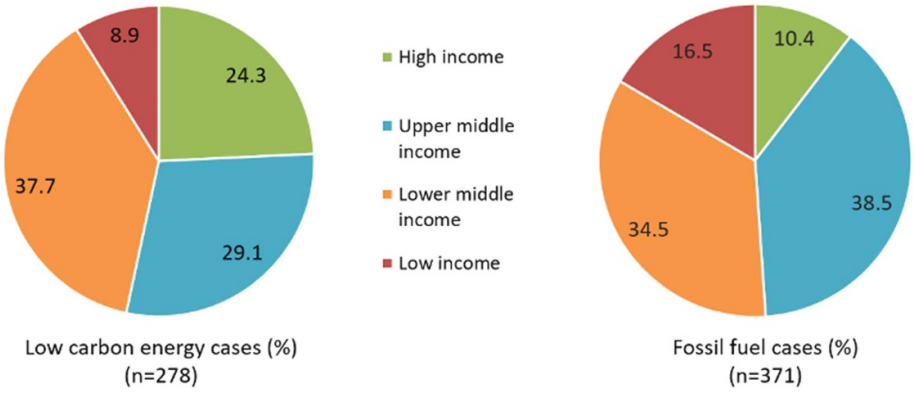
In the Netherlands, center-periphery disparities within the country were brought into focus after the biggest gas field in Europe caused over a thousand earthquakes, leading to the damage of 100 000 homes and sparking mass protests in Groningen. The mobilizations gained national support with the slogan 'Don´t let Groningen Fall Down' and ultimately led to Dutch plans to cut gas production to zero by 2030. According to the Dutch government, 'While it was technically feasible to exhaust the gas bubble, it was no longer socially acceptable'.[27]

The proposed moratorium on hydrocarbon exploitation in the Yasuni-ITT oilfield in Ecuador was based on the effective protection and collective survival of the Indigenous peoples there in conditions appropriate to their particular cultural and spiritual relationship with the territories they have traditionally occupied (Murcia and Del Mar Pérez 2015). Secondly, the moratorium built on the idea that wealthy countries should help pay for non-exploitation and biodiversity conservation in the Global South. While the attempt to create a model of international cooperation for the non-exploitation

[25] Criminalization refers to criminal prosecutions of individuals and the opening of criminal investigations unlikely to reach the trial stage which are used to disarticulate, demoralize and discourage social protest; as well as the use of disproportionate sentences for offences to punish practices often deployed in social protests.

[26] https://ieefa.org/ieefa-note-public-relations-problem-swedish-utility-coal-giveaway-czech-energy-group-%E2%80%A8/ https://corporateeurope.org/en/climate-and-energy/2w016/06/ende-gelaende-vs-vattenfall https://corporateeurope.org/en/climate-and-energy/2016/06/ende-gelaende-vs-vattenfall

[27] Groningen Gas production goes to zero 'Gaswinning Groningen gaat naar nul'. Louis Hoeks, Carel Grol: 29 March. 29 March 2018 by the Dutch Financial Times, Financieele Dagblad. Retrieved from https://fd.nl/economie-politiek/1247988/gaswinning-groningen-gaat-naar-nul



Graph 3. Distribution of cases by country income groups.

of FF resources failed in that particular case; this ground-breaking but ultimately unsuccessful initiative has spurred further initiatives to keep FFs in the ground. These include North Victoria, Australia´s moratorium on unconventional fuels (Case 2698), and Norway´s stoppage of oil exploration in the Lofoten islands (EJAtlas 2020).

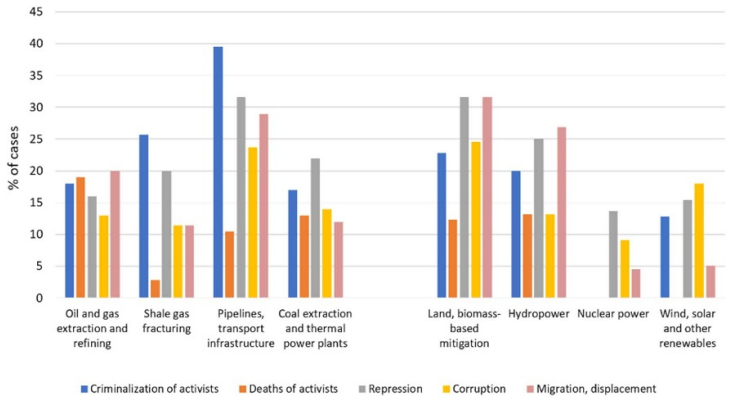
One possible model for the integration of distributive social justice considerations into energy policy towards decarbonization is the Office of Environmental Justice in the US Environmental Protection Agency (EPA), and specifically Executive Order 12 898, which requires federal agencies to consider and address the ways in which their policies affect the health and environment of low-income communities and communities of colour (U.S. EPA 1992). These legal provisions, won after years of struggle by the US movement against environmental racism (Bullard 2008), have led to numerous instances where the siting of noxious facilities in communities of colour has been halted. Mcglade and Ekins (2015) calculate that a third of oil reserves, half of gas reserves and over 80% of current coal reserves should remain unused from 2010 to 2050 in order to limit global warming to 2 °C. The integration of equity concerns in deciding on unminable and unburnable sites, including through methods such as geographical identification of Indigenous territories (Codato *et al* 2019), or through tracking social mobilizations and acceptability (Brown and Spiegel 2017, Gaulin and Le Billon 2020) would be one way to ensure a more just transition.

4.2. All that is green does not glitter

The evidence we examined highlights that FF and LCE and mitigation projects display similar levels of conflict intensity. Repression and violence against protesters and land defenders is rife in almost all activities, and particularly in those involving hydropower, biomass, pipelines and coal extraction. Globally, 10% of all cases entailed the assassination of one or more activists. This points to how LCE sources can easily replicate the patterns of violence and dispossession inherent in traditional extractive industries and operate according to the same logics that prioritize private profits over social and environmental concerns. Further, it raises the concern that the urgency of responding to climate change and decarbonizing the energy system is overriding social and environmental concerns of low carbon project impacted communities.

Amongst LCE projects, hydropower was found to be particularly socially and environmentally damaging. Solar, wind and other renewables were less conflictive, entailing lower levels of repression, which suggests that such energy projects, if implemented including aspects of distributional and procedural justice and the democratic participation of citizens and communities, hold the most promise for social acceptance. For wind and solar power, the data shows that communities do not mobilize against renewable energies per se, but against the ways in which technologies are deployed and the lack of due process in implementation. In countries of the Global South, communities advocate for mandatory social and environmental impact assessment of wind and solar power projects (Rojas 2012, CSE 2013, Patiño-Díaz 2017). They contest the mushrooming of small and mini hydropower plants over concerns that these plants risk community water sources, are being added on top of mega-hydro projects and that ownership and management remain in the hands of corporate actors rather than local governments (Islar 2012, Baker 2014, Silber-Coats 2017).

Demands for 'energy democracy and sovereignty' from mobilizations against both FF and LCE suggest that the low-carbon energy transition needs to move beyond the centralized power model of the FF regime to focus on shortening energy supply chains, 'energy sufficiency' and the construction of low-carbon alternatives to the global energy system that eschew the market in favour of collective control, universal access and social justice (Abramsky 2010). Different works highlight community initiatives in



Graph 4. Frequency of repressive outcomes.

this regard (e.g. Burke and Stephens 2017, Stephens *et al* 2018), including '(…) variegated forms of collective organisation and ownership as an instrument for achieving socio-environmental transformations (Moss *et al* 2015) and the decommodification of the provision of energy (Becker *et al* 2017)' (cited from Becker and Naumann 2017:4).

The conflicts examined also open new political spaces to discuss the social and environmental justice approach needed in the low-carbon transition. In Mexico, the long-lasting struggle against a wind power corridor in Oaxaca has led to forums on the transition and the articulation of a cooperative scheme for wind power production (Case 2108, Oceransky 2010, Avila-Calero 2017). Alternatives to the industrial expansion of renewable energies have been proposed in Greece (Case 1683) and the United States, where a controversial offshore wind power project led communities to discuss a comprehensive approach to reducing emissions in the state of Massachusetts (Case 2525). In Brazil and Colombia, anti-dam mobilizations are promoting community-run solar and small hydropower initiatives, along with just energy national policies and alliances across sectors and between rural and urban communities. These examples provide evidence of how place-based movements advance just sustainability transformations through the innovation of 'niche' grassroots community initiatives, while also pushing for top-down institutional policy changes.

4.3. Antagonistic activism as climate action

Place-based mobilizations against FF contribute to mitigation by modifying, stopping and delaying projects, leading to reduced environmental impacts and emissions as well as increased costs for project proponents. We found, in line with previous research (Martínez-Alier *et al* 2018, Le Billon and Kristoffersen 2019), that place-based movements using forms of mobilization such as protests, blockades, divestments and litigation are successfully contributing to curbing fossil-fuel production.

Project cancellation or suspension, incurred in more than one in four FF projects encountering social resistance in our sample, imply significant costs for project promoters. Establishing clear causality between mobilizations and project cancellation is fraught, as multiple factors, including fluctuations in commodity prices, can contribute to project cancellation; however social protest is a contributing factor. Other outcomes that demonstrate how mobilizations contribute to improving environmental governance of FF projects include judicial victories (10% of cases), new legislation (13% of cases), application of existing regulations (20%) of cases, new environmental impact assessment (17% of cases)

Estimating the economic impact of these project cancellations and delays was not possible in this study, however studies in Canada by think-tanks have estimated that 100 billion dollars of FF projects were scrapped between 2017 and 2019 in Canada, due in large part to local opposition (Bishop and Sprague 2019),[28] while a 2014 study estimated that anti-tar sands campaigns in Canada cost the industry 17 billion dollars in lost revenue and stymied 3 tar sands projects in 2014 alone(Sanzillo *et al* 2014).

Yet instead of being recognized for their contribution to mitigation, climate and energy justice activists are systematically violently targeted and killed for their activism. Ten percent of all cases surveyed entailed the assassination of one or more activists. This shows that despite rhetoric regarding participation, procedural injustices mean that many projects lack meaningful engagement, consultation and consent with impacted communities.

The latest IPCC report (2018) calls for strengthening the capacities for climate action of civil society, Indigenous peoples and local communities, but

[28] This includes documented projects such as CNOOC Ltd.'s Aurora LNG (case 2935), Petronas Bhd's $36-billion Pacific North-West natural gas export project (case 2554), TransCanada Corp.'s $15-billion Energy East pipeline, and the government´s revocation of the Northern Gateway Enbridge pipeline (case 376).

there is no clear roadmap for achieving this and for ensuring the participation of these underrepresented groups in climate change decision-making arenas (Brown and Spiegel 2019). This exclusion has a bearing on the framing and content of the discussion on the energy transition. The protection of environmental defenders' rights, including Indigenous rights enshrined in international law for Free Prior and Informed Consent, is a key step in meaningful participation. This means respecting the rights of Indigenous peoples not to develop, and to decide the terms of their participation into the global economy (Etchart 2017). Beyond this, global climate change governance structures should consider the creation of a formal body for incorporating Indigenous and local community input into centralized climate change decision-making along the lines of the International Indigenous Forum on Biodiversity, funded through the Convention on Biological Diversity.

The energy networks of the future will be an outcome of, and active participants in, fluid and antagonistic social and political processes. Unfortunately, global climate policy documents often frame climate action in narrow and overly consumeristic terms, for example, emphasizing shifts to energy efficient appliances or electric cars. Such a framing forecloses possibilities for active political engagement and dismisses the contributions that activists and poor and Indigenous communities make to shaping energy futures. Furthermore, the concept of 'acceptability' itself suggests a technocratic top-down approach where it is implied that communities should accept (or not) prepackaged climate solutions decided as pathways forward. The data presented here shows that citizens worldwide are seeking more active political engagement regarding what their energy systems and climate futures will look like.

5. Conclusions

This paper maps and presents mobilizations on FF and LCE projects for the first time, drawing from the largest empirical dataset on the subject currently available. We find that place-based movements are succeeding in curbing both fossil-fuel and low-carbon energy projects. Over a quarter of projects encountering social resistance have been shelved, suspended or delayed. The evidence highlights that low carbon, renewable energy and mitigation projects are almost as conflictive as FF projects, (30% of FF conflicts and 26% of LCE projects are high intensity) and that both project types particularly impact vulnerable groups such as rural communities and Indigenous peoples; Indigenous peoples are involved in 58% of the cases analyzed. Amongst LCE projects, hydropower was found to be particularly socially and environmentally damaging, leading to mass displacement and large-scale eco-system transformation. Incidents of repression or violence against protesters and land defenders occurred in one third of cases, with violent responses most common in hydropower, biomass, pipelines and coal extraction conflicts. Ten per cent of all cases involved assassination of activists. Wind, solar, and geo-thermal renewable energy projects were the least conflictive and entailed lower levels of repression than other projects.

The data highlights 'sacrifice zones' in both the FF and the emerging LCE economies (Scott and Smith 2017), as well as the claims and demands coming from project-impacted communities for a socio-environmental justice approach in building low-carbon futures (Tramel 2016, Borras and Franco 2018). Our study highlights the disproportionate impact of FF projects on marginalized groups, and suggests that the energy transition and decarbonization risk producing similarly unequal social burdens unless there is a deeper transformation of the energy system, informed by engagement and co-design with communities on the energy futures they want.

We propose that the analysis of citizen mobilizations can inform climate policy-making on demand-side or lifestyle approaches which currently rely largely on economic methods to understand citizen preferences. Increased attention to citizens' political engagement, and in particular contentious and oppositional behaviour, can illuminate more transformative pathways to just decarbonization. Further research on such mobilizations includes identifying the determinants of successful outcomes, in-depth analysis of policy and judicial outcomes, and investigation of conflicts over upstream and downstream linkages such as mining for rare minerals for LCE projects and disposal conflicts. Research should also seek to assess the contribution of such movements to shaping social norms regarding climate change and demand-side behaviours in order to shed more light on justice dimensions of the energy transition and the agency of such movements.

Lastly, we find that movements are driven by multiple concerns, climate change amongst them, and their claims and goals include localization, democratic participation, shorter energy chains, anti-racism, climate-justice-focused governance, and Indigenous leadership. Through conflicts, communities aim to meaningfully inform the coming energy regime. Attention to such demands holds potential to guide the transition not only towards a climate resilient, low-carbon, energy-sufficiency-oriented future but also towards a more just global governance system for the atmospheric commons.

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Data availability statement

The data that support the findings of this study are openly available at the following URL/DOI: https://www.ejatlas.org.

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