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Conflicted transitions: Exploring the actors, tactics, and outcomes of social opposition against energy infrastructure

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ABSTRACT

Given the growing frequency, severity, and salience of social mobilization and community action on energy and climate issues, in this study we systematically explore the configurations of types of infrastructure, actors, tactics, and outcomes of recent opposition to energy transitions across seven carbon-intensive regions in Asia, Europe, and North America. Based on both a literature review and an original dataset of 130 case studies spanning the past decade, we track opposition to a wide range of energy infrastructure in these regions, including low-carbon options such as renewable energy and nuclear power; provide network analyses of the actors and coalitions involved in such events; and develop a typology and frequency analysis of tactics (such as litigation or protest), and outcomes (such as remuneration, policy change, concessions, or labor protections). We show that the politics of energy transitions in carbon-intensive regions varies significantly from country to country and across types of energy, and we discuss how the configurations of infrastructure, actors, tactics, and outcomes can be explained by differences in national institutions and their responses to global or supranational pressures. By bringing both a sociotechnical and comparative perspective to the global analysis of social movements and energy transitions, we suggest how goals of energy transition are refracted through national and subnational institutions and through local mobilizations both in support of and opposed to those transitions.

1. Introduction

The past decade has witnessed a metamorphosis in social activism related to climate change and energy policy, with millions around the world participating in climate protests, strikes, and other forms of resistance (Boucher et al., 2021). In particular, the Global Climate Strike of 2019 led by Greta Thunberg involved an estimated 7.6 million people across 185 countries and catalyzed important concessions and notable climate pledges from corporations such as Amazon, Google, and IKEA (Martiskainen, et al. 2020).

Such climate activism and the attempts to stifle it testify to a recent, parallel rise in populism and protests involving energy systems or concerns about environmental injustice, with recent examples across actors as diverse as immigrant farmworkers in California (Chandrasekaran, 2021), right-wing parties in Poland (Żuk and Szulecki, 2020), rural communities concerned with electrification in Uganda (Trotter and Maconachie, 2018), and British citizens expressing their views about shale gas and nuclear power in the United Kingdom (Batel and Devine-

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Table 1
Summarizing three literatures of comparative studies of social opposition and energy transitions or infrastructure.

Literature	Disciplinary groundings	Predominant focus	Common unit of analysis	Key concepts	Key citations
The sociotechnical dynamics of sustainability transitions	Transition studies, innovation studies, science and technology studies	The conflicts between actors and social groups, rules and institutions, and technologies and socio-technical systems that can occur across multiple levels of an energy transition	Sociotechnical system and its governance	Technological determinism (critiques of it), sociotechnical systems or configurations, niches, regimes	Geels et al. (2016), Köhler et al. (2019), Hess and Sovacool (2020)
Social opposition and social movements	Sociology, political science, environmental and energy justice, political ecology	Patterns of movements and opposition, identification of injustice, outcomes and remediation	Social movement or case of opposition mobilization	Coalitions, forms of energy justice, tactics	Levenda et al. (2021), McAdam and Boudet (2012), Sovacool (2021), Temper et al. (2020)
Capitalism, policy styles, and democratic cultures	Energy studies, political economy, institutional studies, organization studies, public policy, governance	Different traditions of institutional orders, regulatory intervention, policymaking, and culture will affect conflicts and mobilizations	Energy project or country case study	Institutional styles, policy styles, varieties of capitalism, energy cultures	Jasper (1992), Jasanoff (2005), Toke et al. (2008), Mendonça et al. (2009), Andrews-Speed (2016), Stephenson et al. (2021), Geels et al. (2021)

Source: Authors.

Wright, 2018). One study noted, "As the energy transition proceeds, local opposition against various energy developments is increasingly widespread" (Ocelík et al., 2021, p. 1). Opposition to energy infrastructure or climate policies attempting to shape them can arise from a variety of drivers, including sense of place identity (Devine-Wright and Batel, 2017), political ideology (Stanley et al., 2021), views about climate science or economic growth (Vesa et al., 2020), a commitment to anarchist or green-anarchist ideology (Sovacool and Dunlap, 2022), and perceived poor social safeguards or heightened environmental risks to projects (Kirchherr et al., 2016).

However, such efforts of opposition accompany calls for greater community involvement, increased attention to broad justice issues or the equity implications of decarbonization pathways (Patrizio et al., 2020), and, sometimes, a reorganization of who owns, and benefits from, energy projects (Burke and Stephens, 2017). These mobilizations have begun to permeate policy planning efforts and formal regulatory documents (Szulecki and Overland, 2020). For example, the European Union Clean Energy Package prescribes the removal of barriers for the development of local and community-owned energy projects.

Community mobilization, protest, and social opposition matter not only because they can reflect democratic ideals and hold important decision-makers more accountable for their decisions, but also because they can impact energy security or result in lost revenues and even violence. In Australia and the United Kingdom, for example, saboteurs have already forced coal-fired power plants to unexpectedly shut down or forced the closure of export terminals for coal and liquified natural gas (Sovacool, 2013). In Brazil, hundreds of women occupied industrial sugar mills to protest their position on gender and labor practices connected with ethanol and biomass cogeneration, actions that resulted in the suspension of operations for weeks; in the Guangdong province of China, police killed as many as twenty people for protesting against lack of compensation for land for local wind farms (Abramsky, 2010, p. 522).

Some of these incidences are certainly alarming and some were illegal. But from the participants' perspectives, some of the tactics were justified given the lack of response from institutional actors. Such actions and "community defiance" can cost companies millions of dollars in delays, lawsuits, missed opportunities, social dislocation, and damage to corporate reputations (Piller, 1991). Social opposition to energy infrastructure more generally has become so frequent in modern society that one commentator quipped that "not in my backyard" sentiments, or NIMBY-ism, was rapidly turning into "build absolutely nothing anywhere near anything," or BANANA (Horvath, 2004). However, we do not view opposition from the narrow perspective of NIMBY-ism, a concept that scholars from several social sciences as different as sociology, geography, political sciences, and critical psychology have criticized since the early 1990s (Freudenburg and Pastor, 1992; Wolsink, 2000; Devine-Wright, 2009; Burningham et al., 2015; Batel, 2018; Cuppen, 2018); rather, as some of those very scholars have suggested, we view it from the broader lens of social movements and mobilized publics.

Given the growing frequency and salience of social mobilization and community action on energy and climate, in this study we systematically explore the actors, tactics, and outcomes of opposition to low-carbon transitions across seven carbon-intensive countries with different types of carbon-intensive regions across Asia, Europe, and North America (see Table 1). We use the concept of mobilization in a broad sense that is consistent with its use in the social movements literature, that is, networks of individuals and organizations that utilize institutional and/or extra-institutional tactics to gain responses to grievances from incumbents (in the state, industry, or other organizations) who are perceived as responding inadequately to those grievances. Based on an original dataset of 130 case studies, we ask: Against which forms of energy infrastructure does opposition occur? Who are the actors and coalitions opposing (but also supporting) those infrastructures? What tactics did they use (litigation, protests, etc.)? What were the outcomes (remuneration, policy change, concessions, labor protections, etc.)?

In proceeding to answer these questions, we hope to make multiple contributions. First, we offer a comprehensive and interdisciplinary review of the recent literature on social opposition to energy transitions and energy infrastructures, to identify key themes within the literature and to reveal critical gaps that we seek to address in our study. Second, we hope to add to the social science energy literature on opposition and social acceptance, especially within a growing corpus of research that emphasizes how the siting, construction, adoption, or decommissioning of various renewable electricity systems and infrastructures such as high-voltage transmission lines can be contested by local communities and other stakeholders. Third, we intend the paper to inform activists, local communities, and other affected groups around the world on which types of coalitions and tactics might work better or be riskier and for which outcomes, within a perspective of generally increasing the democratization of these processes and associated justice issues at a global level.

2. Social opposition and energy transitions: Reviewing the literatures

In this section, to both set the context and also to summarize key themes (and gaps), we present the result of a review of the *recent* literature on energy transitions and social opposition, with a focus on peer-reviewed studies (indexed in Scopus) published in the past twenty years, i.e., generally from 2002 to 2021. We focus on three broad areas of research: (1) the sociotechnical dynamics of sustainability transitions;

(2) the role of social movements, opposition groups, and contestations over energy and environmental justice; and (3) studies examining varieties of capitalism, policy styles, and the embedding of democratic cultures. We recognize that there are vast literatures here, and our strategy in this section is to provide some crucial points of orientation. To keep the review focused and relevant to the comparative project of this study, we highlight mostly comparative research. Table 1 offers a high-level summary of each of these literatures.

Notably, while some studies fall entirely within one body of literature, others cut across these three literatures and can produce rich, thick accounts that capture linkages between institutions, sociotechnical systems, social movements, policy styles or culture, and case studies or examples of opposition or injustice. The different categories of studies also use common heuristics and methodologies, including not only comparative approaches but also social actors or institutions as their unit of analysis.

2.1. The sociotechnical dynamics of sustainability transitions

With respect to energy social science research, there is growing attention to sociotechnical perspectives in energy social science research, and there are reviews available (Hess and Sovacool, 2020). Although there are many versions of these perspectives, we are most interested in how they can help to avoid a technologically determinist approach to social opposition and energy transitions, that is, the idea that resource endowments can explain in a relatively straightforward way the configurations of energy systems, policy choices, and political conflicts. Indeed, some of the differences between the countries are related to endowments of different natural resources that lead to reliance on different types of energy technologies.

In contrast, in this study we argue for the analysis of how the national configurations of state, industry, energy technologies, and civil society can contribute to the explanation of the patterns of mobilization (e.g., actor types, their networks, their tactics, and outcomes). We are careful not to overstate causal claims about how sociotechnical configurations and institutional dynamics of countries are related to patterns of mobilization and outcomes, but we also intend to show the value of this type of analytic strategy for the literature.

There is a significant body of comparative, sociotechnical research in the energy social science field. One example that informs our study is the comparison of sustainability transitions across countries (Geels et al., 2016). This approach includes actors and social groups, rules and institutions, and technologies and socio-technical systems. The central conflict, as in much of sustainability transition studies, is generally between regime and niche actors, which have opposing positions in technological, industrial, and political conflicts between high-carbon versus low-carbon alternative. The analytical strategy is historical and processual; that is, it examines the changing configuration of actors and technologies over time at a national level.

Social movements, such as the anti-nuclear movement (Rüdig, 1990; Tarasova, 2017), can appear in this type of analysis (see especially Section 2.2), and the comparative analysis of institutional differences (see Section 2.3) can appear in this literature, but the locus of attention is more on the broader national policy conflicts over the goals and direction of energy transitions and sociotechnical systems. Thus, we draw on the work on energy transitions and institutional dynamics by assuming that carbon-intensive regions are embedded in long-term energy transitions, but we also recognize that these transitions are generating especially intense conflicts in these regions. Some of the conflicts are over the sunsetting of fossil fuel, but some of them also are about new forms of fossil-fuel extraction (e.g., natural gas), new forms of low-carbon energy (e.g., wind farms), the use of nuclear energy, and the defense of threatened fossil-fuel industries.

2.2. Social movements and public opposition

A second important perspective involves the recognition of the role of social movements and public opposition. Two helpful definitions of a social movement are "a network of informal interactions between a plurality of individuals, groups and/or organizations, engaged in a political or cultural conflict, on the basis of a shared collective identity" (Diani 1992: p. 2) or "collective challenges, based on common purposes and social solidarities, in sustained interaction with elites, opponents, and authorities" (Tarrow 2011: p. 11). Although many of the studies in this group include perspectives from social movement studies, we define this area of research in broader terms to include studies that examine opposition in energy infrastructure cases as well.

One important perspective in this second group of studies is the analysis of opportunity structures. For example, Kitschelt's (1986) classic comparative analysis of anti-nuclear social movements identified institutional characteristics of national governments that contributed to more or less open opportunities for social movements and that affected the potential for effective outcomes. The opportunity structure described in this study is one central concept in this literature that connects the analysis of institutional structures with strategic action. Subsequent research after foundational studies such as Kitschelt (1986) resulted in significant modifications of this approach, including the conditions under which opportunities were more or less open, and recognition of the temporality of opportunity structures (McAdam, 1996; Meyer and Minkoff, 2004). In other words, some institutional features are relatively stable (e.g., constitutionally mandated separation of powers), whereas others are more ephemeral (e.g., changes in party control) (Kriesi, 2004). Researchers also diversified from the focus on political opportunities to examine opportunity structures in other fields, such as the industry opportunity structure (Soule, 2012). They recognized that opportunity structures also change in a dynamic process that includes responses to mobilizations.

Another relevant area for this study is research on outcomes or consequences of mobilizations. The topic is complicated, partly because outcomes may not match the goals of coalitions (e.g., unintended outcomes or broader outcomes that researchers identify) and partly because the goals of mobilizations vary over time and across actors in a coalition (Amenta et al., 2010). There is also a potential problem of sampling on the dependent variable; in other words, it is possible that outcomes could have occurred in the absence of a mobilization. This problem can be solved either by including cases of infrastructure development for which there was no mobilization or by limiting the scope of the analysis to the question of how differences between types of mobilizations are associated with outcomes. In cases where researchers have studied both mobilizations and non-mobilizations for energy infrastructure, the presence of a mobilization is linked to movement goals such as not building a site (McAdam and Boudet, 2012).

An important dimension of outcomes-oriented research is the attempt to specify the conditions that lead to outcomes that are at least partially aligned with coalition goals. Some of the studies have suggested that different types of tactics have variable effectiveness. For example, there is fairly consistent evidence that gaining support from government officials is important (Hess and Satcher, 2019; McAdam and Boudet, 2012; Sherman, 2011), but research is more mixed (or context-dependent) for other tactics such as litigation and protest (Hess et al., 2021a). There is also converging research that suggests that the breadth and/or strength of coalitions are important for outcomes (Hess et al.,

2021a; Janzwood, 2020; Mix, 2011). Moreover, network analysis indicates that tactical choices of actors are related to their embeddedness in coalition networks (Hadden and Jasny, 2019). Protest can also play an important role in some mobilizations (Rootes 1997; Rootes, 2003; Sovacool and Dunlap, 2022).

Moreover, this literature draws attention to the composition of coalitions, which is an important perspective for the current study. Rather than focusing just on social movement organizations, the research also draws attention to the role of trade unions with respect to energy transitions (Räthzel and Uzzell, 2011), or the emergence and intensity of resistance by local communities to energy resources (Conde and Kallis, 2012). Shah et al. (2021) examined social opposition against four large hydroelectric dams in India, Colombia, Spain, and Lesotho. These cases showed the importance of diverse and broad coalitions that include urban elites, lower-income communities, allies in other industries, and multi-scalar governmental actors. Peet and Watts (2004) offer a compendium of ecological and environmental mobilizations around the world, including many energy-related conflicts, and show a similar diversity in both the composition of opposition groups and their tactics. Likewise, in a study of movements resisting coal in the United Kingdom and Indonesia, Brown and Spiegel (2017) identify the importance of "translocal solidarities" and multi-scalar coalitions that involve global actors supporting an "end coal" campaign.

Some of the research in this area is less directly tied to social movement studies frameworks but nevertheless provides important perspectives on agency and opposition. In a comparative study of global resistance to energy projects, Temper et al. (2020) document not only mobilizations against energy projects but also responses from governments and energy actors that draw attention to the agency of incumbent actors. They show that violence and acts of force against protestors are more common than thought, with about 10% of cases involving the assassination of activists. Such acts of violence were prominent among not only cases of coal extraction and biopower but also hydropower and biomass. Comparatively, wind, solar, and other renewables were the "least conflictive" and had the lowest levels of perceived impacts. Likewise, Sovacool (2021) conducted a review of a fairly large sample of case studies of climate change mitigation actions, policies, or transitions (more than 330). He delineated four main processes by which energy incumbents can harm local environments and communities. Similar to Temper et al. (2020), Sovacool (2021) reports 62 cases of acts of violence, including murder and torture, and also 61 cases of where energy projects dispossessed or negatively impacted indigenous peoples. In another comparative study of global scope, Levenda et al. (2021) categorized incumbent action from a justice perspective and showed that there were both distributive and procedural justice problems and corresponding frames used by opposition actors.

Some of the research in this area also points to the importance of comparing different types of energy infrastructure, a topic that connects with the first area of research, which also draws attention to the material dimensions of energy conflicts and transitions. For example, Levenda et al. (2021) found that hydropower and municipal solid waste facilities had the most documented instances of perceived environmental injustice. Baigorrotegui (2019) examined the social opposition to two large electricity projects in Chile, a large hydroelectric dam and a coal-fired power plant. The study noted that collective action tactics were very effective in stopping both projects, and that the tactics included the media and bottom-up *communitas* in their daily struggles against the energy projects. The study draws from these two cases to argue that three mechanisms of opposition often occur: pressure, obstruction, and public overflow, all of which question the state of neoliberal energy transitions in Chile.

In summary, this literature often is connected with the analysis of sociotechnical change and political conflict identified in the first group, but it also identifies other crucial topics that are important for the analysis that follows. These topics include opportunity structures, outcomes, tactics, coalition composition, incumbent strategic action, and types of infrastructure.

2.3. Capitalism, policy styles, and democratic cultures

Last but not least, there is an extensive literature and research on different political and national contexts and the relation of institutional differences with respect to energy-related conflicts. These studies can also engage with analyses of higher or lower levels of energy democracy, or energy justice, or the principles of good governance, all of which can create more (or less) opposition against energy projects.

One stream of this work has been termed "variants of capitalism" or "varieties of capitalism" and comparative institutional approaches in energy research (for a review, see Andrews-Speed, 2016). Again, research in this area can overlap with comparative studies of sociotechnical transitions and associated policy conflicts, and it can overlap with institutional dimensions in the study of public opposition. Research utilizing this perspective attempts to categorize or explain how different countries embrace (or reject) market forces related to energy production and use, resource management, industrial relations, and other activities, which then impact social perceptions and the scope and severity of public opposition. Some countries promote liberal market policies, and others prefer to centralize or coordinate actions (Hall and Soskice, 2001). Spencer et al. (2005) argued that national political institutional structures for energy innovation, for instance, can differ organizationally and socially. They suggested that such institutions can fall into four quadrants: social corporatist; state corporatist; liberal pluralist; and state nation. They noted that Denmark is a typical example of a social corporatist country and that the United States is a typical example of liberal pluralist nation. In social corporatist nations (Denmark), the role of the state is to facilitate and not to dictate, whereas in the liberal pluralist nations (the United States), the state is relatively weak and has thus a smaller role in technical development. Whitley (2000) also explored the institutional structure for innovation in capitalist countries and found that the United States was more corporatist, fragmented, and even destructive. The result is that many energy and technology firms that could not compete went bankrupt. The European environment, by contrast, was more cooperative, publicly supported, and populated by smaller and medium size enterprises.

An important implication of this group of studies is that the "varieties" in institutional orders or capitalist societies can lead to different degrees of conflict, or social legitimacy, for energy planning and projects. Mendonça et al. (2009) noted that the cooperative, bottom-up, and community inclusive approach to energy planning in Denmark explains why so few wind farms are opposed there, compared to the corporatist, top-down, community exclusive approach taken by the United States. Toke et al. (2008) similarly analyzed six country cases (Denmark, Spain, Germany, Scotland, the Netherlands, and England/Wales) and argued that those with supportive "national traditions" of robust planning systems, strong financial support mechanisms, landscape protection measures, and local ownership patterns have more favourable rates of acceptance (i.e., less opposition). Sataøen et al. (2015) noted that countries in northern Europe, such as Norway, historically have a

Table 2
Overview of seven geographic regions chosen for our analysis.

Location	Silesia*	North Rhine-Westphalia (NRW)	Western Macedonia	Ida-Virumaa	Central Appalachia**	North East***	Coastal Norway****
Country	Poland	Germany	Greece	Estonia	United States	India	Norway
Primary industries	Hard coal mining, power generation, basic metals, automotive manufacturing	Lignite mining, power generation, aluminum production, paper, petrochemicals, automotive manufacturing	Lignite mining and power generation	Shale oil, mining, and power generation	Coal mining, natural gas extraction	Nuclear power, hydropower, rail networks, coal mining, and fossil-fueled agriculture	Oil and gas supply, fisheries, shipyards
Degree of diversification of the regional economy	high	high	low	low	medium	low	low
Degree of urbanization	urban	*peri*-urban	peripheral	peripheral	*peri*-urban	peripheral	peripheral

Source: Authors. Some of our regions encompass informal geographic areas (i.e., Appalachia, Costal Norway) whereas others encompass formal administrative areas (i.e., Ida-Virumaa or Western Macedonia). Since the main aim of this study is to analyze each region's conflict characteristics, rather than rank countries by their conflict potentiality, the heterogeneity of our datasets is an additional strength to the analysis.

* Includes Upper and Lower Silesia in Poland.

** The Central Appalachia Region of focus for this study includes all of West Virginia, western Virginia, and eastern Kentucky.

*** The Northeast of India consists of the eight states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura.

**** Includes cases along the Norwegian coast, from Bergen to Kirkenes.

tradition of decentralized and participatory inclusion (e.g., strong democracy), and as a result the frequency of protests against energy infrastructure (in this case transmission lines or grid development) is fundamentally different than in Britain or even Sweden.

A final stream of work in this area emphasizes the import of either policy styles or policy cultures, and how these may link to patterns of inclusion (acceptance) or exclusion (opposition). For example, in contrast with a more precautionary and qualitative approach in Europe, the United States has at times exhibited a policy style of managing risks to energy systems (such as nuclear power) based on open and adversarial processes of rulemaking, litigation, and reliance on formal quantitative measures of costs and benefits (Jasanoff 2005). Jasper (1992) classically and humorously characterized French policymaking around nuclear power as consisting of "gods" (governments), "titans" (large industries and utilities), and finally "mortals" (the general public). The institutional key to success in France was the extremely limited number of institutional actors: "mortals" never got their say or the ability to oppose major plans. Geels et al. (2021) more recently examined four policy styles to promoting smart meters (often linked to renewable energy) and noted how some of them can germinate severe opposition. According to them, and using analogies to winter sports activities:

- The Netherlands utilized a style of an initial push-approach, but after societal opposition they switched to a curling path, in which various "brooming" activities (societal debate, technical adjustments, pilot projects) increased alignments that improved social acceptance;
- The Portuguese program had a style like a snow-balling pathway, in which the first pilot project was followed by others, which enabled learning and alignment and steadily increased company confidence and social acceptability;
- The United Kingdom's style had characteristics of a halted snow-shoveling machine, with the government powering ahead (working like a machine) and pushing objections (snow) aside, until accumulating social acceptance problems piled up to block and halt the transition, due to high amounts of opposition and low levels of acceptance.
- The Norwegian style is characterized as a ski-jump, in which prolonged preparations ("descending down the ramp") through experiments, network building, and stakeholder consultations enabled a fast "jump" towards targets without much social opposition.

Stephenson et al. (2021) take a different approach and argue that national energy cultures can strongly shape the desirability of different energy and climate pathways. These cultures can be shaped by the feasibility of different technologies but also other factors such as economic dependency on fossil fuels and degrees of state involvement in the energy sector.

2.4. Synthesis

In the sections to come, we draw on these three background literatures to inform the range of questions that we ask about mobilizations in carbon-intensive regions. From the literature on policy conflicts and sustainability transitions, we pay attention both to role of natural resources in shaping energy transitions and to conflicts over the governance of energy transitions and systems. From the social movements literature and empirical research on public opposition, we examine tactics, coalitions, outcomes, and differences across types of infrastructure. From the studies on institutional and policy styles, we examine how differences in law, political organization, or cultural resources can affect mobilization and outcomes.

3. Research questions, case selection and analytical protocol

This study aims to bring a comparative, sociotechnical perspective to the study of public opposition or social mobilizations to energy infrastructure. In this section, we describe our four key research questions, explain our selection of seven regions for analysis, and elaborate on how we built a unique dataset of 130 cases.

3.1. Research questions

Our original goal was to determine if different types of tactics were

Table 3
Definitions of Variables for Energy Infrastructure, Tactics and Outcomes.

Infrastructure Type (N = 10)	Tactics (N = 8)	Outcomes (N = 8)
Power-line transmission (TRANS)	Meetings, consultations, and participation in regulatory hearings (MEETI)	Low-carbon status quo (SQLOC)
Wind power (WINDP)	Litigation, includes defense against litigation by incumbents (LITIG)	High-carbon status quo (SQHIC)
Solar power (SOLAR)	Rallies or protests (RALLI)	Neutral-carbon status quo, for power-line transmission cases (SQNEU)
Hydropower (HYDRO)	Petitions and public comments (PETIT)	Proposed project not built or existing project phased out (NOTBU)
Pipelines for oil or gas (PIPES)	Gaining an independent assessment (GAINA)	Change design or route (CHADE)
Coal mining (COALM)	Use of experts and research (UEXRE)	Delay project (DELAY)
Oil and gas wells (OGWELL)	Articulate alternative plan (AAPLA)	Provide compensation or remediation (REMED)
Nuclear energy (NUCLE)	Suppression and/or violence, including suppression of protest (SUVIO)	Broader policy or regulatory change (BROCH)
Oil and gas processing plants (OCGPP)		
Oil and shale-gas extraction or quarries (OSHQU)		

related to outcomes such as decisions to build or not to build a proposed infrastructure (or to provide remediation if it was built). However, the analysis did not reveal strong associations at an aggregate level between tactics and outcomes, and we became increasingly convinced that causal analysis of the relationship would require a different type of study design. For example, our more detailed knowledge of some of the cases indicated that some tactics (such as successful litigation) could be linked to outcomes. Conversely, a large dataset with a more limited scope (such as one type of energy infrastructure mobilization in one country) might also provide more meaningful connections. Thus, our approach shifted increasingly toward identifying and describing the configurations of energy infrastructure mobilizations and how they are related to institutional differences across countries.

To this end, the study addresses the following descriptive questions:

1. What types of energy infrastructure have become the target of social movement mobilizations, and how do the types vary across countries?
2. What types of actors are involved in the coalitions, and how does the coalition composition vary across countries?
3. What tactics are used in the mobilizations?
4. What outcomes occur, and what associations are there with types of infrastructure and tactics?

The four questions provide the basis for a broad description of the main characteristics of mobilizations regarding energy infrastructure in carbon-intensive regions. We then use these descriptions to develop a discussion of how the configurations of mobilizations are associated with the broader institutional and sociotechnical differences across the regions.

3.2. Case selection and regional context

The comparative perspective encapsulated in our project includes seven countries and diverse types of social mobilizations related to energy infrastructure. The project is based on an international effort involving teams of social scientists located on four continents. We focus on four carbon-intensive regions in the EU with comparison cases from three other non-EU regions (See Table 2).

We argue that the more descriptive project that emerged from our research also provides several contributions to the literature. First, we draw attention to the need to study carbon-intensive regions comparatively because they are at the forefront of efforts to promote a "just transition" and often have some of the most pressing concerns about energy equity or physical infrastructural vulnerability (e.g., to terrorist attacks) (Carley et al., 2018; Mayer et al., 2020; Snyder, 2018).

Second, we move well beyond the use of English-only data and rely on a systematic mapping of cases using ten languages, with either native speakers leading the data collection or utilizing advanced automated translation software.

Third, whereas previous work on opposition has tended to look at energy supply and demand exclusive of distribution (Temper et al., 2020), our criteria include high-voltage transmission grids for electricity or gas distribution networks. This is relevant as renewables-based electricity systems are presumed to require a vast increase in the density and distribution of transmission infrastructure (Larson et al., 2020; Mortaz and Valenzuela, 2019).

Fourth, whereas previous work has examined the characteristics of conflict and conflict triggers for some forms of opposition, here we look more deeply at actors and their coalitions, and most critically, at a broader typology of tactics and outcomes. We offer an exploration of a greater range of tactics and their differentiated outcomes, and we explicitly compare countries and opportunity structures.

Fifth, we conduct network analysis using original data, including state-of-the-art visualization techniques, for our network diagrams. The network analyses show connections between types of actors and their tactics, thus allowing us to see differences in the configurations across countries.

Sixth and lastly, we develop a comparative, institutionalist approach to explaining the different configurations across the countries.

3.3. Research design and analytical protocol

With our questions and case study regions selected, our research design centered on the construction of an original dataset followed by rigorous analysis including bivariate statistics as well as network visualization.

3.3.1. Dataset construction

We began by building an extensive, original dataset of case studies consisting of events of energy opposition across our seven regions. We coded for five distinct variables for each case study:

- The type of energy infrastructure (including coal mines, oil and gas pipelines, oil shale quarries, wind, solar, and hydroelectric renewable energy installations, oil and gas wells, nuclear power stations, and transmission lines);
- The actors involved (including multiple actors in coalitions), including both those opposing and those supporting the existing infrastructure or the new infrastructure project;
- Their tactics (including rallies, litigation, regulatory hearings, etc.);

- The outcomes (including no change, project delays, compensation measures, project withdrawal, violence, etc.);
- Case duration

Our coding template is offered in Appendix I, and the list of cases is in Appendix II.

To develop a manageable dataset within our resource constraints, we restricted the cases to active opposition in the selected areas from 2010 to 2020. For longer conflicts that began before 2010, we calculated their duration as if they had started in January 2010. In order not to exclude ongoing cases from our database, we calculated their duration until December 2020. To ensure that our dataset was as accurate as possible, we only included cases for which we had sufficient information to reliably complete our coding template. We did include cases where actors from a given region acted outside our target regions—e.g., to lobby or litigate in a capital city or national location. We also included petitions or mobilizations to keep energy infrastructure open, that is, not only to close it down. We also included events that were focused on infrastructure-related policies in addition to events focused specifically on infrastructure.

In what follows, we use the terms "initiative" or "case" without distinction. However, we first need to clarify what we mean by saying that we used "cases" as units of analysis. Each case consists of an initiative or campaign in favor of or opposed to a particular type of energy infrastructure. In turn, the initiative is comprised of various events that can range in duration up to many years. A caveat regarding this point is that the case duration also depends on specific conflict modality for each event. For example, demonstrations typically last one or a few days, but the same groups may engage in multiple demonstration events over time, and litigation processes last the longest (up to several years).

In this study, initiatives were classified according to infrastructure type that met the inclusion criteria. To be included, an initiative had to take place during the decade of 2010–2020. Although some initiatives started before 2010 and some were ongoing at the moment of finalizing this study, at least some of the events had to occur during this period. The period provided an opportunity to identify multiple cases in each region that could be researched within the resources available. An initiative also had to include a mobilization of actors, including nonstate actors, either in support of the infrastructure, opposed to it, or both. With respect to technology categorization, we categorized nuclear and renewable infrastructures as low carbon, and fossil fuels and associated thermal power plants as high carbon.

The coding required a decision rule for counting non-coordinated versus coordinated events as part of one initiative or as a separate initiative. Some non-coordinated events relating to the same energy infrastructure occurred at different places at the same time (for example, different groups of activists protested against the same coal mine at the same time in Düsseldorf and Aachen in Germany). We treated these as separate cases because the actors were different and were not coordinating. Likewise, if the actors were coordinating among themselves, we considered the events as part of the same case even if the events occurred at related but different sites (e.g., mining unions' protests at several mines in Poland).

With these exclusion and inclusion criteria set, we then built a dataset of 130 distinct cases based on the English academic and policy literature, as well as local media coverage in all case study regions. The media coverage included materials published in German (North Rhine-Westphalia—NRW, henceforth), Norwegian (Coastal Norway), Estonian (Ida-Virumaa), Hindi, Assamese, Bengali, Meitei and English (North East India), Polish (Silesia), and Greek (Western Macedonia). Data were gathered through web searches using keywords for the type of infrastructure, country, and word stems. For the U.S. region, searches also included ProQuest News and Newspapers and extensive reading of newsletters of the central nongovernmental organizations (NGOs) active on the issues in the region. For the other regions, searches were initially conducted through LexisNexis®, the world's largest electronic database for public-records-related information, and then enriched through further, off-database web searches. A detailed table showcasing all 130 cases is offered in Appendix II. Central Appalachia (U.S.) had the most cases (46) followed by NRW (Germany) (32), Silesia (Poland) (21), Coastal Norway (14), North-East India (7), Ida-Virumaa (Estonia) (5) and Western Macedonia (Greece) (5).

3.4. Variables, coding, and analysis

Variables were created for infrastructure type, tactics for opposition to or in support of the infrastructure, actors involved in the initiatives, and outcomes (see Table 3). These variables were drawn from previous research that used a similar method (Hess et al., 2021a; Hess et al., 2021b). The main outcome variables were related to the status of the infrastructure, which can include not built, phased out, changes in design, delays, or remediation/compensation. In addition, we coded for an outcome of no change for an existing infrastructure after opposition. We also tracked a no change outcome when, once a government decided to phase out an infrastructure (for example, a coal mine), infrastructure advocates would oppose the phase-out but ultimately be defeated. As a consequence, we had to distinguish between two status-quo outcomes. For example, low-carbon status quo included renewable-energy sites that were not closed or that were built as proposed; high-carbon status quo included fossil-fuel extraction sites that were not closed or that were built as proposed; and neutral-carbon status quo was for transmission lines that were built as planned or not changed.

The study also included variables to measure the strength of mobilization, including the number of actors supporting and opposing the project, and the length of the project in years. The data also tracked the actors involved in each case, which included civil society organizations, institutional actors (including government actors), and community actors.

The coding was made on Excel spreadsheets with the cases as the rows and the actors as the columns. The first data set was by country and included binary variables for the type of infrastructure, the position of the actor as either in favor of the infrastructure or against it, and the presence or absence of the actor in the case. This data set was used for the descriptive statistics in Fig. 1. The network analyses (Table 4) were conducted in R, and the visualizations (Figs. 3 and 4) were produced through Gephi. The second Excel data set included the country, the type of infrastructure, the carbon content (low carbon, transmission lines, and fossil fuels), the tactics used by the actors, the duration, and the outcomes. The data set was used for Figs. 2, 5, and 6, and to complete bivariate analyses with a focus on relationships to outcomes. For the dataset as a whole, we conducted only bivariate analyses because there was insufficient power for multivariate analyses such as multilevel modeling.

3.5. Limitations

Although we took care to execute a research design that was as rigorous, timely, and accurate as possible, some limitations do exist. Our reliance on media reports means that the dataset tends to oversample on higher-profile cases, that is, cases with most information or media attention. Likewise, not all types of opposition tactics will appear with

equal frequency in the media; for example, large protests and major litigation are more likely to gain media attention. Although lobbying government officials may also tend to become invisible in this method, the crucial outcome (public support for the coalition from the officials) is not. We defend the method based on two arguments. First, the assembly of a medium-sized dataset based on detailed ethnographic interviews is prohibitively expensive, and the methodological bar would mean that no comparative research would likely be done. Second, the method enables some comparisons of the relative frequency of tactics that are prominent enough to gain attention in the public sphere.

Another limitation is that the dataset is focused on cases where there was opposition; in other words, we do not examine all cases of energy infrastructure to determine the causes for opposition or lack of opposition (McAdam and Boudet, 2012). Although we recognize the value of building datasets that begin with all infrastructure and then assess the causes of mobilization, there is also room for research that examines patterns that emerge in datasets where mobilization is present and visible in the public sphere.

Regarding the number of cases, we had to decide whether instances would count as single events or long-term campaigns. For example, in Poland, several protests were organized by Silesian miners' trade unions but were staged in different locations throughout the country. Demonstrations would typically take place in Katowice or Warsaw, railway blockades at the country's borders, and underground sit-ins in local mines. Although one could consider all of these events as links in a single, temporally long chain with opposition to coal phase-out as a common aim, we decided to consider them as separate cases, unless they were based on a coordinated effort—for example, organized by the same trade union or confederation of unions—and were separated in time by less than one month. To ensure that cases were restricted to initiatives or campaigns, we excluded protests against single legislative acts, but included protests against broad energy policies (for example, protests against the extension of the life of nuclear reactors in Germany and protests against coal phase-out in Poland).

The U.S. dataset was constructed prior to the others. It includes government and business actors where salient, but the dataset focused on civil-society mobilizations in favor of renewable energy or against fossil-fuel energy. Datasets from other countries included mobilizations by all actors (i.e., civil society, industrial firms, governmental institutions). This was accounted for in the development of findings and is noted where appropriate.

The regions we considered vary considerably in their extension and administrative definition: while the four EU cases all correspond to administrative regions, this is not the case for Norway, which includes a territory spanning coastal areas of several administrative regions; India, whose North East includes eight states; and the United States, where the region includes three states in Central Appalachia where coal mining is prominent (Kentucky, Virginia, and West Virginia). Again, this was accounted for when formulating findings and is discussed where relevant.

The cases included in our dataset vary considerably with respect to their historical, political, economic, and social characteristics. As a plus, they span most existing types of energy extraction, production and transmission infrastructures in countries located in three continents. However, six out of seven countries included in our set are located in the Global North, and only India is in the South. Although we believe that our findings are generalizable to transition-related conflicts in the northern hemisphere, we encourage future researchers to test our results and conclusions in Global southern countries.

4. Results: The conflicts, institutions, actors, tactics and outcomes of energy opposition

Results are presented in the following sections that respectively present our key themes concerning conflicts, countries and institutions, actors and coalitions, tactics, and outcomes.

4.1. Conflict and energy infrastructures

This section addresses the nature of conflicts and their geographic dispersion and duration. As Fig. 1 summarizes, our 130 cases involved 9 different classes of energy technologies or delivery systems. Across the

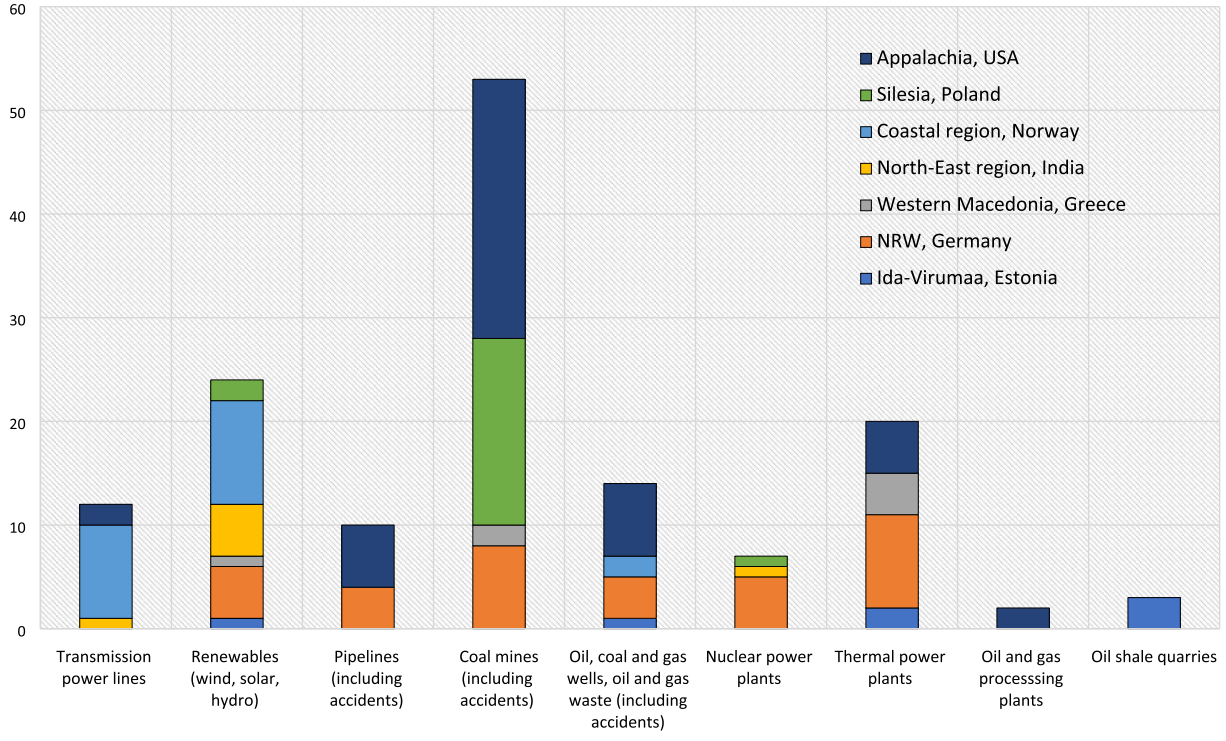


Fig. 1. Transition-related cases of opposition and community mobilization by type of related energy infrastructure.

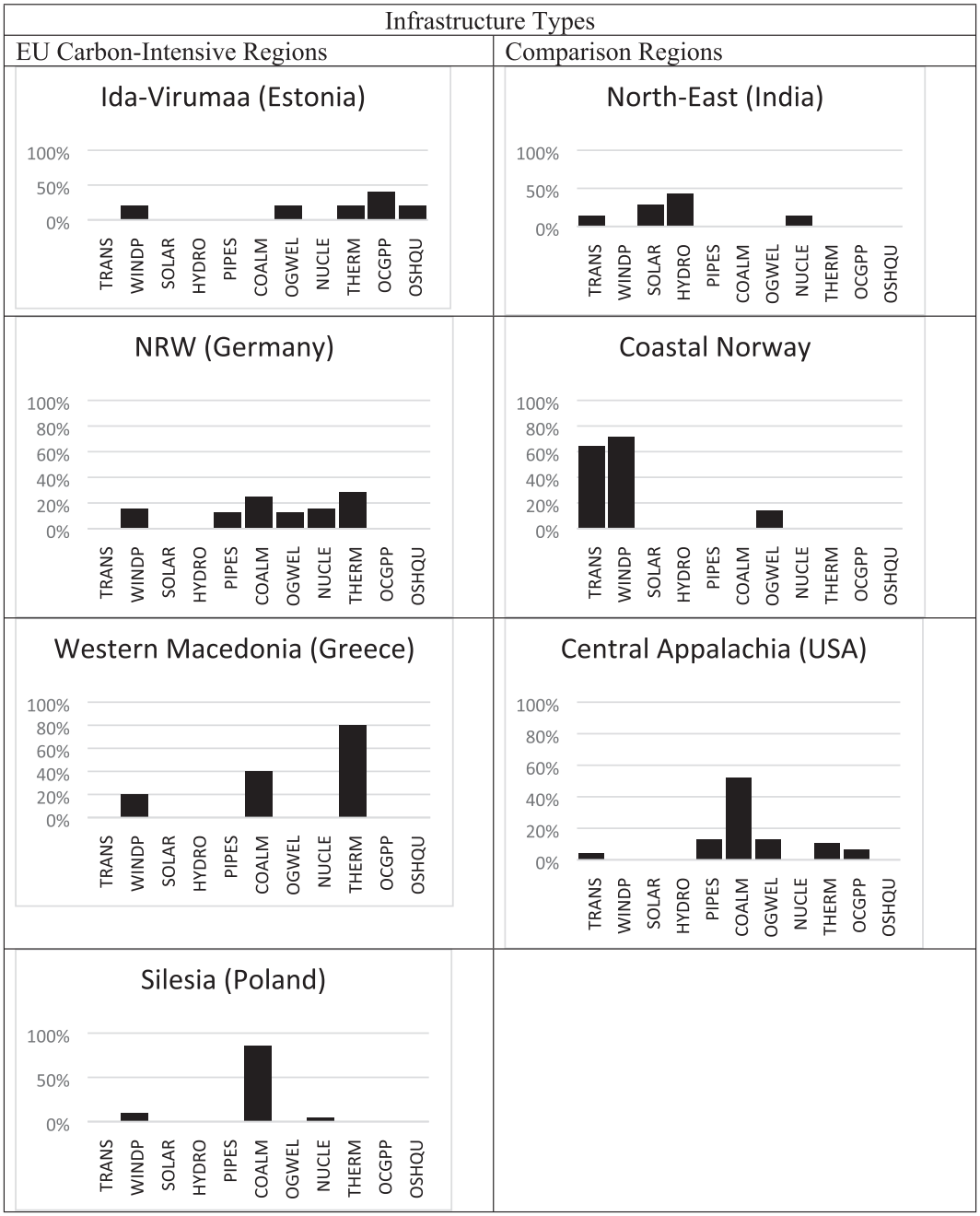


Fig. 2. Transition-related cases of opposition by country. Notes: TRANS: Transmission power lines; WINDP: Wind farms; SOLAR: Solar infrastructures; HYDRO: Hydroelectric infrastructures; PIPES: Pipelines (including accidents); COALM: Coal mines (including accidents); OGWEL: Oil and gas wells, oil and gas waste (including accidents); NUCLE: Nuclear power plants; THERM: Thermal power plants; OCGPP: Oil, coal and gas processing plants; OSHQU: Oil shale quarries.

entire sample, cases involving fossil fuels such as coal (37%), oil and gas (9%), and pipelines (7%) were frequent. Although our database contains several cases of pipeline-related protests (notably in Central Appalachia and NRW), pipeline-related accidents (e.g., oil processing spills) were very few and only found in the Appalachia data. We included them in our general dataset as they generated mobilizations to call for the end of carbon-intensive technologies and policies. However, opposition did not occur only against fossil fuels. About a fifth of the sample related to low-carbon options such as nuclear power or renewables, and another 8% was about transmission lines. Notably, renewable energy infrastructures are the second most contested type of infrastructure overall across our dataset. Opposition occurs against smaller, decentralized, community-scale energy across 17% of the cases, and against low-carbon nuclear power in a further 5% of cases, indicating that both can be a target of protest alongside large, centralized, or carbon-intensive technology.

Fig. 2 provides an overview of the cases by type of infrastructure in each region. The charts show the percent of all cases for a country for each type of infrastructure. Because some cases involve more than one infrastructure (e.g., wind and electricity transmission in Norway), the bars may sum to more than 100%. The cases for the regions in Norway and India show more opposition to low-carbon technologies, whereas the cases for the regions in Estonia, Greece, Poland, and the United States are almost exclusively oriented toward opposing coal and thermal energy. Within India's North-East, coal mine conflicts were not included as most of the cases were one-stop events occurring sporadically before 2010. The German NRW cases are more evenly divided between opposition to low-carbon and high-carbon technologies.

Several cases were coupled and involved more than one type of

energy technology. For example, seven of the wind-energy cases in Coastal Norway also involved transmission lines. In Ida-Virumaa, cases involved both oil shale quarries and thermal power plants. In NRW and Western Macedonia, cases involved both coal mines and coal-fired power plants, especially in the event of organized protests against national energy policy. In Central Appalachia, some opposition occurred against both coal extraction (especially mountaintop removal) and power plants.

The vast majority of cases lasted two-to-five years, signifying that opposition usually involved a protracted amount of time and subsequent legal or other actions. For example, in Coastal Norway, opposition against the Frøya wind power park involved a referendum in 2005, a concession in 2012, construction in 2019, and another referendum in 2019. In NRW, protest against Bayer's carbon monoxide pipeline lasted more than a decade and involved multiple acts of litigation and lawsuits. In Central Appalachia, the dispute over fracking waste in Etsill County, Kentucky, involved a lawsuit, multiple permits, petitions, and litigation over six years. Other cases, by contrast, were very short, with some of the shortest cases lasting less than a day, such as some protest events or sit-ins. With respect to duration, India's North-East was characterized by the highest average case index (5.3 years), followed by Coastal Norway (4.7), Central Appalachia (3.9), Western Macedonia (3.2), NRW (2.8), Ida-Virumaa (1.2, but a considerable number of events in the database were ongoing), and Silesia (0.7: in this case, one has to consider that the frequent events organized by miners' unions were typically planned to be short). The overall average duration of events was 3.15 years (with a standard deviation of 3.32 years).

4.2. Institutional arrangements

The diversity in our findings makes clear that although natural resource endowments and associated energy technologies are important in shaping decarbonization outcomes, the institutional arrangements in which they are embedded can help to explain why these patterns are different across countries and regions. By "institutional arrangements," we refer to structures of norms, cultural categories, actions, and collective actors that pattern social life across different societal sectors, including the state, the economy, and civil society.

In Poland, the center-right, pro-EU government (led by Civic Platform) that ruled the country until 2015 sought to reduce its dependence on coal by shutting down the least profitable coal mines. Those attempts caused a long series of short protests (mostly, underground sit-ins in mines, lasting one to a few days) by coal miners' unions in Silesia (the "Solidarity" trade union, in particular) that forced the government to back down and led to broader policy reform that slowed decarbonization efforts. The protests are reflected graphically in the centrality of the miners' unions and national government in the Silesian case. After a right-wing, nationalist, and anti-EU government (led by Law and Justice) came to power in 2015 (and retained power in 2020), coal miners' unions found new support for their position, and the coal phase-out was further delayed to 2049, much later than the EU had sought. In Silesia, miners' protests occurred with regularity until the 2015 change of government, then they were quiescent for four years, until 2020, when the government made new attempts to shut down the least profitable mines, and a new wave of protests erupted. A second, central actor in the Silesian case was local communities: these, however, were mainly involved in opposing low-carbon projects (nuclear and wind power). The triad formed by the national government, miners' unions, and the national coal company (*Kompagnia Węglowa*; from 2016, *Polska Grupa Górnicza*) takes center place in our network. Greenpeace is the only NGO intervening in more than one case.

In Western Macedonia, unions were also important, but the government committed to an energy transition program as a consequence of EU pressure in the wake of the Greek government-debt crisis of 2007–2008. The Greek government decided to privatize almost half of its public electricity company, the Public Power Corporation (*Dimosia Epicheirisi Ilektrismou*), and to phase out coal mines that were burdened with debts. Those policy changes contributed to the country's energy transition, but they also generated widespread protest in Western Macedonia, Greece's main mining region. The center-right government that rose to power in 2019 continued the previous government's plans and decided to support a total coal phase-out by 2028. Thus, opposition by miners—mostly in the form of protest rallies—has been relatively ineffective, and the leading outcome in Western Macedonia is low-carbon status quo (i.e., in favor of continued energy transition). In our diagram, the national government appears at the core of a typical centralized network; the diagram highlights the national government's role as a mediator of diverse actors, including miners' unions, civil society actors, and subnational governments.

In the Ida-Virumaa case, miners' unions are less central than in Silesia and Western Macedonia. The country's main electricity provider, *Eesti Energia*, and local governments, connect more frequently with the national government. Estonia is characterized by a substantial oil shale production, which accounted for 73% of the country's total primary energy supply in 2018 (International Energy Agency, 2022). Estonia is therefore significantly reliant on this resource, and the investments made in oil shale extraction have converted Estonian firms into world specialists of this technique. However, the support for the industry has also created path-dependency, in Ida-Virumaa in particular, which is the hub of the country's oil shale industry. Hence, Eesti Energia has played a central role. Local governments generally oppose the government's plans to build oil shale processing plants or to authorize shale gas exploration. However, strong national government support for the extractive gas industry has meant that most opposition has been weak and ineffective. We see this situation reflected in the most frequent outcome, which is a delay in a project's implementation, but not a no build or remediation decision.

NRW provides us with a more diversified situation. The role of the German government, although important, takes a back seat to local communities, which are the most central actors. The participation of citizen committees was the norm in our dataset. An important role is also played by regional governments, which in Germany have considerable decision-making power due to the country's federal structure, and by local institutions. These actors have often sided with activist groups to prevent the implementation of energy infrastructures, especially but not exclusively coal-based technologies. However, there has also been considerable opposition to nuclear infrastructures, even beyond Germany's borders, and to wind-energy projects. The nuclear and wind cases show in the outcomes as status-quo low-carbon outcomes (i.e., protest had little effect). The dense fabric of local, national, and transnational activism was evident in the participation of the BUND (*Bund für Umwelt und Naturschutz Deutschland*, the German chapter of Friends of the Earth), whose legal actions against thermal power plants and coal mines played an important role in delaying projects or phasing them out. More recently, NGOs such as Greenpeace, and citizen movements such as Fridays for Future, Extinction Rebellion, Campact, and Ende Gelände, also contributed to those outcomes. Their mobilizations have often taken the form of rallies and protests, which are salient in the tactics

found in NRW. In several cases, the mobilizations have led to outcomes of decisions not to build infrastructure or to provide remediation.

In contrast to the other cases, the coastal area of Norway was characterized by a multiplicity of actors taking part in infrastructure conflicts, which resulted in diffuse networks. Local, rather than national, governments played a predominant role in the conflicts, which were mainly over wind farms and transmission lines, and which mostly had local impacts. In addition to governmental actors, the local level was also represented by business organizations, recreational associations, and citizens' communities, often with a focus on protecting local nature and wildlife. The most prominent environmental organization intervening in the Norwegian cases is Friends of the Earth, together with its youth chapter, Nature and Youth. In addition, environmental issues are incorporated into the concerns of the majority of the local or regional organizations. With respect to outcomes in Coastal Norway, project delay was the most frequent, followed by a change in design or route. The pattern attests to a more open position of the government and industrial actors to discussing modifications of proposed plans with actors from the civil society. This more consultative and deliberative approach is reflected in the high level of meetings, petitions, and expertise in the tactics, but it also led to the two most frequent outcomes for the country: delays and changes in design. However, changes in design were also related to the type of infrastructure because it is indeed relatively easy to change design for a power line by charting a new route through areas where opposition is lower. Some of the cases involve regions inhabited by indigenous (Sami) communities, where consultation processes were required and where there was also an increased level of conflict over location and land use.

In the central Appalachia region of the United States, the state governments have historically favored continued protection for the coal industry and growth for natural gas extraction, thermal electricity power plants, and fossil-fuel processing plants. Although this study did not track state and local governments as actors in opposition networks in the U.S. cases, it is possible to approximate their positions according to these dynamics. The lack of support from state governments (with the exception of the state of Virginia after 2020, when Democrats controlled the government) meant that civil society organizations played a prominent role in opposition campaigns. The most central actor, the Sierra Club, is a national organization with a well-funded "beyond coal" campaign that is supported by a billionaire philanthropist, and the Sierra Club also has active chapters in the three states. The other two prominent civil society organizations have a more specific regional focus

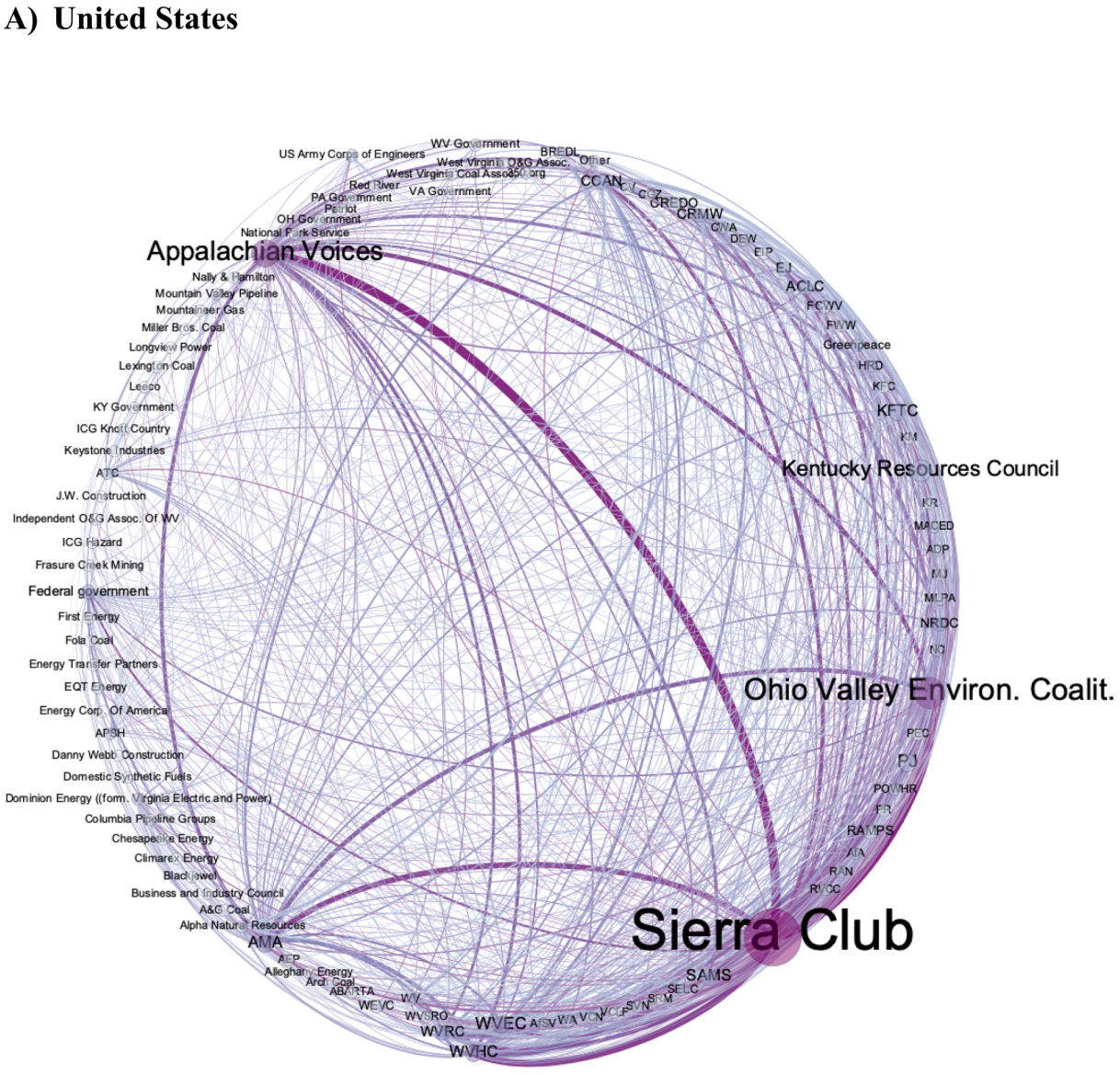
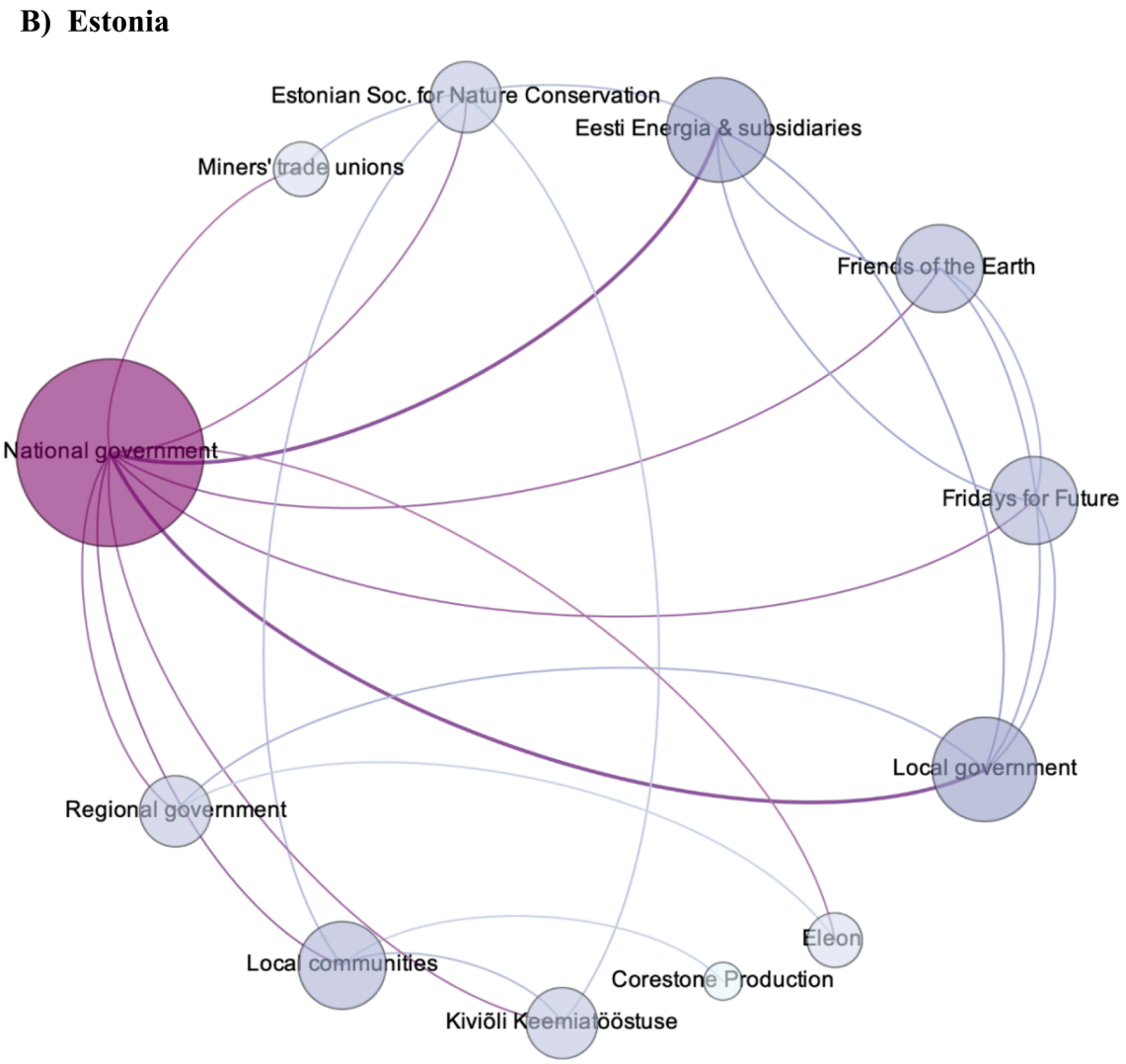


Fig. 3. Network analysis for the actors involved in energy opposition across our seven regions. Note: Acronyms are explained in Appendix III.



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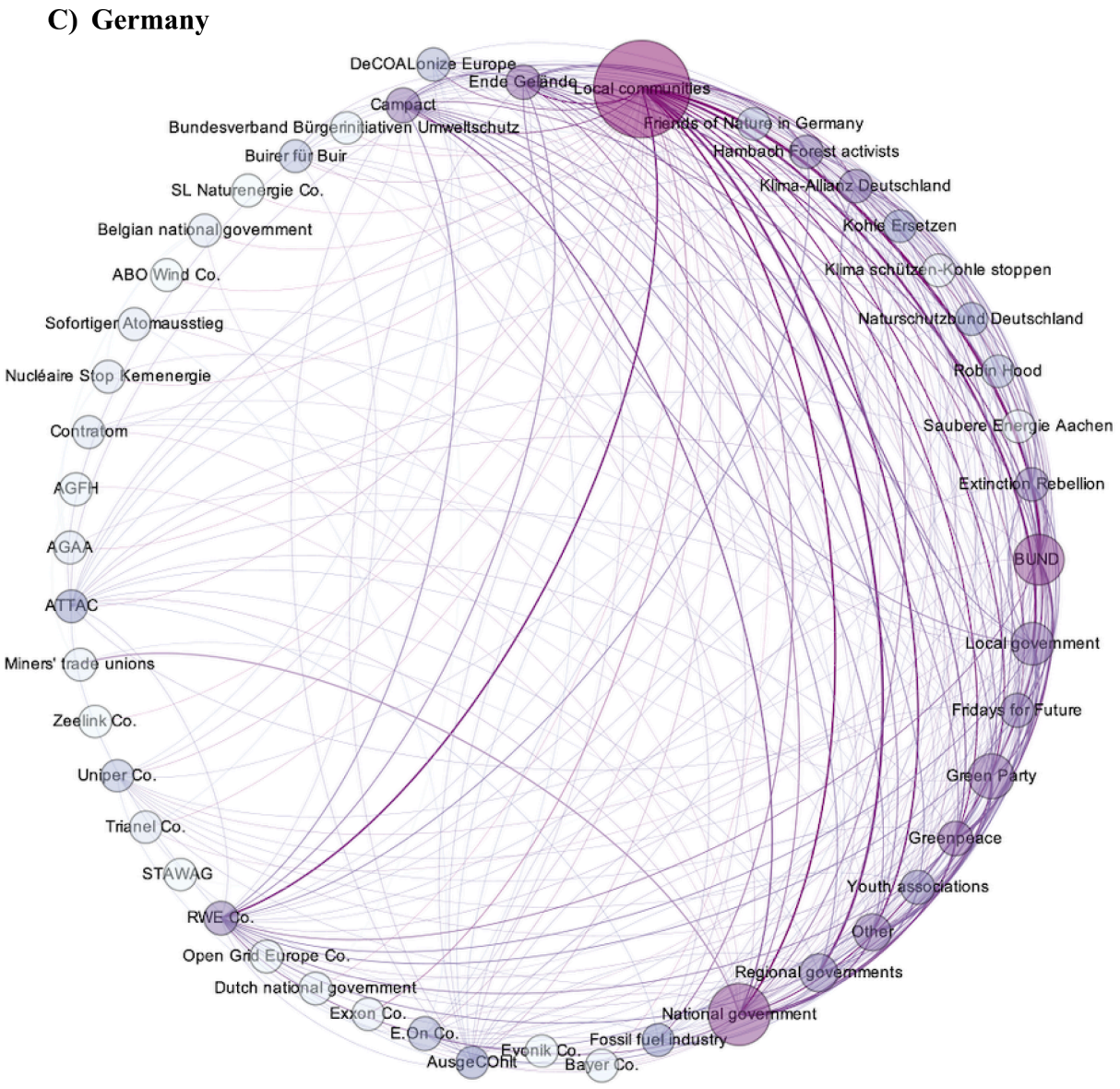
but are involved in diverse types of campaigns. The relative lack of support (even hostility) from the governors and legislators of the state governments was associated with a tactical emphasis on litigation (for remediation especially) and petitions, which included participation in regulatory processes. Some of the other prominent organizations, such as Appalachian Mountain Advocates, specialize in litigation and were involved in various initiatives. Much of the activity was focused on remediation of existing pollution, where advocates made some gains. Protest tended to be directed more at mountaintop removal for coal extraction and at natural gas extraction and pipelines, and efforts to block extraction and transportation technologies met with strong resistance from industrial actors and their government allies.

The North-East Indian cases are rather disconnected from each other. The pattern is possibly a consequence of the large area that North-East India includes (101,228 sq mi), compared with the paucity of cases we had in our dataset. As a result, the network resulting for the analysis of the Indian dataset appears as polycentric. The main actors are the national government (the Ministry of Environment, Forest and Climate Change), which is present in three of our seven cases; local communities as opponents of infrastructures; the Hydroelectric Power Corp., which is a proponent of infrastructure; and state governments. The reason for this square of actors lies in the institutional structures of energy governance. The Indian Constitution specifies that electricity is a concurrent subject, which means that the onus of any dispute resolution for the clean energy transition lies with the state(s) and federal or central government. This situation creates a complex legal terrain.

An example of the complex web of jurisdictions is hydroelectric power. On the one hand, any dispute at the local level related to land must first be sorted out by the local authorities because the states have jurisdiction over land disputes. On the other hand, when it comes to the



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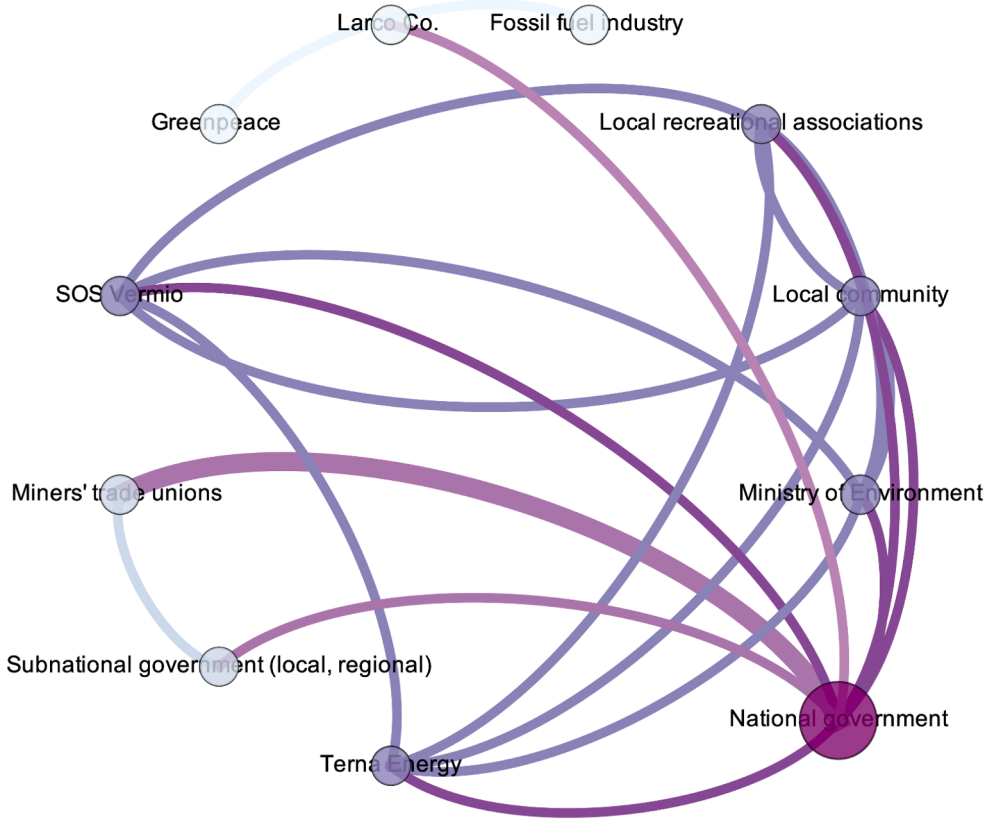
transmission of electricity (from the generation point to the consumption point of the consumers) from hydropower between states, the issue of conflict becomes more complex. Because water comes under the Entry 17 of the State List of the Indian Constitution, any issue related to water storage and water-derived electrical power is under the jurisdiction of state governments. Therefore, all state actors have to be in consonance with the central (federal) government for successful conflict resolution of a hydropower project. Hence, based on the exact context and the location of the conflict in the series from generation through transmission and distribution, the involvement and mechanism of conflict resolution amongst various actors at the central and state government levels will vary. The complex institutional structure helps to clarify the tendency for tactics in India to avoid litigation (with multiple venues necessary for dispute resolution) and to focus instead on protests, meetings, and petitions. Likewise, because of the difficulty of negotiating the complex institutional web, the structure also tends to lead to outcomes of delay and status quo (in this case favoring the low-carbon technologies of hydropower, wind, and solar) rather than no-build or other outcomes.

4.3. *The actors and coalitions of energy opposition*

The actors and actor networks involved in the cases are often complex. Networks usually involve a diverse collection of stakeholder types

D) Greece



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including civil society groups, corporate firms, non-governmental organizations (NGOs), officials at several levels (transnational, national, regional, county, municipality, districts, and villages), trade unions, and academics. The position of particular organizations vis-à-vis energy infrastructures is not necessarily the same (that is, opposed or in favor) for both the low- or high-carbon type of technology. For example, the same environmental organization may oppose coal mines (high carbon) and nuclear power plants (low carbon). Such cases are not surprising, considering that opposition and support are not only developed on the basis of greenhouse-gas emissions but on a broader set of social, cultural, historical, political, and economic variables (Bessette and Mills, 2021). In cases in West Macedonia, Silesia, and NRW, opponents to wind power framed their opposition in terms of effects on the aesthetic value of a landscape. In contrast, in North-East Indian cases involving hydroelectric power, opponents were more concerned with the lack of local communities' participation to decision-making or threats to those very communities and associated environments.

Fig. 3 network diagrams visually map these diffuse actors across our entire dataset using betweenness centrality. Betweenness centrality quantifies the number of times a node (i.e., an actor) acts as a bridge along the shortest path between two other nodes. Betweenness centrality is a measure of the importance or centrality of each actor in our national databases, and it represents the degree to which nodes stand between each other. Nodes and edges (i.e., the links between actors) are colored according to a color gradient: darker lines indicate more central actors, and lighter lines indicate less central actors. The size of each node (circle) depends on the number of links it has with other actors. The weight of lines depends on the number of times two actors are connected.

Another way of analyzing actors is by what is known as modularity clusters. These clusters are an indication of how many times a certain group of actors is found together in the same controversy. Modularity is often used in optimization methods for detecting community structure in networks. A network is said to have community structure if the nodes of the network can be easily grouped into sets of nodes such that each set is densely connected internally. In other words, these clusters can be seen as families of actors. The actors in Fig. 4 are not grouped as in favor of, against, or neutral with respect to a conflict; clusters instead represent involvement in a given conflict. For example, Exxon and an anti-oil NGO may be found in the same cluster (i.e., module) because they have taken part in many events together, one in support of an oil field and the other in opposition to it. The different colors represent different

E) India

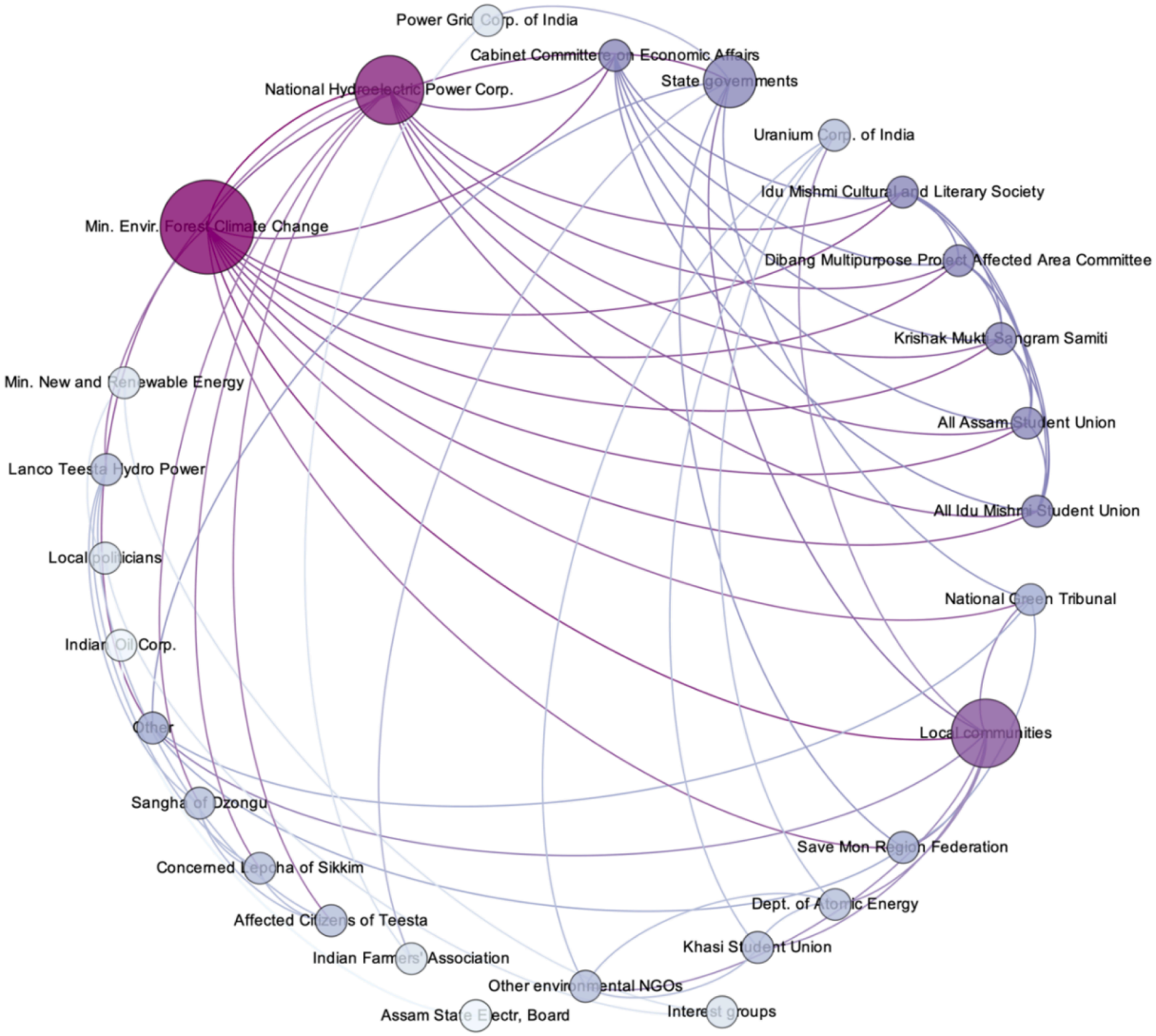


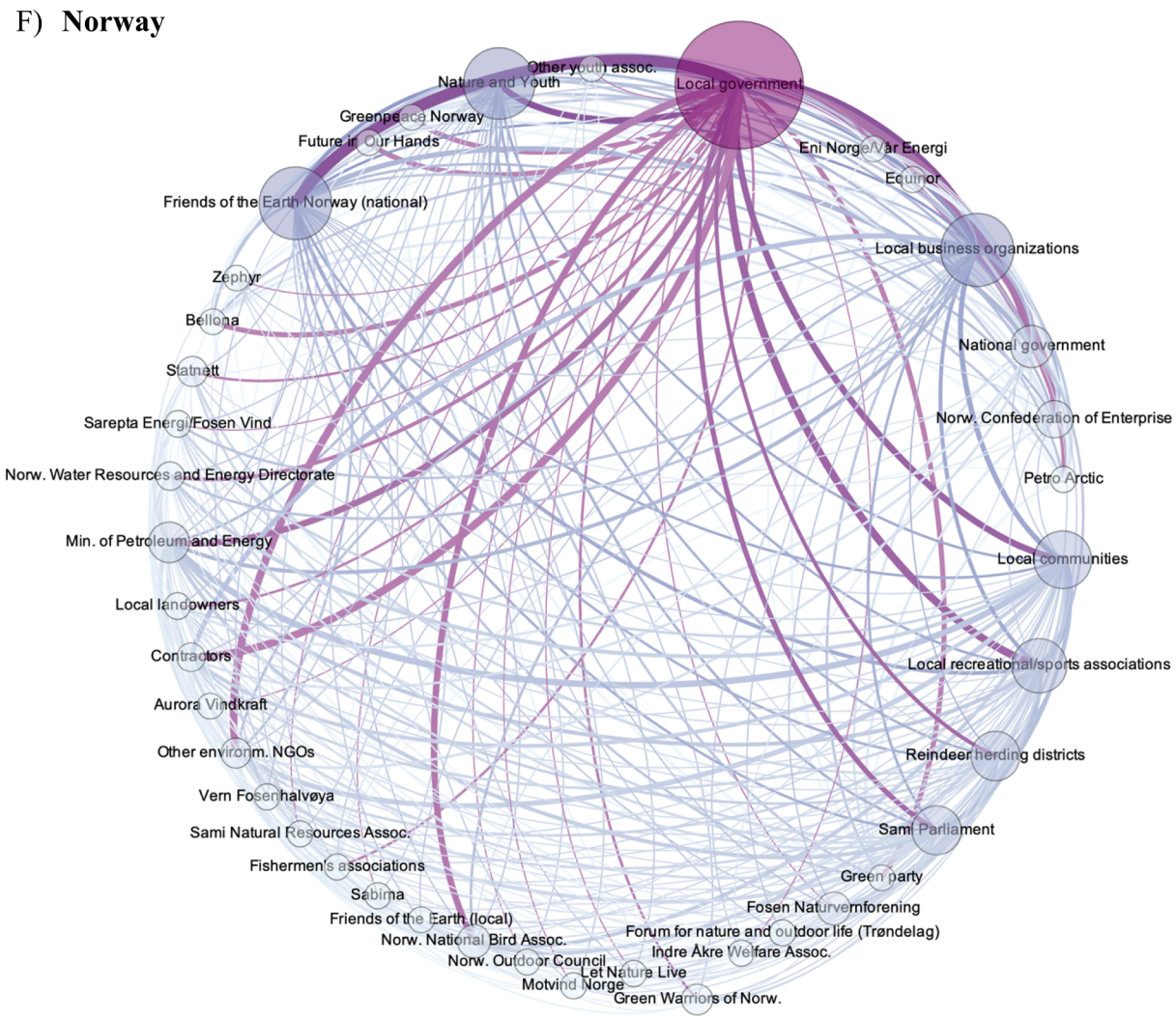
Fig. 3. (*continued*).

modularity clusters. The font size of each actor depends on its betweenness centrality.

The networks in Fig. 4 also represent the position of each case with respect to each actor, and whether the concerned infrastructure would result/has resulted in a change favoring high-carbon (HIGC), low-carbon (LOWC), or a carbon-neutral solution (NEUC). Besides identifying modularity clusters, Fig. 4 visually maps the centrality of the actors across our seven regions.

The most frequent actors in the initiatives are civil society organizations (e.g., coal miners, environmentalists, recreational/sports groups affected by landscape changes), companies associated with different industries (e.g., wind-farm companies, coal and natural gas companies), community groups, local and subnational governments, and national governments.

A third, more accurate but less visual way of analyzing actors is by their centrality in a given region. Here, our analysis of centrality identified a few organizations that had similar high centrality scores. Table 4 shows three types of centrality measures, namely degree, betweenness, and eigenvector. Degree represents the number of nodes, betweenness shows how a node bridges the shortest path between two other nodes, and eigenvector measures a node's overall influence on the network. As the table shows, the position of the organizations with the highest centrality tends to vary from pro-fossil fuel and pro-coal (in Ida-Virumaa, Silesia) to those that are against industrial developments (in NRW, Western Macedonia, Coastal Norway, Central Appalachia). The case of North-East India is more nuanced, with the federal government supporting both thermal and hydroelectric power plants. Therefore, it is difficult to determine a trend based on positions. However, the findings



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show that the most central actors were generally national and subnational governments and local communities (by 'local communities', we refer to initiatives spontaneously organized by local citizens without initial input from existing NGOs or governments). In this sense, Table 4 represents the importance of these two groups of actors in energy opposition movements. As noted, only civil society actors were tracked in the U.S. cases and governmental actors are thus not represented.

4.4. The tactics of mobilizations

The next analysis was the characterization of patterns of tactics. Fig. 5 shows our data for tactics. In Coastal Norway, there is a relatively high reliance on meetings (100% of cases), petitions (100%), and experts (93%), which is suggestive of a strong consultation process. In contrast, rallies and protests are the most common tactic in NRW (59%), Western Macedonia (100%), and Silesia (95%). This type of tactic can emerge where more institutionalized repertoires of action have not been successful. In Central Appalachia, petitions (61%) and litigation (52%) are the most common tactic. Many of the Appalachian cases involved mobilizations that used litigation as a tactic to gain remediation for pollution from existing sites. Violence was involved as a tactic in a relatively small minority of cases, except in North-East India (43%) and Western Macedonia (40%).

4.5. The outcomes of mobilizations

Fig. 6 provides an overview of the frequency of outcomes by country, with the percent of cases that have a particular type of outcome. Project delays are the most frequent outcome in North-East India (71% of cases), Ida-Virumaa (60%) and Coastal Norway (50%), as well as in the global dataset (16%). In NRW, the rate of project delays equals that of project withdrawal/phase-out of existing infrastructures and that of no change resulting in high-carbon infrastructure project being implemented (all three, 25%). In Silesia, the most frequent outcomes are broad policy/regulatory changes—generally, in favor of extending the life of high-carbon infrastructures planned to be phased-out. In Western Macedonia, low-carbon status quo outcomes predominate (60%). Finally, in Central Appalachia, "no change" is the most frequent outcome (30%), followed by withdrawal of project/phase-out of existing infrastructure (28%).

Frequent outcomes in the global dataset are also: broad policy/regulatory change (15%), no change resulting in high carbon infrastructure being built (14%), and withdrawal of project/phase-out of existing infrastructure (14%). Frequency tests showed no strong or moderate correlations between infrastructure and outcomes, but there were a few low associations. Specifically, for infrastructure, opposition to transmission power lines had a low association with an outcome of a change in design (phi = 0.34, $p < .001$) and with a status-quo outcome classified

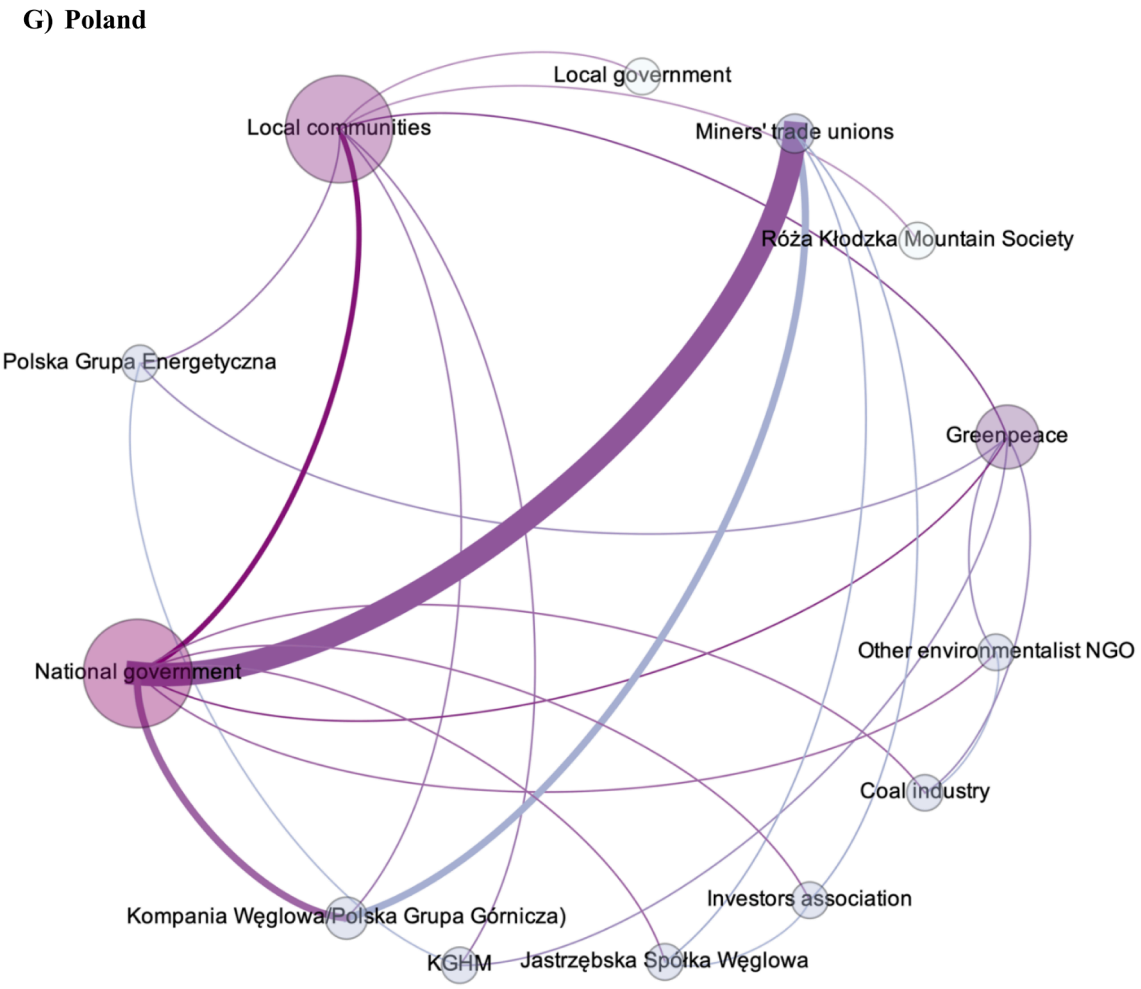


Fig. 3. (*continued*).

as carbon neutral (phi = 0.39, p < .001). Nuclear energy had a low association with a status-quo outcome classified as low carbon (phi = 0.31, p < .001).

With respect to tactics, litigation had a low association with an outcome of compensation or remediation (phi = 0.32, p < .001), the involvement of experts and expertise had a low association with an outcome of change in design (phi = 0.31, p < .001), and the number of supporters had a low association with an outcome of a change in design (phi = 0.32, p < .001).

5. Discussion: Mobilization configurations in context

Having completed the description of patterns of opposition with respect to energy technologies, actors and coalitions, types of tactics, and outcomes, we can now examine crosscutting findings.

5.1. International and supranational pressure

Generally, international or supranational pressure (such as EU directives) is an important contextual condition because it shapes the arenas for action, the actors involved, network composition, and the outcomes possible. However, responses to the pressure are refracted through local political fields and natural resource endowments. For example, in Poland, despite pressure for faster decarbonization timelines from the EU, coal mining is still strong, and well-organized unions were able to use protest tactics that dramatically slowed the transition. However, in Greece, where transitions are in similar early stages but the government had a precarious financial situation, the government has not backtracked. In this case, EU intervention created a context that reduced the effectiveness of union opposition tactics. Although the role of the EU for European countries is important, research on transitions cautions that current constellations of central and influential actors are likely to change as transitions progress (Avelino and Wittmayer, 2016; Hess 2019; Sovacool and Brisbois, 2019). It is thus probable that the opposition patterns and outcomes in these regions will shift as the stage of transition changes, and as dynamics between national governments and EU-level requirements evolve.

5.2. Causality, strategy, and tactics

Although we found no clear relationships between tactics and outcomes across the regions and cases, it was evident that there is a significant strategic choice between institutional and extra-institutional tactics. As noted above, in the Norwegian case, there is a relatively strong consultative process and a corresponding emphasis on more institutionalized tactics, including petitions, meetings, and expertise, and with a high level of local actors. Extra-institutional action is more prominent where the government has not responded to the concerns of opponents, which can include both pro-fossil-fuel mobilizations (e.g., continued coal mining in Western Macedonia) or anti-fossil-fuel mobilizations (e.g., mountaintop removal protest in Appalachia or coal-mining protest in NRW). Some of the tactics also require significant resources, such as litigation against large corporations with deep pockets. Interestingly, the regions where litigation was used the most

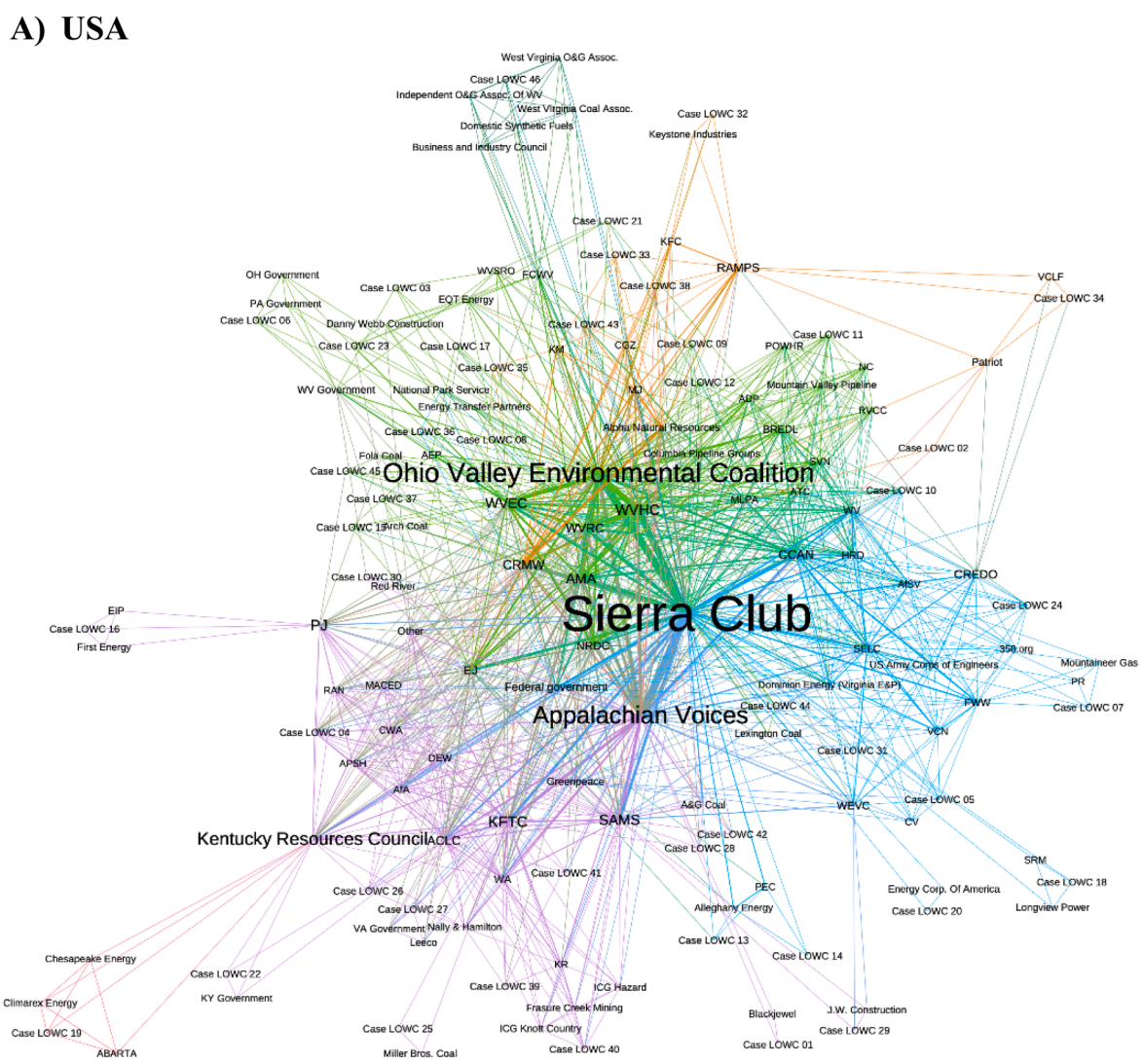


Fig. 4. Actor networks and cluster modularity across our seven regions. Note: Acronyms are explained in Appendix III.

(Central Appalachia, NRW, and Ida-Virumaa) were also those with the highest rate of ultimate project withdrawal or infrastructure phase-out.

Three other findings relevant for strategy and tactics emerged from the data. First, inherent in the findings on the prevalence of litigation, the dataset emphasizes that opposition to infrastructures can become expensive to incumbents. In NRW, the electric company RWE estimated that protests at the Garzweiler mine had caused 250,000 euros' worth of damage and that preserving the Hambach Forest, instead of felling it to make space for an extension of its mine, could cost RWE four to five billion euros. In Western Macedonia, the closure of the Kozani and Kastoria lignite mines generated a government debt exceeding €350 million. In Central Appalachia, one opposition case resulted in a settlement of $126 million. There is therefore good financial reason to seek to resolve or minimize opposition to energy infrastructure.

Second, the dataset reveals that opposition to some forms of community-scale or owned energy occurs alongside opposition to more centralized, regional-scale and commercially-owned technology. This is important because much of the literature on community ownership argues that these types of business models reduce opposition (e.g., Bauwens and Devine-Wright, 2018; Süsser et al., 2017). Given the general consensus that community ownership promotes community acceptance, this pattern warrants further analysis.

Third, several cases were coupled and involved more than one type of energy technology. Seven of the wind-energy cases in Coastal Norway also involved transmission lines. In Ida-Virumaa, cases involved both oil shale quarries and thermal power plants. In NRW and Western Macedonia, cases involved both coal mines and coal-fired power plants, especially in the event of organized protests against national energy policy. In Central Appalachia, some opposition occurred against both coal extraction (especially mountaintop removal) and processing plants. This finding suggests the need for infrastructure studies to be cautious about using single categories (e.g., wind farms or pipelines) when there may be linked infrastructures and multiple sites of contention.

5.3. *Contestations over low-carbon options*

A final finding—and in line with previous research discussed above—is that renewable energy and low-carbon infrastructures are frequently protested across our dataset, they are protested in every country examined, and renewables come only after coal mines in terms of the frequency of protest against them. Nuclear power facilities are protested more than oil and gas processing plants or oil shale quarries.

B) Poland

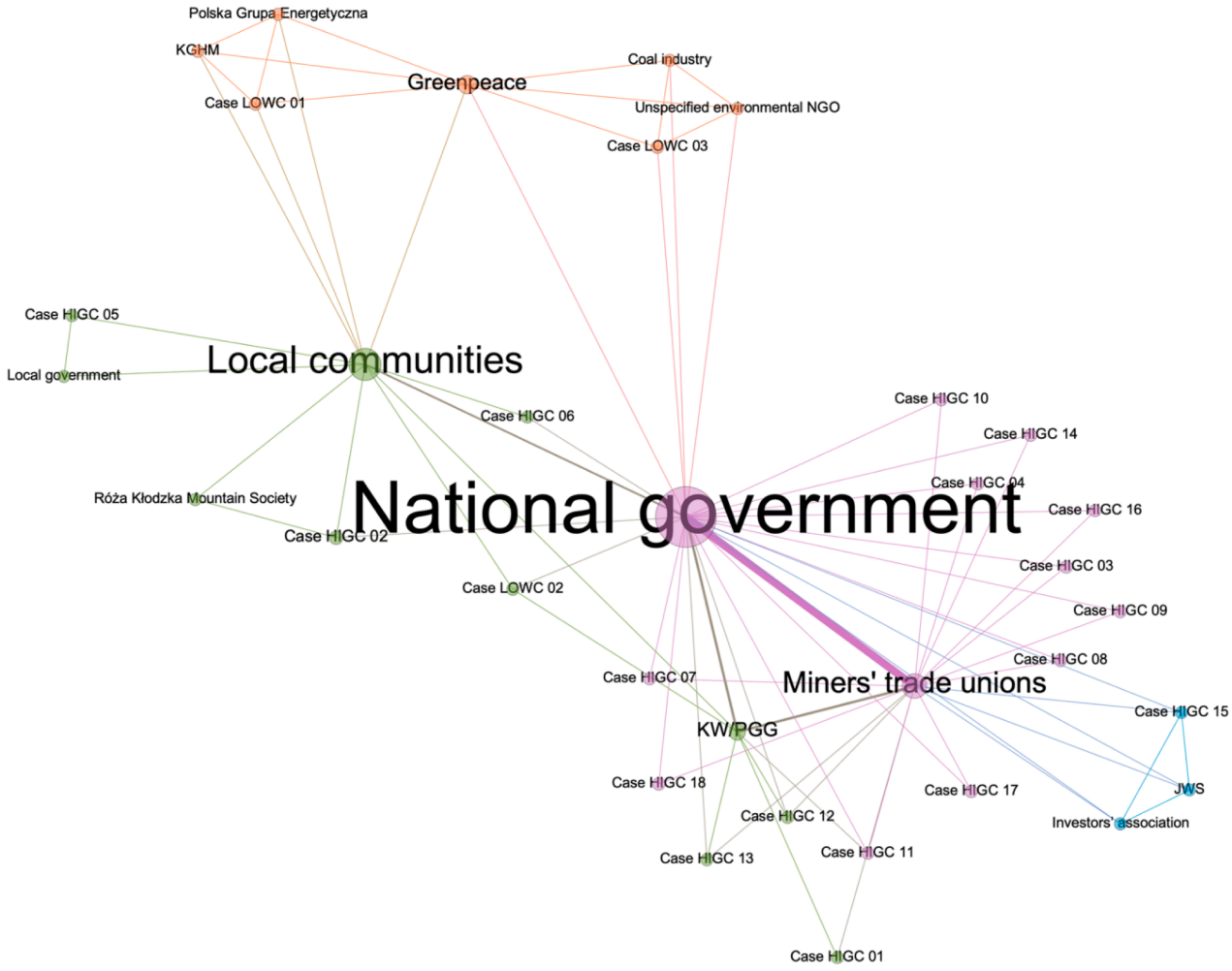


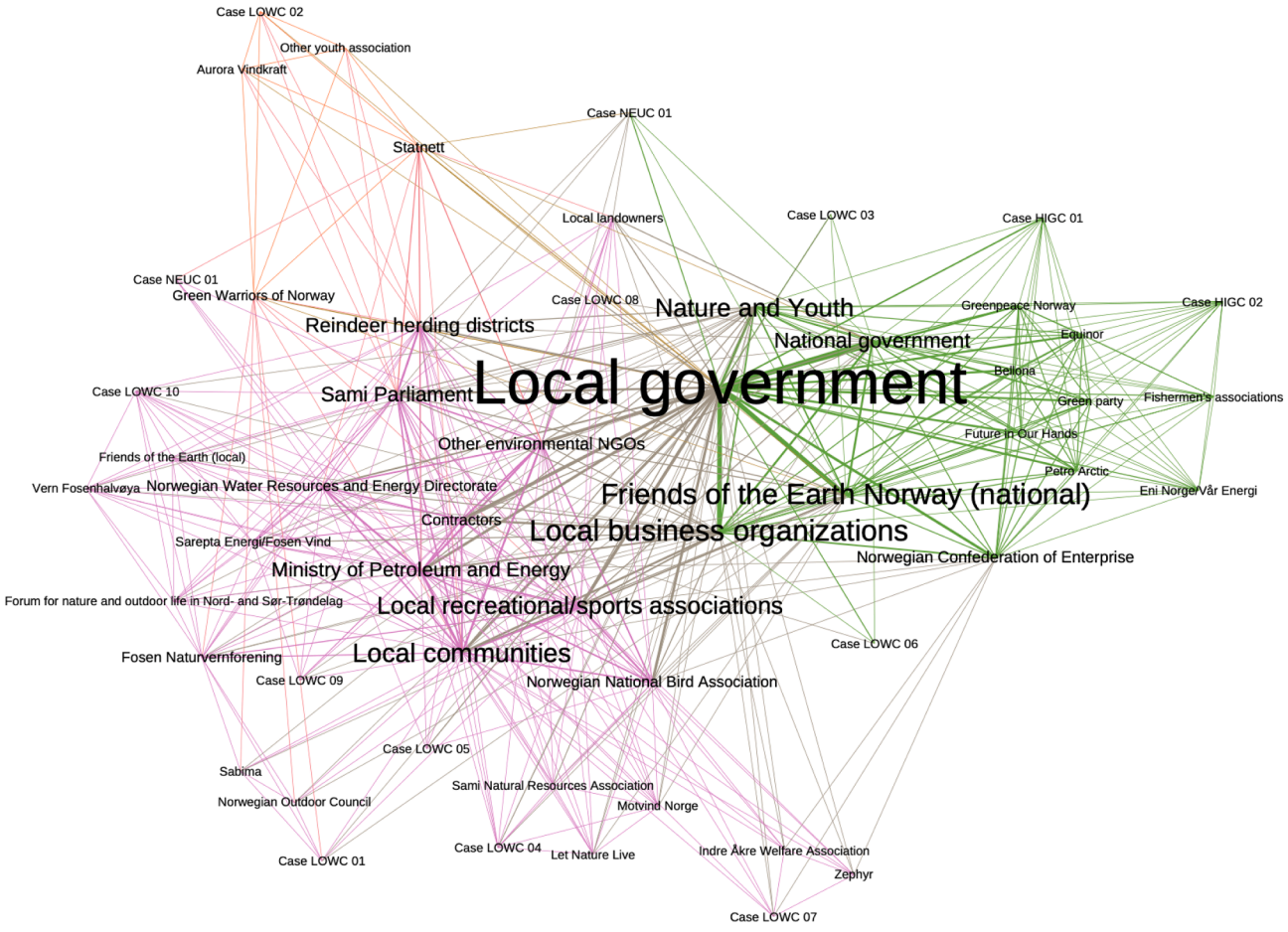
Fig. 4. (*continued*).

This is troubling insofar as the goals of climate protection and decarbonization depend on low-carbon technologies, but such options appear to create strong resistance efforts.

Social opposition to renewable energy projects can occur not only over the technology *per se* but also over the licensing or siting of new infrastructures. New infrastructure plans can become embedded in pre-existing social conflicts over land use, and they can lead to conflicts over the distribution of benefits, the recreational or aesthetic value of a space, or perceived environmental insults such as road building or negative impacts on birds and bats. For example, rural residents may like wind energy in principle but come to oppose the way urban developers are pushing projects into their communities, or they may feel that they have been marginalized in the planning or policymaking process. In this way, renewable energy technologies become more than just generators of electricity: they come to symbolize a personal ethic or reflection of attitudes, a system of ownership and control, or a method of organizing the landscape (Pasqualetti et al. 2002).

One factor compounding opposition is also the general immobility of renewable energy resources, and here the sociotechnical perspective on system design becomes important. Whereas a coal plant or an oil shale generator can be sited almost anywhere and can have its fuel delivered to it, renewable energy generators need to go to where the "fuel" is: where the wind blows the strongest, the water flows the fastest, or the sun shrines the strongest. Renewable resources differ from coal and conventional fuels because they cannot be extracted and transported for use at a distant site. They are thus no longer "out of sight, out of mind," and their site-specific nature means they can aggravate social conflict and lead to more protracted and intense forms of opposition (Pasqualetti, 2004). Because nothing can make renewable energy technologies invisible, little will make them more acceptable to those perceiving land-

C) **Norway**



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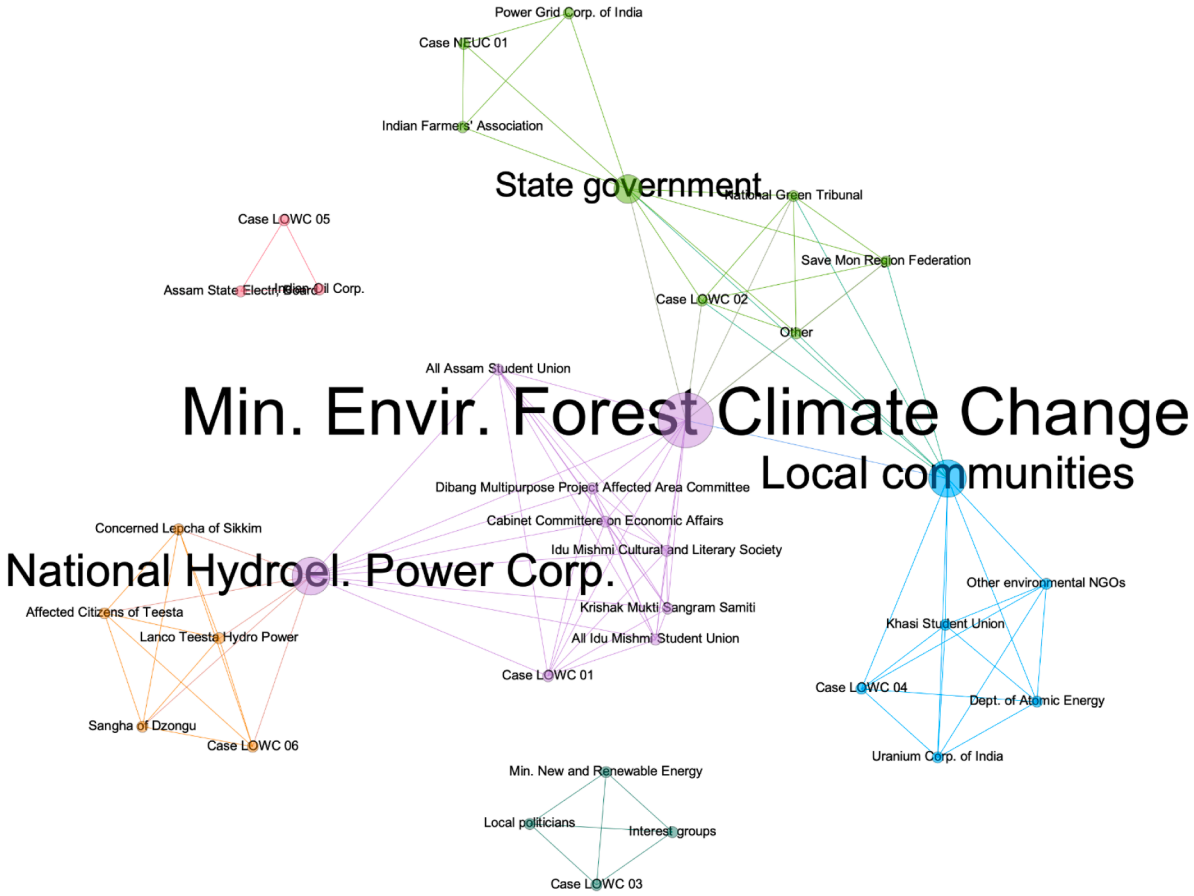
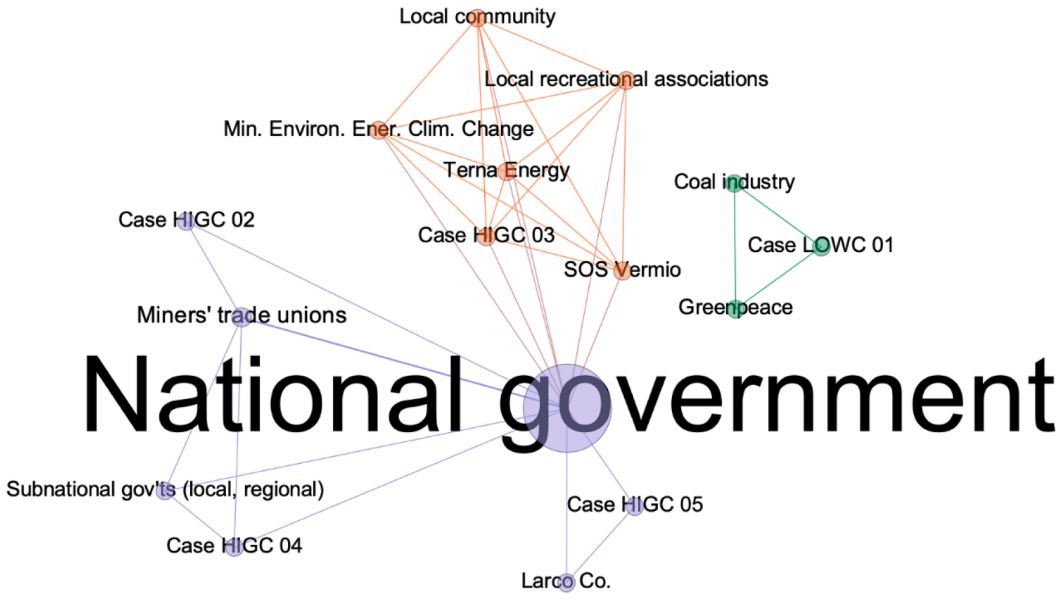
D) India



E) Greece



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F) Germany

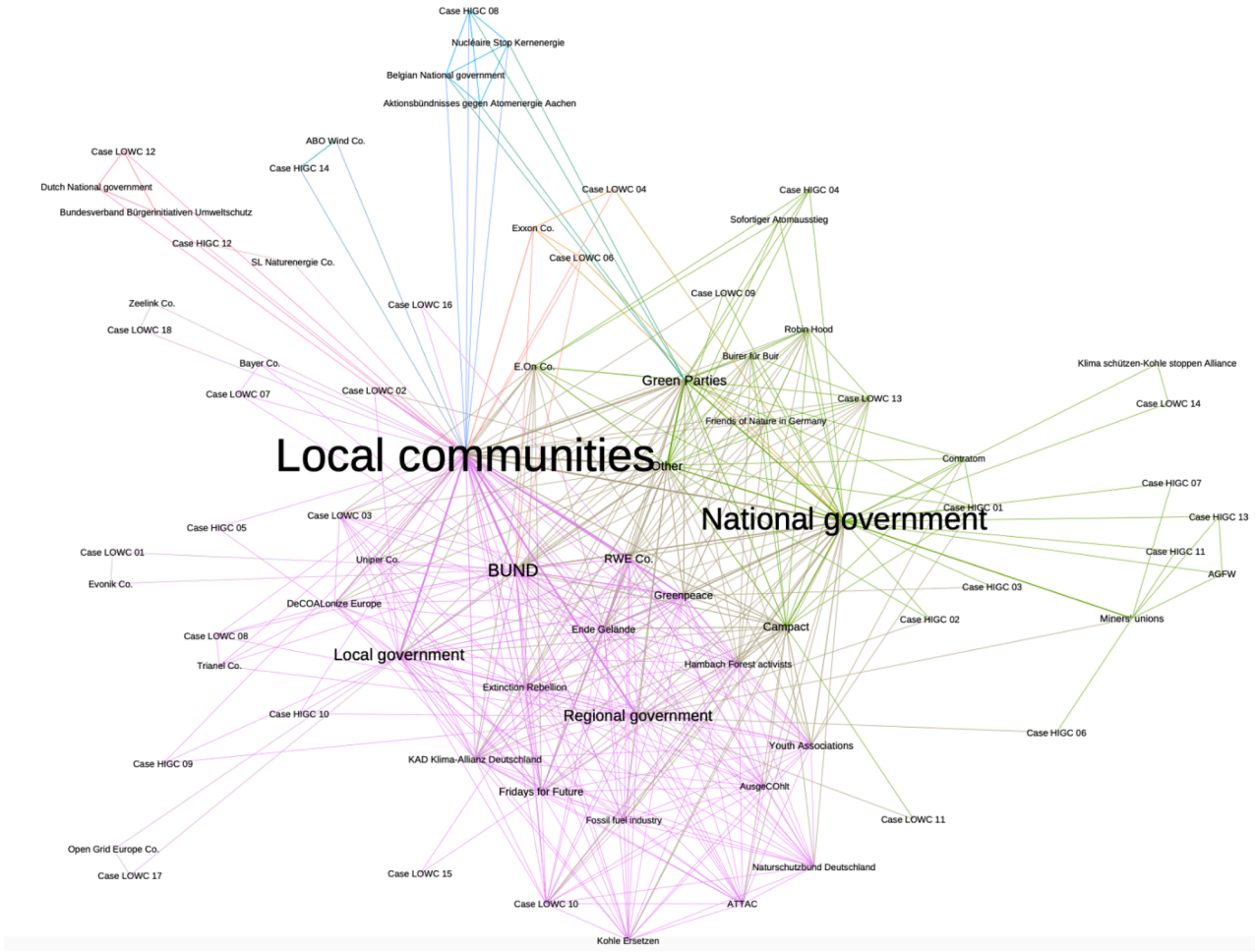

Fig. 4. (*continued*).

use interference (Hirsh and Sovacool, 2013).

Nuclear power does not fall into this category of being fuel-site source specific, and it therefore generates more distinctive reasons for resistance. Public attitudes typically afford greater attention to some pronounced negative features of nuclear infrastructures, such as perceptions of nuclear energy as connected to weapons of mass destruction, polluting, risky, and technocratic (Verbruggen et al. 2014; Schneider et al. 2019). Some research has shown that nuclear accidents have severe psychological or psychosocial impacts alongside their environmental or technical ones, resulting in stigmas associated with the technology (Bromet 2014; Edwards et al. 2019). Moreover, nuclear waste facilities in particular often lack "a social license to operate" in many regions and are opposed for risks surrounding long-lived spent fuel storage (Lehtonen et al. 2020).

6. Conclusion

Our original, extensive dataset of community mobilizations across 130 cases in seven regions and three continents reminds us that energy transitions are not merely technoeconomic affairs but also deeply social and political events. The mobilizations create strong resistance against both carbon-intensive and low-carbon energy infrastructure, including renewables and nuclear power. Opposition also spans different scales, intensities, and temporalities (some of the fracking cases are very short-term and local, whereas some of the pipeline and coal cases stretch over years and multiple regions and have dozens of events). Some mobilizations lead to violence (the cases of NRW's Garzweiler mine and of several of North-East India's dam projects are exemplary) and protracted litigation, but others reach compromise and mediation.

Fig. 4. (*continued*).

Opposition to decarbonization is, confusingly, undertaken by both advocates for a coal mine or advocates against a wind farm, and some conflicts are about whether to build a new technology, regardless of location, whereas others are about contesting the technology itself.

Our study affirms the value of comparative, cross-country analysis of energy technology infrastructure opposition. Even in regions with similar types of natural resources (e.g., coal mining in NRW, Western Macedonia, Silesia, and Central Appalachia), government responses to decarbonization can be significantly different. The responses and policies of leading institutional actors, such as the state and energy corporations, opens up different opportunity structures for action. Tactics and outcomes vary in response to different opportunities, such as the more consultative approach in Norway versus the state-government hostility to energy transitions in the central Appalachia region coupled with a regulatory and judicial system that offers some independence from pro-carbon interest groups and some potential for remediation via litigation.

The approach remains limited to seven regions, and it raises questions that could inform additional comparative analysis of opposition to energy infrastructure. This study includes only one country outside the North Atlantic region (India), and all countries in this study have relatively democratic traditions. One future research problem in the comparative tradition would be to study a wider range of countries to understand better the effects of variables such as national income per capita, the dependence of the government on fossil-fuel extraction revenues, the government's capacity for investment in other energy sources, differences between advanced Western societies and other world areas, and varying levels of democracy and corruption. Furthermore, considering additional contextual factors such as the degree on inequality or cohesion of societies in different contexts, extent of unemployment or other deprivations, and educational base (both formal and regarding environmental issues), are some salient factors might have a bearing on opposition. Lastly, exploring how social mobilizations can be channeled to deter high-carbon transitions and encourage low-carbon ones is a pressing problem—and one contrary to our findings that show renewables and nuclear power frequently protested across our dataset. These are certainly deserving of future scholarship.

In addition to providing the basis for more extensive comparative research, this study also has policy implications that, because of the geographical specificities of our database, are especially valid for

Table 4
Centrality Measures of the Actors in Energy Opposition across Seven Regions.

Country	Organization	Position	Degree	Between-ness	Eigen-vector
EU Carbon-Intensive Regions:					
Estonia	National government	Supports fossil-fuel development	32	78.333	0.537
	Local communities	Pro low carbon and pro environmental change	12	28	0.148
	Local governments	Depends considerably on each community	16	4	0.381
Germany	Local communities	Generally against industrial developments, whether fossil or low-carbon	182	1078.137	0.374
	National government	In favor of coal phase-out; pro-renewables (esp. wind); against nuclear	124	635.113	0.263
	Bund für Umwelt und Naturschutz Deutschland (Environmental NGO)	Pro low carbon and pro change	118	262.9	0.278
Greece	National government	In favor of coal phase-out and renewables	10	45	0.56
	Miners' trade unions	Support coal mining	10	1	0.2
Poland	National government	Against coal phase-out but forced by EU regulations; against wind power; pro-nuclear	86	317.167	0.632
	Local communities	Depends considerably on each community	28	131.167	0.141
	Miners' unions	Support coal mining	68	82	0.609
Comparison Regions					
India	Federal government environmental ministry	Pro-thermal energy, pro-nuclear	26	183.333	0.422
	National hydroelectric power company	Pro-hydropower	24	111.333	0.31
	Local communities	Depends considerably on each community	22	110	0.274
Norway	Local governments	Against both fossil fuel use and wind projects	290	267.151	0.474
	Local business organizations	Mixed	146	91.106	0.291
	Friends of the Earth Norway (Naturvernforbundet)	Pro low carbon and pro environmental changes	124	87.537	0.247
USA	Sierra Club (Environmental NGO)	Pro low carbon and pro environmental changes	492	3372.124	0.435
	Ohio Valley Environmental Coalition (Environmental Justice NGO)	Pro low carbon and pro environmental changes	356	1482.147	0.361
	Appalachian Voices (Environmental and justice NGO)	Pro low carbon and pro environmental changes	336	1291.388	0.331

Note: "Mixed" refers to sometimes in favor of low-carbon infrastructures, sometimes against them. "Pro environmental changes" refer to being in favor of the changes that would generally enhance environmental sustainability.

countries located in the Global North. Although there is general recognition of the need for international agreements and a global effort to engage in a transition toward lower greenhouse-gas emissions, it is also clear that global agreements and plans have been far from adequate. For example, the Nationally Determined Contributions to greenhouse-gas reductions have tended to be aspirational and often fall far short of reductions needed in absolute emissions levels. There is a need for better understanding of why it is so difficult for governments to endorse and implement actions.

Our approach, which recognizes that energy transition processes and decarbonization outcomes are a product of societal organization and social conflict, points the way to thinking about grassroots mobilizations and coalitions as a crucial fulcrum for change. There are powerful social mobilizations both against new low-carbon energy sources, such as wind farms and nuclear energy, and in support of continued and new high-carbon sources, such as natural gas extraction and continued coal mining. Understanding why social movements and other forms of opposition occur can help to inform policies and programs that address opposition, such as remediation efforts, changes of design, and even no-build decisions in some cases.

Conversely, understanding the conditions of success for mobilizations against high-carbon energy, and in support of low-carbon energy, can enable governmental and nongovernmental actors to develop effective strategies. Those seeking to oppose a particular energy transition or type of infrastructure need not only organize meetings and consultations, or arrange for rallies and protests. They can pursue legal changes through litigation, solicit petitions and public comments, gain independent assessments, or tap into the use of expert or independent research. They can articulate alternative infrastructure plans or even rely on direct action tactics such as violence (or countering the threatened use of force by incumbents). The outcomes of these tactics can result in changing the essence of projects or even cancelling them, providing compensation for damages, and changing broader policies and regulations. Thus, we reveal levers for change that extend well beyond the traditional sense of government policy and into the more expansive realm of strategy and the direct action of individuals and coalitions.

Declaration of Competing Interest

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

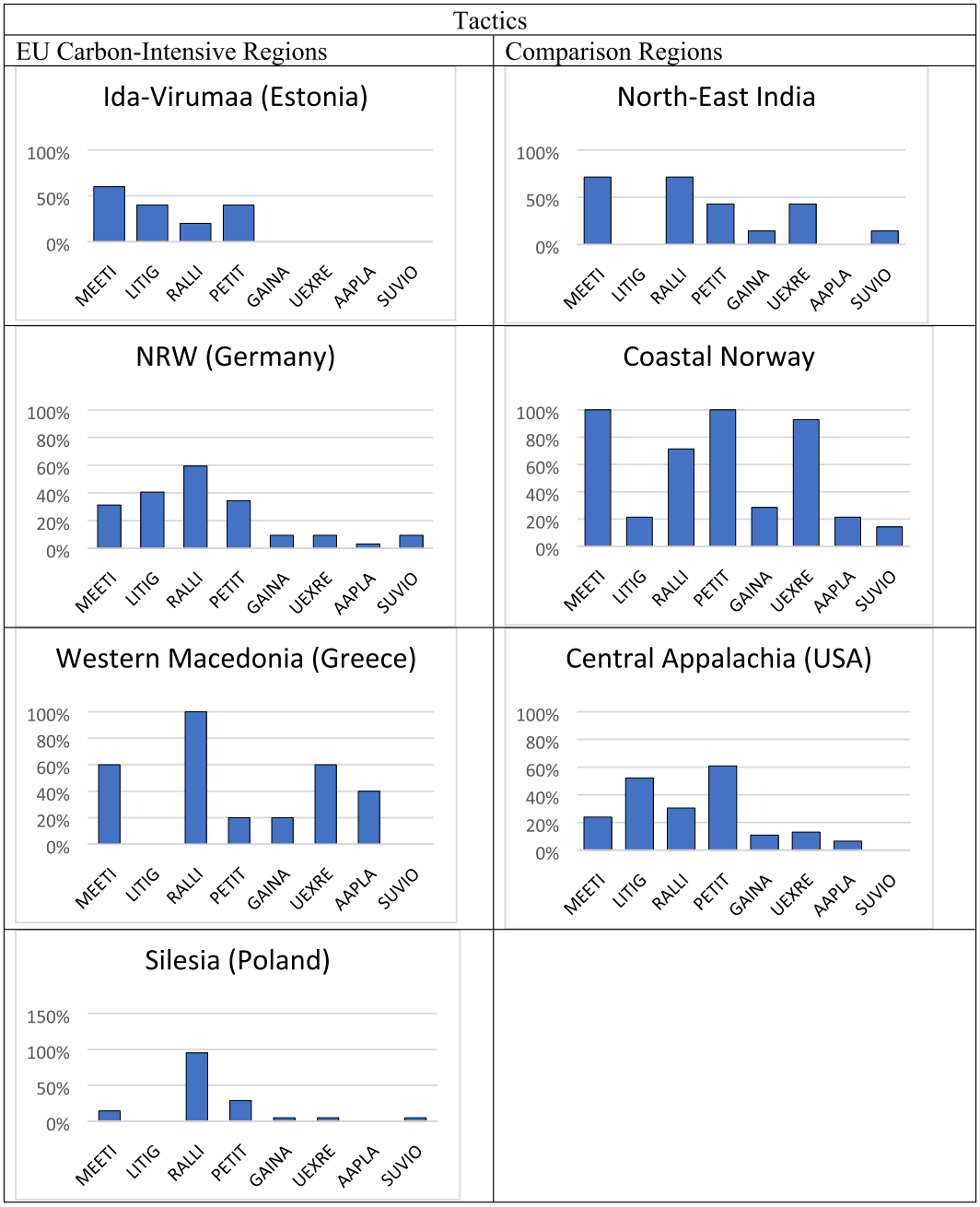

Fig. 5. The tactics of energy opposition and community mobilization across the regions. Note: MEETI = Meetings, consultations, and participation in regulatory hearings. LITIG = Litigation, includes defense against litigation by incumbents. RALLI = Rallies or protests. PETIT = Petitions and public comments. GAINA = Gaining an independent assessment. UEXRE = Use of experts and research. AAPLA = Articulate alternative plan. SUVIO = Suppression and/or violence, including suppression of protest.

Fig. 6. Frequency of Outcomes for energy opposition across our seven regions. Note: SQLOC = Low-carbon status quo. SQHIC = High-carbon status quo. SQNEU = Neutral-carbon status quo, for power-line transmission cases. NOTBU = Proposed project not built or existing project phased out. CHADE = Change design or route. DELAY = Delay project. REMED = Provide compensation or remediation. BROCH = Broader policy or regulatory change.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.gloenvcha.2022.102473.

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