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Editors

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Editorial

Politics and (Self)-Organisation of Electricity System Transitions in a Global North–South Perspective

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Abstract
Dominant electricity systems are inevitably transitioning into new forms in terms of power generation mix, mode of energy system governance and vested interests, the extent of state and consumer/citizen participation in the energy system, and energy justice expectations in different geographies in the Global North and Global South. In this editorial to the thematic issue entitled *Politics and (Self-)Organisation of Electricity System Transitions in a Global North–South Perspective*, we discuss politics and (self)-organisation of (just) energy transitions to expose how messy, convoluted, and fluid future electricity system transitions can be in both the Global North and Global South.

Keywords
decarbonisation; energy transition; global north; global south; Paris climate agreement; solar photovoltaic systems

Issue
This editorial is part of the issue "Politics and (Self-)Organisation of Electricity System Transitions in a Global North–South Perspective" edited by Eberhard Rothfuß (University of Bayreuth, Germany) and Festus Boamah (University of Bayreuth, Germany).

1. Global Decarbonisation and the Role of the Electricity Sector

The destructive consequence of fossil fuel consumption is now self-evident. Causal mechanisms and scientific remedial measures are well known and yet the proposed decarbonisation initiatives seem either far-fetched or run the risk of adventuring into an arena of obscurities, uncertainties, and ambivalences. In cases where decarbonisation initiatives are fairly straightforward and perhaps seamless, debates about the choice of pathways that would produce just outcomes raise more questions than answers. Carbon lock-ins are indisputable in critical sectors such as the electricity and transport sector, heavy industries, as well as the aviation and shipping industries. The consensus to keep the global average annual temperature rise to well below 2°C and even aspire to reduce it further down to 1.5°C—as stipulated in the Paris Climate Agreement reached in 2015—may have provided a timely inspiration and execution plan for future decarbonisation. Yet there clearly exist inconsistencies between the carbon emission trajectories, planned emission reductions, and required emission reduction targets of all countries, not excluding the so-called "climate progressive" nations (see Anderson, Broderick, & Stoddard, 2020). The energy industry alone contributes over 40% of global carbon emissions (International Energy Agency, 2020), and so the claim that the Paris-compliant global carbon budget requires complete decarbonisation by 2030–2045 (Anderson et al., 2020) suggests a radical transformation of the society, the economy and governance of energy systems across the world in less than three decades. The backtracking of wealthy nations from the Paris Climate Agreement (e.g., USA under President D. Trump), display of carbon lock-in syndromes, and/or structural contradictions in decarbonisation declarations among champions of sustainable energy transitions (Germany, UK, Sweden, and Norway) and obvious reluctance of coal-dependent European countries (Germany, Czech Republic, and Poland) to honour coal phase-out pledges (Europe Beyond Coal, 2019; Osička et al., 2020) speak louder than the popular adage. In other words, it is easier said than done. These wealthy western countries may have failed to exhibit exemplary behaviours in the transition to decarbonised energy systems due to structural and circumstantial constraints over which they have limited or no control. What appears intriguing, however, is the continuous promotion of low-carbon energy solutions in Global South countries where the technology is neither cost-effective nor easily compatible with their politics, energy system, socio-economic conditions, and the energy visions of different social groups (Boamah, 2020b). This double-standard or perverse approach to sustainable energy transition has been described as "energy bullying" (Monyei, Jenkins, Serestina, & Adewumi, 2018; see also Boamah, 2020b). The greater contribution of 'climate progressive countries' to global carbon emissions—compared to developing countries—places non-negotiable moral and political responsibilities on them in global decarbonisation initiatives. In fact, many developing countries do not feel morally obliged to implement renewable energy technologies unless they are cost-effective and fit seamlessly into their overarching socio-economic development master plans (Boamah, 2020b). The term 'energy bullying' could perhaps be an apt description to foreground justice considerations in the transition to low-carbon energy technologies. However, although least-developed countries are the primary victims of climate change impacts, a number of them (e.g., Indonesia, Philippines) are equally guilty of heavy carbon emissions, and thus, cannot shun their contribution to global climate change mitigation efforts solely on claims of 'energy bullying' by the Global North.

The pathways to decarbonisation remain convoluted and debatable in both the Global North and Global South. Climate scientists may have their say while politics and modes of energy governance drive decarbonisation initiatives in opposite directions, especially in the shipping, aviation, and heavy industry sectors where further decarbonisation options are either limited or too expensive. Of course, there is no single 'silver bullet' solution to this quandary of the Anthropocene and so the debate should rather be focused on identifying the most promising entry point for the discussion of trade-offs in decarbonisation pathways—of the menu of available options. Electricity reaches approximately 4.3 billion people, and the sector constitutes the single largest source of aggregate greenhouse gas emissions in most countries, predictably the fastest growing energy sector of the future. Moreover, the emergence of electric cars makes the sector a promising decarbonisation pathway (Sovacool & Walter, 2019). The electricity sector certainly has important roles to play in decarbonisation initiatives, especially given recent advancements in low-carbon energy technologies and their capacity to complement fossil fuel-dependent, centralised electricity systems which are currently losing their appeal in favour of decentralised electricity options in both the Global North and Global South (Boamah, 2020b; Bouffard & Kirschen, 2008; Taylor, Turner, Willette, & Uawithya, 2015). Two issues are noteworthy in the discussion of the choice of electricity transition pathways from among the countless available options. The first crucial issue is the direction and nature of the transition process, which would be more appealing in both the short- and the long-term. Put differently, this is whether to maintain the status quo or switch between decentralised, fully, or partly centralised systems, on the one hand; and the political and socio-economic impacts of the transition pathway chosen, on the other hand. The next and related crucial issue is whether the decarbonisation process should be self-driven, state-driven, and/or context-driven. The ambivalence over the potential of (un)just energy transition cuts across both of these issues. In other words, which electricity system transition should be chosen, with regards to where, when, for whom, with what consequences for the economy and fossil fuel consumption, and in order to escape which kind of entanglements?

2. Highlights from the Four Articles and Our Argument

The four articles in this thematic issue sought to engage with the aforementioned issues, and the conclusions reached in all articles suggest electricity system transition pathways are rather less predictable, nested, and in a state of constant flux. As shown in the articles, the socio-economic and ecological impacts of the direction of electricity system transition would depend on local circumstances and a complex set of conditions, e.g., in Kenya and Turkey. And even in cases of obvious transition towards decentralised electricity systems, the co-existence of both systems is still inevitable and desirable. Furthermore, transitioning to energy efficiency technologies like electric vehicles (EVs) does not automatically guarantee desirable decarbonisation pathways (e.g., in Germany) and decentralised electricity transition is not always driven by defossilisation considerations, especially in Norway where the electricity sector is already fully decarbonised. The issue of just energy transition becomes even more complicated when entitlement notions, development priorities, and aspirations of different countries are compared and put in context. We discuss in this editorial politics and (self)-organisation of (just) energy transitions to expose how messy, convoluted, and fluid future electricity system transitions can be in both the Global North and Global South.

3. Centralised–Decentralised Electricity System Dichotomy, Self-Organisation, and Just Energy Transition

Centralised electricity systems, which have dominated the electricity regime in most countries for decades, depend on fossil fuel-powered generation plants. The governance mode of these systems limits the capacity of consumers to produce energy and proactively mitigate power supply shortfalls and unreliable power supply. The mainstream discourse of the Anthropocene and characteristic features of a centralised electricity system are rendering this dominant power supply paradigm less desirable mainly due to the fast depletion of fossil fuels and attendant negative climate change impacts. Furthermore, the desire of investors to minimise risks through the deployment of smaller-scale, modular generation and transmission systems, as well as public reservations about system corruption, gross inefficiencies, and other uncertainties play a role in this tendency (Boamah, 2020b; Bouffard & Kirschen, 2008). Small-scale decentralised systems are emerging as suitable alternatives or complements to centralised systems. They are mostly based on renewable energy technologies or on high-efficiency fossil fuel-based technologies such as combined heat and power or have the capacity to use diverse sources of energy simultaneously, thereby mitigating many power generation and supply uncertainties (Bouffard & Kirschen, 2008). The flexibility and opportunity to integrate renewable technologies to drive decarbonisation initiatives add vitality to calls for a radical transition towards decentralised electricity systems particularly in Global North countries generating high carbon emissions and urgently seeking to mitigate their high carbon footprints out of 'ecological guilt'—primarily per moral considerations.

Meanwhile in Africa, Asia, and Latin America, over 800 million people live without electricity access (World Bank, 2019). In these geographies, a single focus on state-led centralised electrical grid extension to territorially remote and lower-income locations is either unfeasible or costly. The transition to flexible, commercially viable, and scalable decentralised electricity systems seems to be the obvious option to move toward in the near future (Banal-Estañol, Calzada, & Jordana, 2017; Bisaga & Parikh, 2018; Taylor et al., 2015). Another important avenue for decarbonisation is the energy efficiency measures and/or practices that result in reduction of energy demand as well as the transition to EVs or heat pumps (Geels, Sovacool, & Sorell, 2018). It is worth clarifying that the term self-organised, decentralised system used here denotes a system of energy generation and distribution primarily initiated, owned and/or predominantly financed by users themselves rather than the state, parastatals or private companies and where electrical power is generated from (local) sources other than conventional centralised grid systems. Self-organisation of energy therefore encompasses embedded generation or net metering, private sector-driven mini-grid electrification, and complete stand-alone solar photovoltaic (PV) systems where even regulatory frameworks and incentives are driven by the state, parastatals, or by private companies.

The transition to self-organised decentralised electricity provision has gained much prominence in the Global North (e.g., Germany, UK, Switzerland, Australia, Norway, Spain, and some areas in the USA), primarily to encourage the transition to low-carbon energy solutions (Bach, Hopkins, & Stephenson, 2020; Dharshing, 2017; Inderberg, Tews, & Turner, 2018; Passey, Watt, Bruce, & MacGill, 2018; Schmid, Pechan, Mehnert, & Eisenack, 2017). Particularly prominent is the emerging phenomenon of electricity users simultaneously becoming consumers and producers of electricity—often referred to as 'prosumers'—using small-scale solar PV systems as well as offset electricity tariffs usually with centralised grid connection. The deployment of these systems facilitates effective involvement of users in electricity provision by sharing excess power—produced from renewable sources—with the grid and other electricity users, supports peak load demand management, energy system efficiency and plays a vital role in ensuring reliable and sustainable electricity supply in the future (Inderberg et al., 2018; Razzaq, Zafar, Khan, Butt, & Mahmood, 2016; Zafar et al., 2018). While the potential contributions of decentralised, self-organised electrification systems to decarbonisation and the empowerment of consumers are pretty clear, the expectation that particular transition pathways would ipso facto produce just outcomes for all groups, communities, and sectors of the economy in different geographies is still debatable. The 'just energy transition' approach entails a critical discussion of the social, economic, and political repercussions of decarbonised energy transition or decarbonisation strategies to avoid potential re-production of exploitation in the quest to eschew carbon lock-in (Healy & Barry, 2017; Unruh, 2002; Newell & Mulvaney, 2013). Studies show that decentralised systems grant consumers some autonomy, provide increases in the uptake of low-carbon energy technologies, alter the political power wielded by energy companies, and still have the tendency to create social inequalities in favour of more affluent groups who can afford and undermine the operation of conventional energy players who may lose customers (Brisbois, 2019; de Wildt, Chappin, van de Kaa, Herder, & van de Poel, 2020; Sovacool, Lipson, & Chard, 2019). The transition to prosuming will reconfigure the electric utility sector towards low-carbon solutions with many unpredictable risks, and so policymakers and planners are advised to proactively consider effective and efficient measures for their entry into competitive electricity markets (Parag & Sovacool, 2016). As promising as this sounds, the implications for just outcomes remain open to question. Another conundrum is that most Global South countries are transitioning towards a decentralised paradigm primarily to complement centralised power supply systems and mitigate the accompanying spatial inequalities. Accordingly, decarbonisation is the least important consideration for the transition. Whereas the wealthy carbon-dependent Global North countries are compelled decarbonised their energy systems out of moral and political obligations.

The most crucial motivating factors behind the transition processes, entitlement notions, and other contextual conditions in specific geographies deserve attention here since different transition pathways are possible. In Norway, for example, where electricity prices are relatively low, and centralised electricity generation is significantly based on renewables, the transition to self-organised grid-connected solar PV systems may be less inspiring (in the future). At least out of ecological sustainability and financial concerns since the electricity sector is already cost-effectively "de-carbonised" compared to that of Germany, and UK, for example (see Inderberg et al., 2018). This does not suggest a seamless transition in Norway, as shown by Inderberg (2020) in this volume. The grid companies and their interest organisations certainly still hold key positions but their interests have become increasingly less unified since 2011. Higher fragmentation is likely to yield reduced political influence. On the other hand, the grid companies have endorsed the idea of nationally determined regulations. Although depending on the details, the policies analysed either favour or discourage further developments toward decentralised electricity systems, Inderberg (2020) suggests that the centralisation–decentralisation dichotomy obscures many nuances involved on three accounts. First, decentralising initiatives in the energy system can go hand in hand with centralised political steering. It is pretty clear that nationally mandated initiatives have developed digitalisation and prosuming provisions that may lead to increased decentralisation. Second, this complexity underlines the fact that a rough categorisation of actors into incumbents and new entrants is not sufficiently fine-tuned: Analysis of decentralisation requires significantly more refined categorisation and contextualisation to enable more precise predictions. Thirdly, transitioning includes several development paths, which may lead to diverging interpretations. Even though Norwegian electricity sector is fully decarbonised, there are still several different transitions underway. This indicates that even in countries where much of the policy drive is mandated by a decarbonisation goal, subtler causal agents are likely to exist. It is, therefore, necessary to contextualise and make a nuanced analysis to clarify factors influencing ongoing energy transitions, paying a keen attention to pathway directionality complexities as well as the energy justice implications of the ongoing changes.

Developments in Germany are not straightforward either. Carbon emissions from the road transport sector are still significant and so the transition from fossil fuel vehicles to EVs has been featured an as important decarbonisation initiative. Since early 2010, the German government implemented a series of measures to promote the use of EVs, including purchase subsidies and the development of charging infrastructures. The article by Zink, Valdes, and With (2020) discusses the impact of an increasing share of EVs on the electricity grid and suitable locations for charging stations with examples from a case study in Lower Bavaria. The impact of purchase subsidies on EV purchases in Germany, a high-income country characterised by an important automotive industry and an increasing share of private vehicles, is also examined. The authors conclude that neither an increasing electrical charging infrastructure nor EV subsidy policies are sufficient in accelerating EVs transition per se. And even if the two conditions did facilitate the transition, they still do not warrant successful decarbonisation since Germany generates approximately 30% of its electricity from coal. The overall effect of the EV transition must be set in relation to the nature of the country's power generation mix and the fraction that may be constituted by renewable energy sources in the future. Also, it should be pointed out that the total carbon dioxide balance of EV production (e.g., the battery system) can cast doubts on the proposed climate neutrality associated with the transition from fossil fuel-powered cars to the electric types.

Socio-economic conditions and political systems in Turkey make the co-existence of centralised and decentralised systems more desirable, as shown in Dolunay's article (2020). Instead of approaching centralised or decentralised transitions as two separate paths, in which an entire energy system and/or institutional structure need to be revised accordingly, partially managed models could provide faster transitions to renewable energy and enable practical solutions for people. Indeed, from a technical perspective, a centralised grid-connected energy system is a combination of many decentralised energy systems into a grid. Depending on the particular sources of social power in a country, region, or government as discussed in this article, a different model of renewable transition with different layers of liberalisation, privatisation, or self-organisation is also possible. This could in some cases facilitate a faster renewable transition than purely centralised or decentralised options. The organisation of the (de)centralised electricity transitions are dependent on the history, geography, and the overlapping relations of these sources of social power. Nevertheless, the answer to the question of who is prepared to take responsibility within a given country will determine how social power will play out in renewable energy transitions.

In the foregoing, analysis of geographies of self-organisation and just energy transition notions are necessary to expose the nature and cause of conundrums and conflicting perspectives surrounding electricity system transition in different geographies. Self-organisation is seen as a way of institutionalising new social relationships deriving from (or establishing) a variety of local networks, which potentially offer new pathways for the emergence of 'alternative forms of governance.' It is achieved through encounters—perhaps of a serendipitous nature—that lead to the identification of mutual interests, positions, and relations based on shared space, knowledge, values, and norms (Atkinson, Dörfler, & Rothfuß, 2018, p. 2). Fundamentally, self-organisation is a way of representing processes that institutionalise the social relationships deriving from a variety of local networks. These interactions initially generate trust derived from individual relationships which, over time and through further interactions, become transformed into collective forms of trust and create practice(s) with 'collective intentionality' (Hasanov & Beaumont, 2016). This does not imply that they operate in an 'anarchical' manner as they have to institutionalise some of their procedures, although they always try to uphold a certain 'fluidity' and openness of social processes and internal innovation. However, self-organisation can take on many different forms as it develops within local and regional contexts in response to locally experienced and defined 'problems.' Given this, in attempting to identify a somewhat general 'definition' of self-organisation, we need to exercise caution. There are multiple ways of conceptualising self-organisation that are not necessarily mutually exclusive. Two examples will suffice to illustrate this (see Atkinson et al., 2018, p. 170). Nederhand, Bekkers, and Voorberg (2016, p. 2) define self-organisation as a "collective process of communication, choice, and mutual adjustment of behaviour resulting in the emergence of ordered structures"; while for Boonstra and Boelens (2011) it is the absence of government involvement, and thus, of external control (see also Boonstra, 2015). We do not see these two approaches as necessarily contradictory. However, we should also acknowledge that some forms of self-organising may consciously choose not to engage with established forms of governance, indeed they may seek to demonstrate that there are alternative ways of organising society. Meerkerk, van Boonstra, & Edelenbos (2013) point out that self-organised initiatives represent a challenge to existing governance structures yet evolve together within existing institutional settings. We want to argue that the most fruitful way of doing this and of understanding self-organising is a discursive approach that identifies particular 'local issues,' 'frames of orientations,' and which develops associated narratives, visions and practices and then seeks to construct particular courses of action—appropriate to local contexts. Here self-organising is a dynamic process that emerges in response to the development of shared local understandings and ways of addressing these (Rothfuß & Korff, 2015). Moreover, as the experience and knowledge of such groups evolve, they themselves are likely to change and, perhaps, expand their horizons beyond local contexts, making connections with wider national and global causal processes. Self-organisation as a means of action 'from below' emphasises interaction and discussion between participants leading to the identification of relevant local issues and the formation of an accompanying 'discourse/narrative' of problem definition that may challenge and subvert existing governance forms or enhance them. It provides alternative ways of doing things, it potentially offers new ways of 'governing from below' that reflect local contexts, understandings of problems, and solves them through innovative practices (see Joas, 1996).

In the energy transition literature, self-organisation encompasses a variety of topics ranging from active participation of the population and local ownership of projects by citizens and communities in local energy initiatives to the resultant 'transformative outcomes' in the transition to new energy systems and how these create promising avenues to facilitate energy transition towards a low-carbon future (Hasanov & Zuidema, 2018). Self-organisation of distributed generation in the Global North, for example, ensures reliable energy supply and sustainable energy practices, grants some autonomy to energy users (Bulkeley, Powells, & Bell, 2016; Strengers, 2013; Strengers, Pink, & Nicholls, 2019; Zafar et al., 2018), not excluding availability of financial incentives, relevant technical information, as well as the existence of clear regulatory frameworks (Boamah, 2020b).The driving forces behind self-organisation of energy and their consequent effects in the Global South vary markedly not only from experiences in the Global North but also even within and between countries. Major drivers of the transition include unjust billing systems, inefficiencies in state-driven centralised electricity provision, and unreliable and unavailable grid power supply particularly in Ghana, Kenya, Uganda, Tanzania, South Africa, and many other African countries. Self-organisation of electricity towards decentralised electrification systems seems like a promising approach to addressing energy injustices, and thus, economic challenges in the Global South. In Africa in particular, self-organised electrification initiatives are expressions of despondency, aspiration for autonomy in energy generation and consumption, and thus, remediation responses to energy injustices considered realisable through limited or no dependency on state institutions (Boamah, 2020a, 2020b).

Decentralised, self-organised models of electricity production have thus been perceived as an opportunity for countries in the Global South to leapfrog directly into the future of electricity. That said, in the Global South where decentralised electricity systems appear as the better alternative, outcomes of the mode of governance present yet additional dilemmas. Despite interest in self-organised decentralised electrification, states are still ambivalent due to potentially negative effects on their monopolistic practices. States have strong vested interests in power generation and aspire to retain substantial control in centralised electricity provision in order to directly drive their socio-economic development agenda throughout the country. This is particularly striking where centralised electricity distribution is structured around state monopoly primarily for 'developmental state' visions in order to secure revenue flows and/or in response to a history of unsuccessful private sector-led development approaches (Boamah, 2020a, 2020b; Van der Merwe, 2017). Central governmental structures and parastatals strategically organise decentralised electricity provisions in a way that keeps citizens perpetually within the bounds of patronising state-driven electricity services. Even in South Africa, a country that supports embedded electricity generation or net metering through state-driven initiatives—such as tax incentives and cost reductions to reduce its huge carbon foot-prints

(Didiza et al., 2016; Van der Merwe, 2017)—regulations on permissible power exports by net-metered customers are designed to prioritise the financial sustainability of state electricity distribution against the interests of customers who want to mitigate impacts of unjust electricity provision in 'self-fulfilling' ways (Boamah, 2020b).

Similar ambivalence occurs in Ghana and Kenya where the centralised electricity sector also serves as the state's cash-cow and any aberration from this tradition spells financial doom for the state electricity distributors and the implementation of collectively binding decisions by the state (Boamah, 2020b, in press). Kenya Power has reservations against self-organised, decentralised electrification systems due to its cyclical financial challenges and financial obligations to numerous power producers, sometimes with contracts extending beyond 20 years (Boamah, 2020a). Unless decentralised electrification systems are organised within the state apparatus and tailored to specific rural electrification visions of the state, decarbonisation considerations through self-organised mechanisms do not present any practically compelling motivation for the promotion of self-organised, decentralised initiatives of the population. This is especially the case given that renewables constitute approximately 85% of power generation mix (43.50% geothermal, 27.61% hydro, and 15.12% wind) as of May 2019 (Boamah, 2020b) and given the existence of 3.2 million off-grid solar PV installations as of December 2017—which are mostly private sector-driven. Furthermore, neither decentralised nor centralised systems provide precise instructions for socio-economic transformation especially for territorially remote areas.

The spatial concentration of centralised electrical grids in urban and higher-income locations of Kenya affects the development of micro-business enterprises in remote areas (Boamah, 2020a). Well-to-do households who invest in more efficient solar PV systems to serve as power back-up systems are able to satisfy energy needs for social and business activities even in areas noted for unreliable grid supply. Poorer households, on the other hand, have to restrict dominant social and economic practices according to the energy services of inefficient solar PV systems, which eventually hinders the development of home-based and other rural business enterprises. The emergence of precautionary energy practices contributes to unintentional production of low-carbon landscapes in the periphery but reveals inherent injustices associated with complete dependence on decentralised systems too. This also exposes governance challenges since decentralised systems are usually organised with little or no adherence to state regulations and the desperate customers are often exploited by unscrupulous solar energy service providers (Boamah, 2020a). The governance mode of either centralised or decentralised electricity systems can play an important mediating role in terms of impacts on rural livelihoods. The article by Klagge, Greiner, Greven, and Nweke-Eze (2020) sheds light on this issue. The types of multilevel governance in geothermal energy development in Kenya include institutional interplay, co-management, and the Geothermal Development Corporation as a bridging organization. Their study shows that centralised electricity generation can, as with decentralised electricity systems, have strong local impacts, with local communities playing an active part. The Baringo community in Kenya, for instance, is not a passive recipient of benefits but rather an active participant in negotiations as well as acts of resistance and sabotage when important demands are not met or if Geothermal Development Corporation activities are regarded as unfair. Community action and responses, therefore, have the potential to disrupt project advancement. The conclusion reached by the authors is that cross-scale links need to be considered to understand how power relations impact the implementation and governance of large-scale electricity generation.

There are certain distinct motivating factors and frictions in electricity system transitions which are exclusive to particular countries in the Global South. Ghana is a classic case in point. The strategic handling of tariffs and the quality of electricity supply present governments with the opportunity to shape the public's impression of the ruling government. Ghana experienced acute power outages caused by power generation shortfalls, grand energy sector corruption, and controversial tariff increases between 2012 and 2016. Rampant power outages were satirically represented in the Ghanaian media as *Dumsor* whereas 'hyper-speed' recording of electricity units by alleged 'faulty meters' were termed 'Usain-Bolt Meters' due to public perceptions of unfair billing systems (Boamah & Rothfuß, 2018; Pyman & Boamah, 2019). *Dumsor* is a word in the Ghanaian Twi language which refers to frequent and unexpected power outages within a short period of time. The satirical term was invented by the frustrated Ghanaians to ridicule the government's poor management of energy crises, especially prior to the general elections in December 2016. These developments made the incumbent government unpopular in the run-up to the 2016 general elections. The Ghanaian government introduced off-grid solar PV subsidy program primarily to mitigate the energy crisis. Net metering policy which had been in existence was given a more serious attention by the government before the general elections. The net metering sub-code was published by the Energy Commission in 2015 and on the 30 September 2016 the Public Utilities Regulatory Commission of Ghana published the net metering rate to guide the policy implementation. The Ghanaian government and energy sector agencies, however, continue to express ambivalence on net metering system policy implementation due to cyclical financial indebtedness of its main electricity distributor, Electricity Company of Ghana (ECG), and the state's obsession with monopolising the means of electricity generation and distribution. The ECG has refused to offset monthly electricity bills of net-metered customers for over 5 years contrary to tariff regulations published by the public regulatory commission of Ghana (Afful, in press; Boamah, 2020b). Beside financial considerations, the obstinacy of the ECG has been attributed to the fact that power generation shortfalls between 2012 and 2016 and related power supply instabilities—which reinforced the idea—have been reversed with excess power generation capacity of approximately 2400 megawatts after 2017; hence, the policy has outlived its usefulness, at least in the meantime (Boamah, 2020b). Players in the renewable energy sector and state energy agencies argue that since the country does not feel morally obliged to promote low-carbon energy solutions and does not have any political obligation to do so, decarbonisation of the sector would be largely dependent upon the cost-effectiveness of the technology (Boamah, 2020b). Reference to excess power supply—although Ghana currently produces almost 70% of its power from fossil fuels—and financial considerations, which are largely decisive of the electricity system transition pathways, suggest that decarbonisation cannot be on the radar of relevant agencies until it coincides with certain desirable conditions and emergency situations.

Moreover, in other circumstances, self-organised energy initiatives imply that there are citizens who are almost fully fending for themselves via self-financing of power back-up systems, making direct negotiations with private sector energy providers at exorbitant costs, and/or depending on mini-grid electrification systems (particularly in remote areas) with tariffs significantly higher than that of conventional centralised electrical grids while the state may have limited control over the matter (Boamah, 2020a, 2020b). Although self-organisation of decentralised electricity systems may mitigate energy injustices and satisfy energy needs of lower-class social groups in extreme areas of Kenya and Namibia (Boamah, 2020b), it results in feelings of entrenched energy injustices and misrecognition particularly in countries like Ghana where individuals and groups deem limited or no access to state-driven grid as characteristic denial of privileges of national citizenship, sometimes regardless of socio-economic status, class, place of residence, and so on (Boamah & Rothfuß, 2020). Even within Ghana, state-led decentralised solar PV electrification produced conflicting responses regarding the issue of justice: The government-sponsored free dissemination of 500-Watt solar PV to off-grid communities created a collective consciousness of misrecognition due to the social preference for centralised grids, whereas a 50% subsidy of the same program for urban households generated contrary feelings (Boamah & Rothfuß, 2018, 2020). The off-grid community had voted for the incumbent government in expectation for centralised electrical grids and the offer of free solar PV systems was perceived as misrecognition of citizenship rights when compared with fellow Ghanaians living in grid-connected locations. This had been the case despite the widespread outcry of injustices around dependencies on centralised electricity provision (Boamah & Rothfuß, 2020). This is a clear case of frustration born out of relative deprivation; the disenchanted off-grid residents issued subtle threats to vote against the ruling government during 2020 election upon failure to provide electrical grids (Boamah & Rothfuß, 2020). Self-organisation and the politics of electricity system transitions in contemporary Ghana shows a situation where the quality of electricity supply and spatiality of electrical grid access has been a driver and sometimes an outcome of elections. Therefore, the organisation of energy infrastructure is intertwined with multiple interests at different geographical scales—from local to national.

Again, in the Republic of South Africa, the state-sponsored Free Basic Electricity project increased energy access for lower-income groups and residents of off-grid communities, and yet the energy output of decentralised solar PV systems was way below energy needs of the population relative to the more privileged groups who had access to more efficient and lower-cost centralised electrical grids (Masekameni, Kasangana, Makonese, & Mbonane, 2018; Monyei, Jenkins, et al., 2018; Monyei, Adewumi, & Jenkins, 2018). Both state-driven centralised electricity systems and decentralised ones do not guarantee just outcomes; and neither do self-organised decentralised systems offer satisfactory remedy due to the above-mentioned contested entitlement notions. The transition to self-organised, decentralised electrification systems in the Global South is driven by quite different motivations in rather ambiguous energy policy regulatory frameworks and public ambivalence.

The transition is not any less seamless in the Global North where regulatory mechanisms and clear incentives exist. There are tensions in Germany as big energy companies have been affected by state subsidies supporting small scale self-organised grid-connected solar PV installations. Experiences in Australia are even more complex. The transition to net metering and battery energy storage systems in Australia have caused significant reductions in grid electricity consumption (and hence reduced revenues of utilities) and yet the resultant peak load demand reductions can, in certain situations, adequately offset grid network investment costs (Passey et al., 2018). Depending on the electricity regime, energy politics and other local conditions, frequent power supply interruptions, poor access to centralised electrical grids, and hikes in electricity tariffs present a comingling of opportunities and challenges in the transition to self-organised solar PV systems in Global South and Global North countries.

Self-organised decentralised electricity provision is decidedly reconfiguring the role of civil society organisations and state actors in electricity regimes of Global North and Global South countries. The conflicting viewpoints about what a ‘desirable energy future’ should look like and the governance structures to realise these revolve around a choice between self-organised decentralised systems—inclined towards renewable energy promotion, energy efficiency, autonomous and 'democratic' electricity provision by individuals/local entities—traditional centralised systems (Schmid et al., 2017), or the co-existence of both systems.

4. Locked between the Scylla of 'Energy Bullying' and Charybdis of Decarbonisation Apathy

Concerns about a fair distribution of the benefits and burdens of the energy system for all in society is certainly a necessary call within the just energy transition debate (see Jenkins, Sovacool, Błachowicz, & Lauer, 2020; Healy & Barry, 2017; Newell & Mulvaney, 2013; Sovacool, 2014), but they are certainly bundled with some constraints too. The justice advocacy in the decarbonisation debate has placed huge political and moral obligations on the major emitters of carbon and this might have obscured necessary contributions from least emitters (predominantly in the Global South) who may suffer from the brunt of climate extremes in the future. According to Anderson et al. (2020), the planned carbon emission reductions of "climate progressive nations" such as the UK and Sweden, will still exceed their fair share of a Paris-compliant global carbon budget by at least two times, and even in the UK where moderate progress has been registered, emissions from international aviation and shipping are excluded. Norway has fully decarbonised its electricity sector and great strides in the transition to electric cars suggest a big leap forward, but these gains are still negated by huge carbon emissions from its cash-cow (oil and gas sectors, aviation and shipping industries). Calculations by Anderson et al. (2020) show that an immediate 10–15% per year carbon emission reduction target is required for Norway to meet its Paris-based temperature and equity commitments, and this also requires a completely zero-carbon energy system in the shipping and aviation industry by 2035. President Trump blatantly flouted the Paris Agreement, repealed anti-fossil regulations to revive coal mining industry in the USA—to honour electioneering promises in 2016—even in the face of evidence suggesting that the coal mining industry and coal jobs decline occurred three decades earlier and that mining workers have become accustomed to transitioning to alternative livelihoods (Sanya, Evans, & Konisky, 2018). President Trump claims adherence to the Paris Climate Agreement could endanger the US economy which thrives on massive production and consumption of fossil fuels, and that he can backtrack this position on the condition that renegotiation of the terms of the agreement is deemed fair to the American economy and workers. The date of formal withdrawal (4 November 2019) is in contravention of the terms of agreement which prohibits termination earlier than three years from the effective start date of the agreement by the signatory—which was 4 November 2016 for the USA under the administration of former President Obama. In other words, the earliest permissible withdrawal date must be after 4 November 2020, but President Trump flouted the agreement out of politics against de-fossilisation. Therefore, decarbonisation initiatives and the set timelines in the Global North can be nothing more than wishful thinking due to the obvious negative impacts they may have on the economies of these wealthier nations and other vested interests around continuous burning of fossil fuels. Lock-in syndromes reinforce energy bullying behaviour in even wealthy and 'ecologically guilty' countries, as for countries in the Global South, it reinforces the stance in which they, understandably, do not feel morally obliged to make strenuous commitments to low-carbon energy solutions. The fact that many least-developed countries in vulnerable geographies (e.g., Indonesia, Bangladesh, and Sahelian countries) lack the wherewithal to make effective climate change adaptation—in contrast to wealthy western countries—reveals the weaknesses of the just transition framework. The skewed attention to the distribution obligations of causative agents without analysis of primary victims of climate extremes may mislead some Global South countries to sit aloof and continue with business as usual. In fact, carbon emission statistics of newly industrialising countries (e.g., Brazil, South Africa, Indonesia, China, and India) place them in the same league of 'heavy emitters' as the wealthy western countries or sometimes even higher (e.g., China). Hence, Global North's energy bullying practices cannot justify ignoring the issue of decarbonisation. Of course, technical, financial, and other forms of support from the Global North are required to equip climate mitigation efforts, on just grounds, but the obsession with justice considerations may stall decarbonisation initiatives in the electricity sector. The just energy transition perspective can thus be not only enabling and but also constraining.

5. Final Reflections and Unresolved Questions Needing Attention

The thematic issue has sought to explore emerging technological, geographical and political trends in different regions of the world as our electricity systems are clearly moving away from the centralized, utility-based, and state-controlled power generation models. No matter how hard opponents may try, a paradigm shift in centralised electricity systems toward self-organised decentralised electricity systems is inevitable be it now or in the future. The shift is a result of a combination of motivations and the relevance of the driving forces shaped by changing circumstances, which are both predictable and unpredictable in specific geographies. The consequences and drivers of electricity transitions are so variable and mixed that attempts to provide blueprints may give rise to new lock-ins. Predicting the trajectory of the transition pathways and governing it towards desirable outcomes are still complicated given the uniqueness of electricity regimes within specific countries, the varying levels of national economic development, different state priorities, and ever-changing energy visions of electricity consumers. Even though the direction and governance mode of electricity transition systems necessary for the realisation of decarbonisation targets are not far-fetched, the pathways that offer just outcomes make electricity system transitions amorphous adventures. We cannot pretend to have settled these issues, but our contribution could perhaps be enhanced by raising some refreshing questions in the hope of informing future research. These include, but are not limited to, the following:

- What are the possibilities for countries of the Global North that have developed excellent centralised electricity systems to make a switch to more flexible and modular energy systems which are predicted to be the dominant model of the future?
- Are Global North countries witnessing a path dependence leading to unforeseen institutional consequences where countries like the UK—with its highly centralised electricity system—are now facing bigger challenges in making the transition to more flexible and sustainable energy systems compared to countries like Denmark and Germany where stronger elements of decentralised electricity generation have been maintained?
- Does transition to a decentralised electricity system create the necessary preparatory grounds to mitigate entrenched energy injustices in the Global South, or does it rather create a dual system where commercial and rich consumers could manage their own energy needs while a less efficient public electricity system is left to serve the poor?
- Should the framing of the electricity system transition debate be shifted from justice issues to pragmatic challenges awaiting residents in vulnerable geographies?
- Does self-organisation of energy and unpredictable outcomes complement or destabilise the dominant electricity systems and state capacity?

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Conflict of Interests

The authors declare no conflict of interests.

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Article

Centrally Decentralising? Analysing Key Policies and Pathways in Norway's Electricity Transitions

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Abstract

With national electricity systems, 'transition' may involve decentralising production and ownership, and digitalising the system. These processes are facilitated by smart metering, 'prosuming,' and changes in consumer behaviour. Driving factors may be national steering, or the process can be left to the market. In Norway, the government has opted for tightly steered national coordination of three key areas: national smart-meter implementation (since 2011), prosumer regulation (since 2016), and a national end-user demand flexibility regulation (expected to be adopted in 2020). These regulations influence production patterns, energy flows and grid activities. Drawing on organisational fields theory, this article asks: Why was it decided to adopt these policies centrally? Which actors have had greatest influence on policy outputs? And, finally, what of the possible implications? The regulations, developed in a sector in a state of field crisis, have generally been supported by the relevant actors. The Norwegian case can help to explain incumbent roles and field crisis, as well as nuanced drivers in complex transitions, beyond decarbonisation.

Keywords

decentralised energy system; energy transition; organisational field

Issue

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1. Introduction

The electricity sector is a crucial area for fulfilling climate targets, along with wider transitions deemed necessary to achieve 'deep decarbonisation,' where the scope of the transition goes well beyond single technologies and sectors, to achieve society-wide and larger-scale emissions reductions (Geels, Sovacool, Schwanen, & Sorrell, 2017; Schot & Kanger, 2018; Sovacool & Walter, 2019). Despite extensive national variations in efforts and results based on factors like historic production portfolios, sector structure and stakeholder interests, and resource endowments, the role of policy has proven important, as have other factors that are shared drivers in these electricity sector transitions (Meadowcroft, 2009; Roberts & Geels, 2018; Rosenbloom, Haley, & Meadowcroft, 2018).

Smart electricity meters, prosuming (whereby households and small firms consume and produce electricity), and flexible electricity use at the consumer level all play distinct but interrelated roles in electricity-sector transitions (Ballo, 2015; Inderberg, 2015; Inderberg, Tews, & Turner, 2018; Skjølsvold, Throndsen, Ryghaug, Fjellså, & Koksvik, 2018). Energy transition can be understood generally as "change in the composition (structure) of primary energy supply, the gradual shift from a specific pattern of energy provision to a new state of an energy system" (Smil, 2010, p. vii). However, electricity transitions today play out in different ways in connection with various drivers and resistances. Although usually driven by political factors (Moe, 2017), an electricity transition should not be seen as *one* unified development or direction. It involves interrelated transitions in production and consumption patterns, grid activities, digitalisation of the electricity sector, the electrification of new sectors, and, usually, decarbonisation. Actually, energy *transitions* should be seen in the plural, embracing various trends and directions, involving a range of actors (often with opposing interests) at several levels. This facilitates an understanding of transitions as non-unitary, contested pathways that require analytical disintegration to be comprehended.

Conceptions of energy futures tend to be contested and are influenced by more and less covert interest conflicts. Here I apply an organisational fields perspective to three key policies in order to explain the direction of Norway's ongoing electricity transitions, drawing primarily on data from public policy documents, reports, and hearings. I ask why it was decided to adopt these policies centrally, and which actors have had greatest influence on policy outputs. I also discuss whether there has been a movement from a centralised towards a more decentralised system. The three policies studied here are the adoption of the nation-wide smart meter programme in 2014, the national prosumer regulation from 2016, and the consumer flexibility tariff from 2018 (withdrawn) and 2020 (pending political decision). These policies are arguably among the most important ones of the past 20 years in determining the degree of current and future decentralisation of the Norwegian electricity system. Ever since the early 1900s, Norway has had a traditional electricity system based on publicly owned hydropower; however, it has demonstrated the ability to change and was among the first countries to liberalise its electricity sector in 1991.

Norway has opted for firm political steering of several processes for transitioning its electricity sector, although politically mandating tightly-reined national steering is not warranted. Other countries have chosen various solutions. For example, New Zealand, Sweden, and Switzerland—small countries with a high hydropower share in their electricity mix—have taken differing paths with lighter governmental steering, perhaps with the partial exception of Sweden for smart metering. New Zealand, dominated by hydropower and roughly comparable in size to Norway, has a voluntary, market-based approach to smart-meter rollout. Sweden had national smart-meter implementation with limited meter functionality in 2009, followed by a recent renewal of all meters—also politically mandated, and resembling the Norwegian programme. Thus far, Sweden has not mandated an end-user flexibility policy, but the need has been officially recognised. Finally, Switzerland does not have a national programme but has several grid-company-level programmes for smart metering. These variations in approach warrant closer analysis, where the Norwegian case can shed light on how system structures change and why, in the face of assumed vested interests.

The selected policies all represent key interventions likely to condition future developments relating to the development of the electricity system—in particular, whether or not steps are being taken toward greater decentralisation.

The centralised–decentralised dimension has numerous interpretations (Judson et al., 2020). 'Centralised' and 'decentralised' are often relative and descriptive terms referring to electricity production, grid and consumption structures, and are as such physical—but they can also reflect control over (parts of) the system, ownership, or other aspects (Bauknecht, Funcke, & Vogel, 2020). Here I relate this dimension primarily to production, energy services and electricity management issues, briefly touching on influence structures. While I do not take a normative stand as to what would represent the 'best' system structure, the policies studied here all enable new balances along this key dimension, and, in my view, represent some movement towards a decentralised system.

2. Theoretical Perspective and Case Selection

The organisational field perspective (Fligstein & McAdam, 2012) is well-suited for shedding light on the interest dynamics within a field or sector. It is useful for explaining changes in dominant interests and perspectives, and ultimately on policy output and institutions (Wooten, 2015).

2.1. Organisational Fields

The electricity sector, like any organisational field, is an area of institutionalised life that includes government and industry, as well as other relevant stakeholders (DiMaggio & Powell, 1983). It is characterised by a shared regulatory framework, as well as relatively consistent patterns of domination and subordination (Scott, 2008). Whereas the regulatory framework may originate from different bodies and levels of administration, an organisational field represents a system of actors, actions, and relations where actors take each another into account as they conduct interrelated and interdependent activities (McAdam & Scott, 2005). In addition to formal rules and regulations, also shared values, norms, and conventions develop within the field; however, I focus on the formal rules and interests. Many organisations, public as well as private, are involved in operating and governing Norway's energy systems, with actors on the political (ministries, individual politicians) and industrial levels, and NGOs or consumer interests.

Established organisations within the field will often work to keep or enhance inherited formal structures (Thelen & Streeck, 2005), as it is at the field level that institutions (including regulatory structures) are established, maintained, and changed and disrupted (Lawrence & Suddaby, 2006). When there is stability, field strategic games are played, to place actors in a favourable future position (Fligstein & McAdam, 2012). In stable fields, changes are usually incremental, but fields tend to exist in one of three states: emergent, stable, and crisis (Fligstein & McAdam, 2012). Emergent fields lack institutionalised regulatory and normative structures, and stable fields are more established, with a settled structure. A field crisis typically occurs when established structures, often held in place by incumbent actors, become challenged by external or internal events or new actors, perhaps leading to transitions and new stable states (Koehrsen, 2018). New challenges may include technological developments, external political pressure, internal rising actors, or other pressures currently ongoing in national electricity sectors. It is likely that the three policies studied: a) are shaped in accordance with the incumbent interests in Norway's electricity sector; or b) stem from external or internal events, challenging the established power structures. In the first case, we expect that current incumbents have wanted national policies in the areas analysed here, and have influenced them to secure regulation in accordance with their interest. As the incumbents are dominant actors in control of a traditional electricity system, little change in terms of decentralisation is to be expected. In the second case, the situation can be identified as a field crisis, where challengers to the current structure have had clear influence on policy outcomes. This represents a shift in the sector and may lead to a more decentralised pathway.

2.2. Case Selection and Empirical Data

The cases have been chosen because they represent particularly important policies for the centralised/decentralised dimension of the Norwegian electricity sector. Such official policies or regulations define key premises for subsequent policies, regulations, and sector behaviour, and therefore also pathway direction. Inspired by 'anchoring practices,' the conceptual notion of a hierarchy in practices that 'anchors' and sets premises for other and subsequent practices (Inderberg & Bailey, 2019; Swidler, 2001), understanding the cases as 'anchoring policies' relates also to their relative place in regulatory complexes, where they strongly shape subsequent regulation. Path change would also entail adaptations in the anchoring policies. The role as dominant premise-setters makes them key arenas for vested interest conflicts within the sector, and useful as analytical units. This means more effective case selection, perhaps at the cost of technical nuances and reduced empirical richness.

The policies for smart metering, prosuming regulation, and demand-side response tariff are related, but separate approaches that all represent such premise-setters. Smart metering enables later possibilities, although their potentials are as yet unrealised. Prosuming—household production of electricity for own use and occasional export of surplus—has been slow to emerge in Norway, but it represents an emerging trend and a possible challenge to the traditional production-grid-consumption model (Inderberg et al., 2018). Finally, demand-side response in the form of a grid tariff is currently being planned.

This study rests primarily on document studies relating to official reports, academic articles, and official policy documents on the development of the policies under scrutiny. All hearings and hearing statements connected to the development of these policies have been investigated, providing important sources for categorising actor standpoints, actor constellations and contestation of different viewpoints. Individual hearing statements have been collected, processed, and analysed according to views expressed. Given the brief format of this article, the presentation of the hearing statements is necessarily somewhat superficial. For each topic, several hearings have been held, with response submissions ranging from 5 to 84 (see Table 1). In the presentation of the results, I have partially conflated several hearings, narrowing them down to those that led to the final regulation, while still seeking to present differences and developments between the hearings. Narrowing down to the 'most important' hearings (indicated in Table 1) does not mean that small technical changes are necessarily unimportant, but here the focus is on more general trends and viewpoints.

While the implications of any policy can often be interpreted in several ways, and the consequences are not always as intended, the policies selected for analysis here are generally assumed or even officially intended to contribute to greater digitalisation, enabling new technical solutions, facilitating decentralised production of electricity, and encouraging flexibility in electricity consumption. The official policy goals are described under each policy.

In addition to the hearing documents, the data include official reports and legal documents, as well as research literature. The main basis for the analysis is the hearing documents, including the official proposal, hearing letters, and submissions by relevant actors. In principle, any legal entity (including private individuals) may submit hearing responses. Thus, there is some self-selection involved in the empirical material, favouring organisations and individuals with sufficient interest in, competence, and capacity to submit a response.

3. Three 'Centrally Decentral' Policies

Norway's electricity system is already fully renewables-based. The share of wind power is increasing and is expected to reach 10% of electricity production by 2021, with the remainder produced almost exclusively by hydropower. Transnational interconnectors are important for securing supply in years with low precipitation, as well as for export purposes. This leads to a unique situation where the electricity system itself is not in need of decarbonisation, and where stored hydropower provides flexibility. While Norway is not a full member of the EU, it is an EEA member, and must transpose most EU regulations relating to the electricity sector.

Highly visible in the hearings are the traditional electricity-sector actors. The grid utilities—about 130 in Norway—are dominant here, ranging in size from 730,000 end-users and down to fewer than 5,000. The largest companies (Hafslund Nett, Eidsiva Nett, BKK Nett, Agder Energi Nett, Skagerak Energi Nett, Norgesnett)

Table 1. Hearings: Main elements and overview.

Start hearing	Main topic	Specific topic hearing	Responses	Regulatory change implemented
2008	Smart metering	Proposed change in smart-meter regulation	48	Conceptual hearing—no change planned
2009	Smart metering	Hearing on the decision await the European Commission group M/441 work, to align standards	37	Decision to await EU developments for standardisation
2011 *	Smart metering	Main hearing with proposal for smart-meter definitions, metering requirements, billing	65	Regulations adopted in full
2013	Smart metering	Short deadline, proposal to postpone roll-out	5	Two-year postponement of smart-meter implementation
2014 *	Prosumer regulation	Changes in control metering regulations	46	Regulation adopted with minor modifications
2015	Prosumer regulation	Additional hearing (short deadline) on net metering of prosumers for support scheme	27	Regulation withdrawn following political instructions from government
2015	Flexible tariffs (demand-side management)	Conceptual hearing exploring overarching principles and potential models	57	New hearing (as planned)
2018 *	Flexible tariffs (demand-side management)	Proposal for tariff model 'subscribed capacity'	81	Proposal withdrawn; new proposal for hearing in 2020 (postponed several times)
2020	Flexible tariffs (demand-side management)	To be launched	n.a.	

Note: * Main policy decision round.

supply the majority of end-users in Norway with electricity, and all these companies have submitted substantial statements to the hearings examined here. The smaller grid companies vary in geographical area and localisation: a bouquet of organisations ranging from those with one or two employees, to larger and more professionalised enterprises (Inderberg & Løchen, 2012). Energy Norway is the dominant interest organisation, representing some 300 companies that produce, transport or deliver electricity—companies that cover 90% of Norwegian end-users. Defo is an interest organisation representing producers and grid companies in rural areas, with 68 member companies. Lastly, KS Bedrift represents the municipalities as significant owners of energy companies.

The next actor group is the newer entrants in the electricity sector, with companies like Otovo, Solenergi FUSen, and Solcellespesialisten. These are represented by the interest organisation Norwegian Solar Energy Society (*Solenergiforeningen*), with about 500 organisational and private individual members. At hearings, these are frequently accompanied by representatives of associations like the interest organisation for electric vehicles, EV Norway. In addition, some of the larger entrepreneurs and housing companies, like the NBBL and OBOS, frequently side with others in this group.

The last group of actors are the NGOs and some consultancy companies. Of the NGOs, Zero, Bellona, and Friends of the Earth Norway have submitted statements to all hearings. Then there are consultancies like Multiconsult, which work to spread information about electricity, control systems, and new modes of production like PV, while also having their own interests.

3.1. National Smart-Meter Implementation from 2014

In Norway, smart meters offer two-way communication that measures consumption at regular intervals (15 minutes) and reports hourly. This includes a remote control element, for limiting or shutting off supply (Inderberg, 2015). The meters can provide accurate information to the consumer and billing for real consumption, as well as activation and de-activation of supply; and they can facilitate limited private household generation of electricity and feeding into the grid. They are generally seen as a necessary step towards smart grids and effective demand-side management, and as contributing to grid digitalisation, enabling new options for managing consumption patterns and energy services.

Unlike some other countries, including large states under EU regulation like Germany (Meister, Ihle, Lehnhoff, & Uslar, 2018) and the UK (Sovacool, Kivimaa, Hielscher, & Jenkins, 2017), Norway has adopted and implemented a complete, nationally-adopted roll-out of smart meters with specific technical requirements, replacing *all* electricity meters in the country. Here Norway was later than frontrunners like Italy, Sweden, and Finland, but this later adoption enabled coordination with European technical standards for metering. Although these are important markets that the Norwegian electricity sector must relate to (Inderberg, 2015; Zhou & Brown, 2017), there was significant national room for leeway. Annex I to the Electricity Directive 2009 (which is binding for Norway) requires EU member-states to implement electricity smart meters for 80% of consumers by 2020, unless the result of a cost–benefit analysis is negative (EU, 2009). This has led to considerable variation in approaches within the EU in terms of meter requirements, degree of state steering, and meter share of end-users. Norway's smart-meter regulation involved a compulsory rollout for *all* meters, where technologically advanced minimum requirements and open standards were established for these meters. To date, three brands of meters have been delivered, from the companies Aidon, Kaifa, and Kamstrup.

Prior to the hearings, the Norwegian Water Resources and Energy Directorate (NVE) issued three reports, mapping the feasibility of implementing smart meters (NVE, 2004a, 2004b, 2006). They all concluded that smart metering was *not* economically feasible. This view had some support among the grid companies, but they were far from unified. Around 2006 the main grid utilities began to favour a national roll-out (Inderberg, 2015), as indicated by a report commissioned by the predecessor to Energy Norway—EBL—which argued that full national implementation could be feasible (ECGroup, 2006). Thereafter, the idea gained political traction.

After further scoping work, four public hearings were held on smart metering: in 2008, 2009, 2011, and 2013—and most of the dynamics centred on these. In addition, there have been working groups that included technical experts, often with experience from or representing the electricity sector. The 2008 hearing mapped principles for functionality, financing, and implementation, as well as several other issues (NVE, 2008). The second hearing (NVE, 2009), was held in order to delay certain decisions concerning technical functionality, so as to align with the work of the European Commission in this area. The main hearing was the third one, held in 2011: It decided for full regulation (NVE, 2011b, 2013). The fourth and final hearing concerned postponement of roll-out, but no further changes. Analysis of the three first hearings is included in the empirical material, presented together here for reasons of space.

In all, 65 responses were received to the main hearing in 2011. The majority (40) represented the traditional electricity sector, mainly the grid companies. Submissions also came from meter producers, a few municipalities, and other relevant public actors; likewise from Zero as well as Friends of the Earth, together with Bellona (representing the NGO sector), and from the Association for Electricity-Sensitive Individuals (FELO) (NVE, 2011a). The statements overwhelmingly supported the installation of smart meters, with the clearest exception of FELO. Several actors, including the Consumer Council and the Consumer Association, brought up concerns relating to their areas. Some grid companies queried how to define real-time readings, but no other submissions touched on this.

Several submissions (including those from meter producers) discussed requirements for IP-based communication with external units for feedback to the consumer. In the final regulation, this was altered to not specifying technology for communication, but with a recommendation for open standards. Several submissions—including those from most grid companies, public authorities like the Consumer Council and the Data Protection Agency—focused on data protection, and on limiting third-party access to data.

Some grid companies (but far from all), as well as the three NGOs, brought up the need for metering prosumer-generated electricity to be exported to the grid. This was supported by some grid companies, whereas others focused on security issues related to this point.

The final regulation requires full national implementation, data measuring enabled for every 15 minutes, actual data measurement every hour, data frequency collection every day, and a physical interface to give instant access to consumption data to the end-user. Meters must also allow remote disconnection and load limitations, and allow for transmission of power prices, tariffs, and steering signals to the consumer (THEMA Consulting Group, 2015b, p. 11).

These were the most important signals from the hearing rounds. However, it should be borne in mind that the full process also involved a series of meetings between the NVE and these actors, primarily regarding the technical scope and implications of the potential design of the regulation (Inderberg, 2015).

3.2. The Prosumer 2016 Regulation

Prosuming is frequently seen as a step towards a more decentralised electricity sector (Bauknecht et al., 2020). Until 2010 prosuming was not formally permitted in Norway: Anyone legally producing electricity and feeding into the grid would have to register as a power plant. In 2010 the NVE created exemptions from the metering and control regulations, explicitly opening up for private prosuming (THEMA Consulting Group, 2015b). The stated purpose was to acquire experience with prosuming, with the aim of developing a full regulation. The NVE announced a prosumer regulation for hearing in 2014. This involved two hearings, with one following in 2015. The chief topic of the 2014 hearing was the general scheme for prosuming: The main aspects of prosuming, particularly legal definition, tariffing, and access to the green certificates support scheme (NVE, 2016a):

> With this proposal, a prosumer was legally understood to be an end user with consumption and production of electricity on the consumer side of the meter, and where the electricity fed exported to the grid at any time does not exceed 100 kW. (NVE, 2014, author's translation)

In addition, a prosumer could not engage in production or trade behind the meter that would require any form of license. Here I focus on the 2014 hearing, as it largely determined the shape of the regulation.

The 46 submissions were divided on several dimensions. First and foremost, no actors officially opposed the legal opening for prosuming. Energy-sector interest groups and actors, primarily grid companies, were active here.

The most contested area was the definition of 'prosuming' (NVE, 2016a), especially regarding the 100 kWp limit on feed-in capacity. The grid companies as well as Energy Norway, Defo, and KS Bedrift argued that the 100 kWp limit was too high. Energy Norway argued for the limit be lowered to 10 kWp, in order to link prosumer activities more closely to private households. Defo argued that some rural grids might not be dimensioned to receive this amount of capacity, whereas KS Bedrift was more open to this arrangement.

On the other side was the broader group consisting of NGOs, entrepreneurs and housing associations, and consultancies/research actors like Multiconsult and NCE Smart Energy Markets. They called for a clearer technical explanation of the need for the 100 kWp limit for qualifying as a prosumer; several actors considered that limit to be arbitrary and wanted it removed. An additional argument was that companies and owners of larger buildings could adapt their systems to this limit, thereby designing economically sub-optimal installations.

Housing association issues were another topic that was mentioned, but only by a few NGOs, some new entrants, entrepreneurs, and Multiconsult. They found it problematic that housing associations should be restricted as regards utilising prosuming as a collective arrangement: In building compounds, each individual flat represents an end-user, but, as shared metering is generally not allowed in Norway, these end-users cannot trade amongst themselves or collectively. This, it was stressed, significantly weakened the potential to expand prosuming within this type of dwelling. That point was not mentioned by the traditional energy actors or their interest organisations.

The last main issue in this hearing concerned cost distribution, relating to the tariff structure. According to the announcement of the hearing for this regulation, consumption from the grid would be priced as for all ordinary consumers. Consumption of self-generated electricity would be 'free': No tax or other charge would apply under the proposed regulation. In addition, prosumers would not have to pay the feed-in grid fee required of ordinary producers.

The rurally focused Defo was critical to exempting prosumers from the feed-in grid fee. Part of the argument concerned the distribution of costs, as prosumers would be exempt from contributing to parts of grid maintenance expenses. That argument has been heard in, for instance, Germany (which has a significantly higher share of prosuming in its system), but was not mentioned by the other hearing partners. No national goals for prosuming were set.

In a Nordic energy market outlook report from 2019, the NVE predicted approximately 7 TWh by 2040 as a realistic potential for solar energy (NVE, 2019). That is the only official prediction of solar potential found.

3.3. The Power-Based Tariffing (Demand Flexibility) Regulation

The official goal of demand flexibility is to achieve more effective utilisation of the grid by moving some of the load away from peak times. A tariff structure reflecting power demand (capacity use) over energy (kWh) is often seen as the cornerstone of such regulation. This may be based on various principles, all involving different trade-offs—not discussed here because of space considerations. To date, no detailed regulation for power tariffing has been implemented in Norway, so grid tariffs have been based on energy only (per kWh). Possible models for power-based elements to the tariff (understood as aggregated use by one consumer at any one time, or certain times) include (based on Naper, Haugset, & Stene, 2016; THEMA Counsulting Group, 2015a):

- Capacity-based tariffs based on the power (in Watts) delivered from the grid. Sub-variants include: subscribed power (where consumers choose their power needs through subscription); actual power use; depending on size of main fuse (in Ampere);
- Time-of-use—where the tariffs vary depending on time: typically the season or time of day;
- System needs/dynamic: tariffs change depending on free capacity in the grid.

These models have different advantages and drawbacks depending on whether the emphasis is put on the ability of the consumer to understand and actively relate to the tariff scheme, or whether it reflects the system needs and represents a fair distribution. The conceptual hearing in 2015 sketched out the above-mentioned conceptual models in three versions, and received inputs on the feasibility of these three, namely: 1) Actual power use; 2) fuse size (Amp) dependent tariff; and 3) subscribed power use. In all, 57 hearing statements were received. Again, these were mostly from grid companies and other traditional electricity-sector actors, along with four private individuals, and with Bellona, Friends of the Earth, and Zero representing the NGO sector. The statements underscored the importance of assessing and modifying the grid tariff structure to reflect power use, and with several alternatives presented for discussion. The grid companies in particular noted that whereas demand for electricity in general had declined slightly, the demand for power—the simultaneous use of electricity in a many locations—was rising. Power use is the deciding factor for grid capacity; the grid companies noted that, as it is expected to rise further, tariffing should reflect the cost structure of the grid (NVE, 2016b).

The main point in many of the hearing statements across a range of actors was the importance of establishing models that are easy for the consumer to understand—in order to achieve the intended effect, and for legitimacy. Many private consumers do not understand the difference between power use (W—the combined electricity use at any given time) and electricity use (kWh—the total number of electricity units consumed). Numerous considerations from the 57 responses discussed aspects of the different models but did little beyond noting the need to link grid development costs, use of power, and consumer tariffs; and that the system must be understandable. Feedback from grid companies supported various models, although most did not favour subscribed power.

The hearing launched in 2017 with a deadline for submissions early 2018 laid out a proposal for a grid tariff based on subscribed capacity. The stated reasons for proposing power-based tariffs were changes in consumption patterns, system needs and not least cost distribution. The proposal described a model of subscribed power where grid tariffs would consist of *subscribed effect* (W per hour) + *power used above subscription* (‘over use,’ at significantly higher cost) + *grid loss* (usually a default sum) (NVE, 2017). Here 81 statements were submitted—again, mainly from grid companies, with the remainder coming from organisations representing similar actors as in the previous hearings.

All grid companies (except Sognekraft) were highly critical of the proposed model. Their main argument was that it would be too complicated for private consumers to understand—counter to what the NVE held—as well as being seen as undermining the reputation of the grid company as it did not send the right price signal. These arguments were also invoked by many electricity producers and traders.

Consumer groups, new entrants, NGOs and other companies were basically negative, and for the same reasons, although—like the electricity-sector representatives—they supported a general power tariff. However, the subscribed-effect model was held to need further analysis before possible implementation and was seen as being too complicated for the end-users. The proposal was later withdrawn; a new hearing was scheduled for early 2020, but the results have yet to be evident at the time of writing.

4. Discussion

Although electricity production in Norway is fully renewables-based, there are several strong development trends underway. This includes digitalisation and diversification of production—all adding further pressure on the regulatory regime, and with implications for decentralisation. This provides a complex background for the relevant hearings.

According to the organisational field perspective (Fligstein & McAdam, 2012), increasingly differing interests within the sector and new entrants with additional perspectives and interests indicate a sector in *crisis*—or at least headed in that direction. In a sector with significant public ownership interests, both today and historically, one could expect more outright or vicarious resistance, whether generally towards state programmes like these three policies, or parts of the policy design. Indeed, there are some elements of resistance as well—for example, with the contested and (to my knowledge) rather unique regulation of a 100 kWp feed-in limit to the grid for prosuming. Another example involves undermining the power tariff in the shape of resistance, not to the general idea of the tariff, but by various actors involved in the process and most of the proposed solutions in the first hearings. This divergence in the perspectives and apparent interests, and, in the larger picture, support or at least not manifest resistance to the changes, gives further indications of a state of organisational field crisis. This might have involved covert resistance by vicarious means—but in that case, we would expect to find other indications as well, for example practical resistance to prosumer connections to the grid (Inderberg et al., 2018). Notably, the NVE initiatives for a national regulation steering full roll-out of smart meters, detailed prosumer regulation, and demand-side management, were generally supported across the organisations—either because resistance was not deemed feasible or because it was not sufficiently in conflict with sector interests.

This is the main reason *why* Norway mandated nationally controlled regulations where the alternatives would have been looser regulation, opening up for market-guided implementation of these. Indeed, large-scale changes have been implemented before, with the liberalisation of the sector in 1991 (Bye & Hope, 2002). At the time, new phases of development and economic efficiency reasons were driving factors behind the radical reform, which also brought in new kinds of actors who further boosted the reform (Inderberg, 2011). Today, technological developments, external pressure, and changes within the sector are driving factors for the state of crisis. Developments may take various directions in terms of centralisation, control, and market mechanisms—but, together with the NGOs, the new entrants in the electricity sector, representing fewer, more mixed, and smaller companies tend to be more oriented towards decentralisation in various forms.

These actors are challenging established practices with new perspectives and alternative technical expertise, and represent more niche activities by their plural business models relating to smart electricity services, household and company-level distributed production. The greater plurality in submissions in the later hearings than in the earlier ones indicates that they are small but getting stronger. One important area where an explicit stand has been taken concerns allowing prosuming activities in housing associations. As yet, these actors have not achieved full acceptance for their view on shared prosuming activities: Norwegian regulations still stipulate only one meter per end-user, and emplace strict restrictions on prosuming activities from multiple meters. However, the ultimate prosuming regulation can be seen as a success for this group—with some limitations, as sketched out above.

Care should be taken not to interpret the findings as indicating stable and general support from the traditional electricity actors. The centralisation–decentralisation dimension obfuscates important differences in the three policies involved, concerning control over the system decisions, ownership of the system resources, and the physical structure of the system. While the hearings show some general support for steps towards decentralisation, the finer nuances often get lost in the hearing processes. Furthermore, in the Norwegian system with traditionally low electricity prices, weak solar incentives, dominated by flexible hydropower (but with rising shares of wind power, including foreign ownership), a prosuming explosion seems unlikely. Therefore, decentralised production is often not seen as a general threat, even though the NVE projections indicate ‘rapid growth of solar,’ with up to 7 TWh as a reasonable potential for annual solar production by 2040, in a system that today produces about 156 TWh in total (NVE, 2019, pp. 4, 21). Even such a level will have an impact on the system.

As to possible pathway directions, all three policies can be said to favour a more decentralised development path. This is true of the smart-meter provision, because it enables digitalisation and greater control over grid management, as well as demand-side responses, storage services, new business models, and new types of collaboration between traditional and new actors (Wadin, Ahlgren, & Bengtsson, 2017). It also holds true of the prosuming regulation, which opens for more decentralised production and incentivises ‘self-consumption’—and lastly, the power tariff, irrespective of the final outcome.

The degree of decentralisation can be evaluated along various dimensions, including physical structure of production and consumption, control, ownership, and/or social aspects (Bauknecht et al., 2020). If poorly designed, the power tariff may discriminate against storage (Newbery, 2018); moreover, it can alienate or empower the end-user, depending on responses. However, the policies studied here seem to provide greater opportunities for third-party actors and new energy service companies. Electricity-consumer flexibility measures link technologies that are key elements in integrating decentralised generation (Judson et al., 2020). Trade-offs are likely here. For example, smart meters provide opportunities for the power-based tariff (THEMA Consulting Group, 2015a), likely to have advantages for the electricity system and cost distribution, but they can negatively influence the profitability of prosuming—at least, without battery storage (Henden et al., 2017).

In sum, the three policies set the direction of *digitalisation*. This in turn can facilitate various technologies, enabling ordinary members of the public to become prosumers. This again facilitates decentralised production and promotes consumer flexibility as well as the integration of new technologies.

5. Conclusion: Norway’s Electricity-Sector Transitions

This study has examined *why* three specific anchoring policies in Norway have been centrally coordinated, what actors have had greatest influence over the policy, as well as discussing possible implications of these regulations for decentralisation of the electricity system. Using an organisational field perspective, I have analysed the official hearing submissions from main actor groups in the official hearings for the smart-meter policy, the prosumer provision, and the peak-power grid tariff scheme.

In accordance with the organisational field perspective, there are clear indications of a system in a state of crisis. A field crisis often occurs when the established structures, held in place by incumbent actors, become challenged by external or internal events or new actors, potentially leading to transitions and new stable states. This is an apt description of the current situation in the Norwegian electricity sector—with pressures from technological developments, developments in neighbouring countries and the EU, and new actor groups in the sector.

The traditionally dominant group of grid companies and their interest organisations certainly still hold key positions. However, their interests, indicated by the hearing submissions for these three policies, have become increasingly less unified since 2011. Higher fragmentation is likely to yield reduced political influence. On the other hand, despite important disparities regarding detailed provisions, the grid companies did endorse the idea of nationally determined regulations, with all three policies. This was an important reason for adoption, with ultimate decision on the power tariff still pending.

By contrast, while new entrants and the NGO group were less influential in the hearings, general portions of the policies under scrutiny do cater to their interests, anchoring developments that move the system toward greater decentralisation. More local prosuming, with an expected potential of 7 TWh solar by 2040, is likely to have significant impact on the system. The policies encourage different dimensions of a developmental path relating to digitalisation, production patterns, consumer behaviour, and grid control. Although the policies analysed favour/disfavour further developments toward decentralised production, depending on the details, the findings indicate that the centralisation–decentralisation dichotomy offers a too-blunt perspective, unable to capture the nuances involved. Further elaborating the decentralisation aspects for dimensions like physical structure, ownership, and control may be needed to provide nuancing so that transition pathway directions and their implications become more apparent.

This study of the Norwegian case offers several lessons. First, decentralizing initiatives in the energy system can go hand in hand with centralized political steering. We have seen that nationally mandated initiatives, with general endorsement from the incumbents, have developed digitalisation and prosuming provisions that may lead to increased decentralisation.

Second, this complexity underlines the fact that a rough categorisation of actors into incumbents and new entrants is not sufficiently fine-tuned: analysis of decentralisation requires significantly more refined categorisation and contextualisation to enable more precise predictions.

Last, energy transitions are complex. Transitioning includes several development paths, which may lead to diverging interpretations. Even within the three policy cases examined here, the implications for potential decentralisation developments are manifold, although we may conclude that they represent steps in that direction.

Even in the absence of a driver for decarbonisation (Norwegian electricity production being fully renewables-based), several different transitions are underway. These forces are probably active also in less decarbonized electricity systems. This indicates that even in countries where much of the policy drive is mandated by a decarbonisation goal, more subtle drivers are likely to exist—warranting contextualised, nuanced analysis to clarify the developments and mechanisms influencing these ongoing energy transitions, a keen attention to pathway directionality complexities that includes a deep understanding of inclusion of a variety of relevant actors, and the energy justice implications of the ongoing changes. This article shows that incumbents are involved in driving the transition, but the implications of a more decentralised system for incumbents as well as other stakeholders, requires further investigation.

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The author declares no conflict of interests.

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Article

Prioritizing the Chicken or Egg? Electric Vehicle Purchase and Charging Infrastructure Subsidies in Germany

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Abstract
To meet current targets for greenhouse gas emissions in Europe, emissions, especially those originating from the road transport sector, need to be reduced. Plans are to achieve this goal by substituting fossil fuel vehicles with electric vehicles (EVs). This article first discusses conceptually the impact of an increasing share of EVs on the electricity grid and suitable locations for charging stations with examples from a Case Study in Lower Bavaria. Secondly, the impact of purchase subsidies on EV purchases in Germany, a high-income country characterized by an important automotive industry and an increasing share of private vehicles is examined. To achieve this, yearly information on EV purchases were analyzed by applying the Synthetic Control Method. Combining data from different sources including the European Alternative Fuels Observatory, Eurostat, and the European Automobile Manufacturers' Association, an overall picture was developed. Results indicate a difference between private, semi-public, and public charging infrastructures. Its spatial distribution does not correspond to a specific development strategy. Moreover, EV subsidies have a limited effect in Germany when controlling for market size. Limiting the discussion to a trade-off between subsidizing infrastructures or EV purchases obviates the multidimensionality of the problem as neither of them may be sufficient to accelerate the transition per se. Furthermore, if electricity provided for EVs comes mainly from fossil carriers, the changes in the road transport sector will not yield the expected emission reductions. The transition towards renewables is directly intertwined with the effects of EVs on emission reductions in the road transport sector.

Keywords
electric vehicles; energy policy; fossil fuels; Germany; green energy; subsidies; transportation

Issue
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1. Introduction

Policy and climate strategies in several countries give electric mobility an important role in reducing CO_2 emissions to achieve national and international goals such as the Paris Agreement (United Nations, 2015). This reduction is planned to be mainly driven by the substitution of fossil fuel vehicles with electric vehicles (EVs), but it requires millions of drivers to invest in fleet renewal (Riesz, Sotiriadis, Ambach, & Donovan, 2016). A critical discussion about EV adoption and its contribution to reducing greenhouse gases is required. To avoid the well-known costly externalities of coal and nuclear power, governments are subsidizing the use of greener technologies which can reduce these negative externalities. In Europe, policies to support EVs vary from region to region and include purchase tax extensions, reduction and exemption of registration taxes, free parking, preference in bus lanes, and even subsidies for the purchase of EVs (European Alternative Fuels Observatory, 2020). By doing so, governments aim to increase the number of early adopters by creating niche markets with which EV manufacturers can generate revenue to foster new dynamics, such as economies of scale (Geels, 2002).

However, EVs are not a solution by themselves. A thorough assessment of the EV life cycle regarding the energy, greenhouse gases emissions, and materials linked to the power generation mix of electricity used to charge the EVs (Girardi, Gargiulo, & Brambilla, 2015) is necessary. The first aspect addresses the technology used within vehicles, especially the battery, and innovations in materials and production. The power generation mix of electricity used to charge EVs as the second aspect shows large regional and national differences. Among other things, the power generation mix and the contribution of renewable energy depend on the natural potential of a region and political energy strategies. Greenhouse gases emissions from EVs are very different between France, whose power generation mix has a high share of nuclear energy, and Germany which has rapidly increasing renewable energy resources and a politically decided phase-out of nuclear and coal. The variety of possible socio-technological scenarios and the technical complexity involved in charging EVs with renewable energy is represented by the number of studies on the subject (see, for a more recent review, Rae, Kerr, & Maroto-Valer, 2020; Richardson, 2013).

In Germany, despite the enormous expansion in recent years, renewable energy resources currently contribute 40.2% to the gross power generation (AG Energiebilanzen e.V., 2020). Since at the same time the share of coal electricity is still high (around 38% in 2018), the corresponding CO_2 reduction potentials of the power sector and thus EVs has not yet been fully exhausted. Although the number of EVs has steadily increased in recent years, the conversion rate from fossil fuel vehicles to EVs remains steady as the overall number of privately owned cars in Germany grows (KBA, 2020). Even though the conversion of fossil fuel vehicles to EVs reduces the primary energy demand due to the much higher efficiency of an electric motor (Sovacool & Hirsh, 2009), the further expansion of renewable energy resources remains a basic requirement for electric mobility to meet the goal of climate-friendly mobility.

In addition to the substitution of fossil fuels by renewable energy sources, the technological innovation and expansion of electric mobility requires a great deal of investment, both in vehicles and charging infrastructure. In a study of the EV market in Nordic European countries, Kester, Noel, de Rubens, and Sovacool (2018) and Kester, Sovacool, de Rubens, and Noel (2020) find that the cost of EVs is one of the most important barriers to their adoption. Internal combustion vehicles are cheaper than EVs which makes the latter be perceived as a luxury product. For this reason, governments around Europe have established incentive programs for EVs (European Alternative Fuels Observatory, 2020). But the transition to electric mobility also requires a change in the charging infrastructure. Due to the orientation towards the existing traffic infrastructure, fossil fuel stations are available nationwide and built at central locations with small catchment areas. With the transformation towards EVs, mobility is moving more and more into the everyday life of people as the infrastructure is scarce and more oriented towards people's daily lives, consumption, and working hours.

In Germany, the power grid is not fully decentralized, meaning supplied by several energy sources across the country to fulfil every customer's demand for electricity and to reduce losses due to long-distance transfer. Such a decentralization process takes place but will reorganize the fueling processes, such that fueling can take place where drivers spend more time: at home, at work, or at their places of consumption and leisure. This article discusses the spatiotemporal changes towards electric mobility conceptually and differentiates between the categories of private, semi-public, and public space. In this context, a sustainable and user-oriented charging infrastructure is understood to be the essential requirement for any further expansion of electric mobility. This is especially true as, in addition to the high costs of EVs, range anxiety, and the poorly developed charging infrastructure are understood as the main obstacles to change (Sovacool, 2017). Nevertheless, in this transformation process, for many countries, the question remains as to what must be given preference: the chicken or the egg? More EVs can justify the (economic) need for a nationwide charging station (CS) network and could enhance private investment in the charging infrastructure development. The support for a gapless network of CSs, on the other hand, would enable electric driving in a practical nationwide manner and could, by reducing range anxiety—a main inhibitor for EV purchases—substantially increase EV sales. In Germany, one of the countries with well-developed charging infrastructure, the small number of EV charging events in most regions, results in most CSs not being profitable. The analysis presented here shows that neither a well-developed charging infrastructure nor an EV subsidy policy may be sufficient to accelerate the transition in Germany. These results have important implications for studies in the area of electro-mobility as they highlight the need to explore other dimensions with a less techno-economic perspective.

The present work provides an overview of the current EV literature in Section 2. Section 3 discusses spatial patterns of the new electric charging infrastructure followed by an examination of direct subsidies to EV purchases in Germany in Section 4. Section 5 concludes.

2. State of the Art

The development of the charging infrastructure is closely linked to the adoption and acceptance of EVs. The modelling of the charging infrastructure is of paramount importance in the electrification of the transport system since it delimits the mobility associated with the vehicles. For this reason, while one part of academic research focuses on surveys to analyze trends in acceptance rates or changes in perceptions (e.g., Lieven, 2015), others build upon these results and try to find out how EV adoption can be intensified. Nearly all authors state that purchase subsidies are most important for EV adoption, some describing it as the single impacting incentive. Others explain how purchase subsidies do not incentivize consumers enough, so that post-purchase incentives are necessary. Again, others state that the charging infrastructure is also of major importance. Rohr et al. (2017) for example focused on the evaluation of two surveys in France, Germany, Italy, the UK, Poland, and Spain in 2012 and 2016. The key hurdle for the acquisition of EVs identified was the high price compared to common fossil engines. Other purchase inhibitors were the lack of infrastructure, the limited driving range, and the lack of diversity in model choice. Comparing the results of 2016 with the ones from 2012, people perceive the reduced operating costs of EVs more strongly and appreciate its economic benefit more. More people state they do not know whether there is an environmental benefit. However, even if the key issue in deciding whether or not to buy an EV is still the high purchase price, the perception that they are very expensive has decreased. Purchase price subsidies thus probably have an effect not only on the purchase price but also on the perception of the price to the people. Langbroek, Franklin, and Susilo (2016) compared two different strands of policies by evaluating their respective effectiveness. With rising policy costs, the effectiveness of the same may increase. Use-based incentives such as allowing the use of bus lanes or free parking spaces are not costly, yet also yield lower increases in purchase numbers than the much more expensive purchase subsidies. Research shows that the users' willingness to buy EVs is not only dependent on policies but also on the characteristics of the existing charging infrastructure and that personal perceptions are also relevant.

The analysis of EV purchase rates is influenced not only by subsidies for EVs and CSs infrastructure development but also by oil prices, for example. The higher the price of oil, the more attractive are the lower maintenance and operating costs of EVs, which explains the overall change in the perception of an EV's costs. Additionally, even though the perception of environmental friendliness of EVs decreased in 2016 compared to 2012, it still is a very important factor for customers when buying EVs. Still today, most purchases of EVs are based on the dilemma between wanting to drive a modern car and the increasing understanding of the need to protect the environment. Most vehicle brands offer vehicles purely driven by electricity called 'battery electric vehicles' (BEV) and 'plug-in hybrid electric vehicles' (PHEV), that combine a combustion engine with an electric motor. In PHEVs, when the charged electricity is used up, the combustion engine takes over and the vehicle operates as a conventional, non-PHEV. This helps to mitigate users' range anxiety and inefficiencies in the poorly developed charging infrastructure (Sovacool, 2017). Nevertheless, the number of EVs on offer is very low compared to combustion engines vehicles; in 2015, only 27 BEV and 26 PHEV vehicle types were available in the European market, their costs being at least 40% higher than a comparable conventional car. Lin and Sovacool (2020) when analyzing the market dynamics of the BEV vehicle market in Iceland, observed an inter-niche competition between BEV and PHEV, which may be related to the limited driving range and CS network development.

The transformation towards electric mobility creates completely new spatial patterns of fueling infrastructure. Therefore, several publications on the modelling of optimal locations for electric CSs have emerged. Pagany, Ramirez Camargo, and Dorner (2018) and Wirges (2016), give a broad overview of different spatial localization methodologies published in recent years. Location models are necessary to plan the transformation and rethink spatial patterns of the charging infrastructure. For example, GIS-based approaches offer the opportunity to find spatial hotspots for CSs and to discuss them in terms of public funding measures, spatial planning, or with a view to the power supply network and the provision of renewable energy. Spatial or geostatistical approaches like in Andrenacci, Ragona, and Valenti (2016) or Campaña and Inga (2019) are often applied. The planning of CS deployment leads to mitigate range anxiety, ensuring EVs provide similar performance to those using the internal combustion engine. Most CS planning applications try to locate the CSs where the travel demand is concentrated. However, although there are many models in practice, the CSs are installed in an uncoordinated way. These installation patterns, which may be affecting demand for BEVs, have not been studied so far.

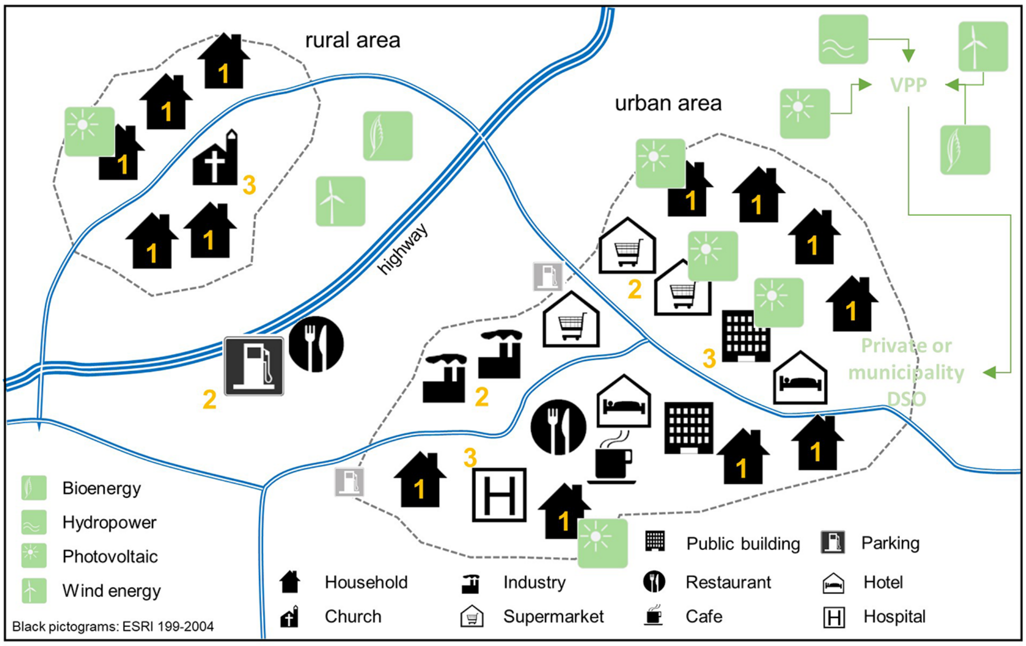
The two strands of literature, charging infrastructure and EV market size, are highly intertwined. Nevertheless, the direct research of both topics in combination is tricky and not yet sufficiently analyzed. Moreover, the adoption and acceptance of EVs have mostly been researched using econometric models based on the assumption of there being large amounts of data available, which is not the case due to the novelty of this market and the recent rapid expansion of EVs. To better combine the two topics and to consider the relationship between them, this article applies the synthetic control method of Abadie and Gardeazabal (2003) to understand the impact of EV purchase subsidies.

The evaluation of public policies using synthetic controls is an area of research that has recently stood out for its innovation (Athey & Imbens, 2017). This area of research is based on the comparison of the evolution of variables of interest between the entity affected by the public policy intervention and a control group. Unlike classical policy studies, the synthetic control method is based on the observation that a combination of untreated units (i.e., a 'synthetic control unit') can provide a closer approximation to the characteristics of the unit affected by the intervention than any individual unit. In the context of this comparative study in which there is a small sample with interventions at the aggregate level (countries and states), it is fundamentally complex to find adequate controls that have not been affected by the intervention and that possess characteristics similar to those of the intervened unit (Abadie, Diamond, & Hainmueller, 2010). This problem is well known in the discipline and has always caused researchers to do more comparative case studies (Collier, 1993; Lijphart, 1971). However, the synthetic control method excels in cases where there are too few observations to make an assessment using other statistical techniques (Abadie & Gardeazabal, 2003), which is why the topic discussed here is a perfect fit for this method.

3. Spatial Pattern of Electrical Charging Infrastructure

While the charging process for a car powered by fossil fuels (petrol, diesel, gas) is highly standardized worldwide, CSs are more complex. Different charging modes allow flexibility in terms of time, which means that the charging process can be integrated differently into the existing supply structures and everyday life. This has been seen as an opportunity to build electric charging infrastructures independently of existing structures, however, with an increasing penetration rate of EVs it would require smart grids and the regulation and control of existing electrical infrastructure. This transformation strongly influences the spatial design of the charging infrastructure, which is why it makes sense to distinguish conceptual variants regarding the spatial division into private, semi-public, and public spaces. A key success parameter will be how the charging infrastructure, described and graphically visualized (Figure 1) below, can be integrated spatially and temporally into the current traffic system as well as into the electric supply system.

The CS infrastructure is context-dependent: Differences between rural and urban areas have to be taken



	1 Private	2 Semi Public	3 Public
Examples and number of cars	max. 2	> 50	> 20 > 5 parking site
Charging system	Schuko, Wallbox	Combined Charging System	Combined Charging System
Power connection	230V – 400V / 16A max. 22kW	200-1000V / <500A <350kW (CCS 2.0, DC)	200-1000V / <500A <350kW (CCS 2.0, DC)
Charging time	▪ at night ▪ in combination with photovoltaics ▪ up to 8 hours	▪ fast charging at restaurant or supermarket ▪ during working time ▪ 30 min to 8 hours	▪ fast charging ▪ 15 min to 2 hours

Figure 1. Spatial pattern of the electric charging infrastructure.

into account as the different population densities or the different economic activities, generate variation in the number of CS needed and overall electricity demand. Moreover, in an urban context, there is a need for closer integration with local public transport, whereas in rural areas, individual transport is more significant. Finally, an orientation towards the needs of the people and an appropriate integration into their everyday life is required in both types of regions. Figure 1 conceptualizes this approach and shows that the spatial structure is evolving from the few conventional petrol stations, predominantly along primary roads or motorways, to full-coverage possibilities for charging. In the private context, the provision of energy can be achieved by e.g., using small photovoltaic systems or other decentralized renewable energy resources as a maximum of two cars per household usually have to be charged. In public and semi-public parking sites, the number of CSs increases, which also means that a larger energy capacity is required. That is why local or national electricity suppliers mostly take care of the supply. In order to achieve the goals of climate-friendly mobility, power must be provided by a low-carbon or de-carbonized power sector with high proportions of renewable energy (Die Bundesregierung, 2009, p. 8), e.g., combined in a virtual power plant (Figure 1). Therefore, in addition to the charging infrastructure, it is also necessary to change the power generation mix, which implies a spatial transformation with new spatial patterns (i.e., Blaschke, Biberacher, Gadocha, & Schardinger, 2013; Bosch, Rathmann, & Schwarz, 2019; Zink, 2015).

3.1. Private Context

Refuelling at home is a completely new option that is made possible through electric mobility. With a correspondingly expanded electric infrastructure available in all industrialized countries, electric mobility infrastructure is added to the household, making households consumers of both EVs and CSs. Charging is possible via conventional power connections (in Germany mostly Type C and Type F [Schuko]; International Electrotechnical Commission, 2020) or by installing so-called wall boxes. Using Schuko, however, the charging process takes several hours due to the low charging power, whereas wall boxes (Figure 2) can significantly reduce the charging time; in both cases, the domestic power connection is usually sufficient.

The charging time depends on the downtime of the cars. Since a full charge in these stations requires several hours and charging is usually done at night, the need for fast charging infrastructure is not mandatory. Consequently, large fluctuations in electricity consumption are avoidable. In addition, the intelligent combination with consumers' own power generation is possible, for example, by using rooftop photovoltaics in combination with local storage systems, which offsets the additional local demand for electricity. With their large batteries, the EVs can themselves take on a storage function for the household.

3.2. Semi-Public Context

The semi-public area refers to charging points installed in private spaces that can be used by a large number of people. These are primarily company parking (Figure 3) sites as well as parking sites for supermarkets, malls, restaurants, cafes, or other private but commercially used parking sites. The number of CSs depends on the company or institution providing this semi-private parking and their frequency of visitors. The loading times vary from a few minutes when shopping in the supermarket to several hours at company parking sites. The charging points are mainly visited during the day and their use is based on the opening hours of each facility. Parking (and loading) can be limited in time. The charging of EVs can be provided by the owner of the parking areas either as a free service or as a new fee-based service.

Currently, electric CSs are still a rarity in semi-public parking sites. The *Verband der Automobilindustrie* (2019) reported that, in 2019, German retailers installed over 1,000 CSs in semi-public areas and that semi-public and public locations currently account for 15% of the charging infrastructure available. Nevertheless, as in the example (see Figure 3) of a technology-oriented business park and business incubator *Innovations Technologie Campus Deggendorf* (ITC 2), companies use the charging infrastructure primarily for image and marketing purposes to

Private – BMW i Wallbox Connect for Mini e

Technical Parameters

- Full charge in max. 3 hours depending on the vehicle and charging capacity
- Scalable charging power
- from 10 to 32A at 230V
- single-phase up to 7.4kW
- three-phase up to 11kW

Figure 2. Wallbox: Charging at home.

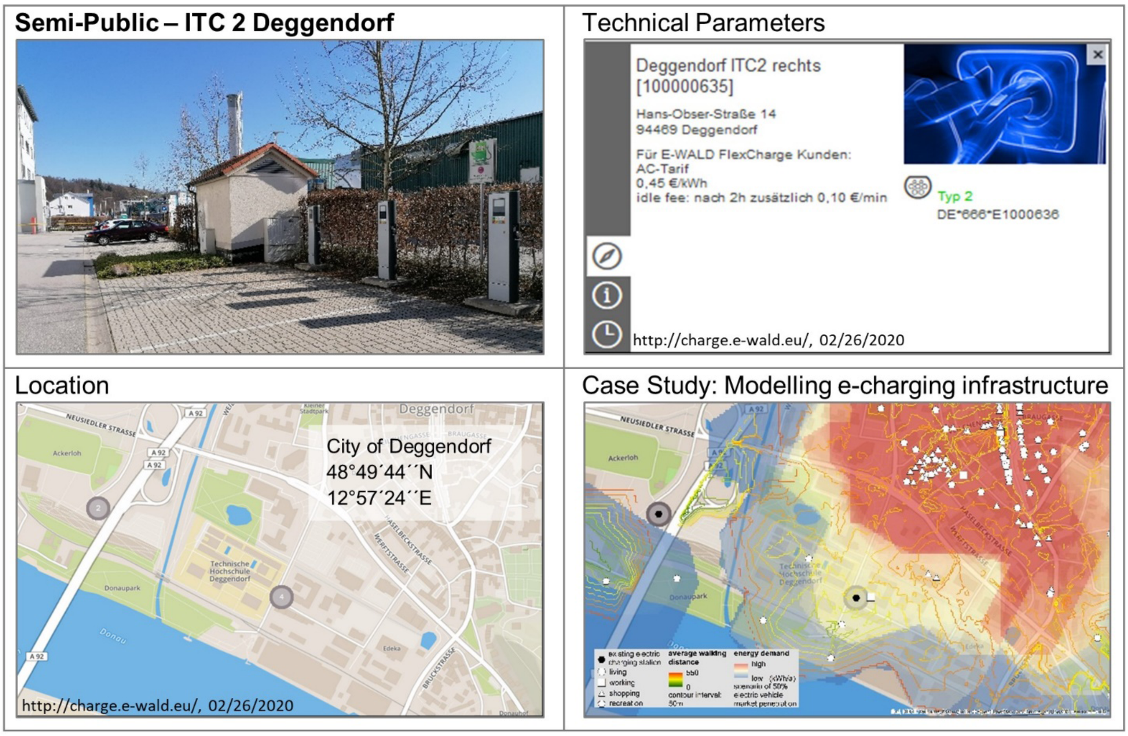


Figure 3. Example for CS in semi-public areas.

meet the social need for increased environmental awareness, especially in Germany. In addition to this 'greenwashing,' companies also want to demonstrate their innovative strength. Although only a few CSs are currently being built, the location modelling shows a high need for charging capacity as the penetration rate of EVs increases. In the private and semi-public sector, however, demand is the decisive factor. Therefore, companies will only expand and provide the charging infrastructure when there is a corresponding demand, i.e., a sufficient number of EVs using the parking site.

3.3. Public Context

Municipalities and cities can design and plan the charging points that fall into the spatial category of public space. As in the semi-public context, the charging points are based mostly on existing parking sites at municipal facilities or in public spaces, for example along streets. The parking sites can be permanently accessible, such as at park and ride parking spaces near the train station (Figure 4) or can be limited in time, such as in public parking sites. Parking and charging can be offered free of charge or as a paid service. The electricity requirement depends on the number of parking sites and their frequency. Similar to the large parking areas in the semi-public space, new electricity infrastructure is usually required here including both new CSs and new electricity networks. They need to be able to provide the large amount of electricity a CS requires. The need for a high energy capacity results from the parking spaces being used mainly at certain peak times as well as the fact that, in transport patterns associated with retail and amenity purchases, cars are usually only parked for short periods. Therefore, the demand for fast charging, which consumes very large amounts of electricity in a short period, increases.

3.4. Case Study

The Case Study region is located in the southeast of Germany, including eight administrative districts (NUTS-3): Cham, Deggendorf, Freyung-Grafenau, Passau, city of Passau, Regen, city of Straubing and Straubing-Bogen, covering a total of 7,200 km^2. The CS modelling method applied in this example was developed by Pagany, Marquardt, and Zink (2019). Other similar approaches include different target criteria such as the minimization of trip length or travel time, spatial hotspots of charging demand following population distributions or driving path densities, traffic, or a mix of criteria (i.e., Namdeo, Tiwary, & Dziurla, 2014; Viswanathan et al., 2016; Wagner, Brandt, & Neumann, 2014). Although the results of these different models may be influenced by their methodology, they are all based on driver behaviour and adapted to specific contexts.

In the case study presented here, the catchment areas around various points of interest of the public and semi-public sector are calculated and combined in a gravitational model with GPS data. The calculated scenario assumes a 50% penetration rate of EVs and slow-CSs. The necessary datasets were extracted from OpenStreetMap in 2016 and were used for the spatial calculation of the catchment areas (Geofabrik, 2016). In addition to the

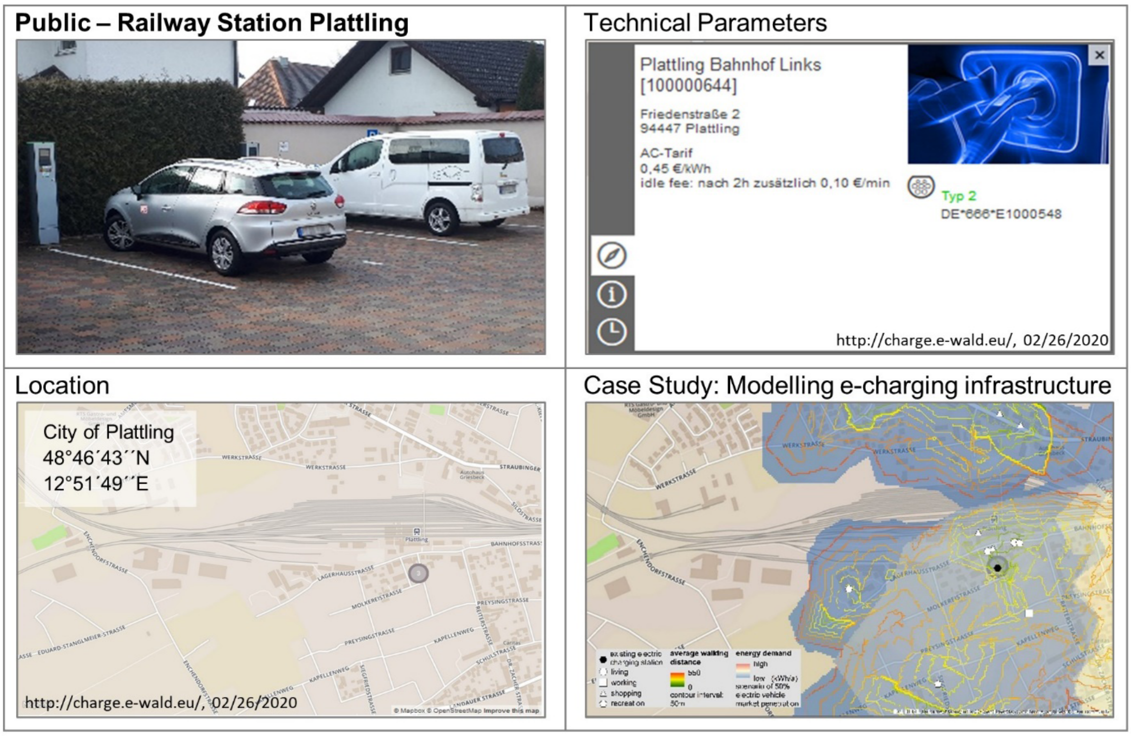


Figure 4. Example of a CS in a public area.

spatial distances, the frequency of use and the length of stay at the locations are important factors to consider. For this purpose, user groups according to age, gender, family situation, leisure behaviour, and occupation, are defined and set in relation to the respective points of interest. The more often and longer a user group stays at a location, the higher the location's importance is weighted regarding the need for CS. Finally, within the modelled catchment areas, specific CS locations can be identified using the preferred walking distances of each user group between their parking and destination points of interest.

Figures 3 and 4 present results of the modelling approach for exemplary areas in the case study region regarding the semi-public or public categories. The charging demand (kWh/a) is graded in colour and the average walking distances are drawn as contour lines (m). The optimum location of a CS within the catchment area is identified based on high electricity demand and short walking distances between parking/charging the vehicle and the destination. The results can be helpful in discussing the new infrastructure patterns either for already existing CSs, as in Figures 3 and 4 with CSs from E-WALD GmbH, or for the planning of new CSs.

Results of this analysis indicate that CS sites are not installed with a consumer view but at the location most interesting to the financing party. This means that the private sector installs a semi-public CS considering what best suits their own interest, thus they are installed where their own customers park. It seems that earning money with the installed CS is just a secondary goal compared to the main objective of demonstrating innovation and caring for the environment of customers and employees. Public CSs are also not always set up at places that suit the consumers best but where it is most representative. Many CSs are for example installed close to town halls rather than to first provide the railway station with suitable CSs. This result shows how difficult it is for the government to influence the organization of the development of the CS infrastructure. Therefore, the question of the initial impulse to implement the transformation towards electric mobility remains. Do EVs first need to be established in the market to ensure profitable operation of the charging infrastructure and to make sure that the parties install CSs for profitability rather than for image reasons, or must the charging infrastructure first be set up so that charging is as extensive for EVs as it is for fossil-fuelled vehicles? Is it necessary for the government to provide a coordinated action so as not to waste CS resources that only serve to improve brand image? What mechanism or policy can allow for the reorganization of the transportation system under public-private coordination? These dilemmas go hand in hand with the question of government impulses for electric mobility. In the German public discussion, especially dominated by the so-called fear of range and the everyday suitability of electric mobility, there are state subsidies for the purchase of EVs and in parallel the promotion of the installation of CSs.

4. Purchase Subsidies in Germany

In addition to the existence of economies of scale and barriers to entry, one of the main characteristics of EV charging networks is the need to have a critical mass of users to make the system sustainable. This makes the existence of a sufficiently large load network necessary in order to compensate for the disincentives associated with current EVs' reduced range when compared to combustion engines. If these hypotheses are true, then it is possible to claim that an insufficient transport network affects EV adoption. However, it is difficult to empirically prove this statement because both variables, availability and characteristics of CSs and EV adoption rates, influence each other. Research based on case studies and comparative studies applying synthetic control units has been an active area of research in policy evaluation and can help to solve this endogeneity problem. We examine the development of the EV market in Germany using the synthetic control method in order to assess the effect of purchase subsidies on BEV and PHEV car registrations. We assume that with the introduction of the subsidies the number of BEVs should increase. Furthermore, to establish the validity of the results, we analyze the impact of the same subsidy policy on PHEV vehicle purchases which have an internal combustion engine as backup included and are therefore much less affected by the lack of CSs.

The synthetic control method is a powerful approach for comparative case studies when there is one or only a few treated units, and only aggregated outcomes are observable (Abadie et al., 2010, 2015; Abadie & Gardeazabal, 2003). The approach allows the construction of accurate counterfactuals of the country of interest using a control group of donor countries not subjected to the policy intervention under consideration. The identifying assumption in the present context is that EV registrations in Germany would have evolved in the same manner as in their synthetic counterfactuals in a hypothetical world without the introduction of the purchase subsidy. Formally, following Abadie and Gardeazabal (2003), under the synthetic control we suppose that there are $J + 1$ countries where $J = 1$ denotes Germany and $j = 2 - J + 1$ includes a group of untreated countries. A total of 12 countries are observed in the sample. The treatment country is Germany and the countries in the control units (donor pool) are different European countries that did not implement purchase subsidies. In addition, T_0 is defined as the time of treatment. For Germany, data are available on the actual emission trajectory (Y_{1t}), and the counterfactual emissions that would have occurred if Spain had not been subject to treatment (Y_{1t}^N for $t > T_0$). For Germany, an estimate of Y_{1t}^N has to be found to obtain an estimate of the treatment effect $\propto_{it}$:

$$\propto_{it} = Y_{1t} - Y_{1t}^N. \tag{1}$$

The differences in the outcome variables between Germany and its synthetic counterfactuals following the treatment measures is the causal effect of the purchase subsidy if the synthetic control assumptions hold. To estimate $\propto_{it}$, it is proposed that a number of observed characteristics of the countries in the donor group are made use of. The underlying idea is to find weights $W = (w_2 - w_{J+1})'$, with $w_j \geq 0$ for $j = 2 - J + 1$ and $w_j = 1$, $j = 2_{J+1}$, so that the weighted average of all countries in the donor group resembles the treated country (Germany) with respect to BEV and PHEV in the pre-intervention period and a number of other relevant aspects used as covariates (Z). In our application, the counterfactual outcome is generated as a weighted average of the following covariates: mean net income, passenger vehicle stock, motorization rates, new passenger vehicle registrations, and electricity prices (Table 1). The information on new car registrations was retrieved from the European Automobile Manufacturers' Association database in July 2019 (European Automobile Manufacturers' Association, 2019). Together with this data, and in order to generate the synthetic control unit from the group of countries of the pool, we retrieved the data from Eurostat (Eurostat, 2019) databases for the selected period.

The European Alternative Fuels Observatory (2020) summarizes the policies applied to the topic of electromobility in most of the European member states. They furthermore provide information on the adoption of EVs, the sum of purchased cars per country as well as facts on the development status of the CS infrastructure. The data set encompasses the period 2010–2017 (see Figures 5 and 6). We, therefore, cover five years before the introduction of the subsidy (pre-treatment) and two years afterwards (post-treatment). The control group includes Bulgaria, Switzerland, Czech Republic, Estonia,

Table 1. Summary statistics.

Variable	Source	N	Min	mean	max
Population	Eurostat	96	1314870	51081276	325446443
Net Income	Eurostat	96	3276	18113	74585
Vehicle stock	ACEA	96	552680	20899574	129053000
Motorization Rate	Eurostat	96	0.3581	52.6135	614.0950
BEV Registrations	EAFO	96	0.0	4082.8	86700.0
PHEV registrations	EAFO	96	0.0	3689.4	72900.0
Passenger vehicles registrations	ACEA	96	6365	1129997	7689110
Electricity Price	Eurostat	96	0.08215	0.15614	0.30480
Purchase subsidy	EAFO	96	0.0	373.9	4000.0

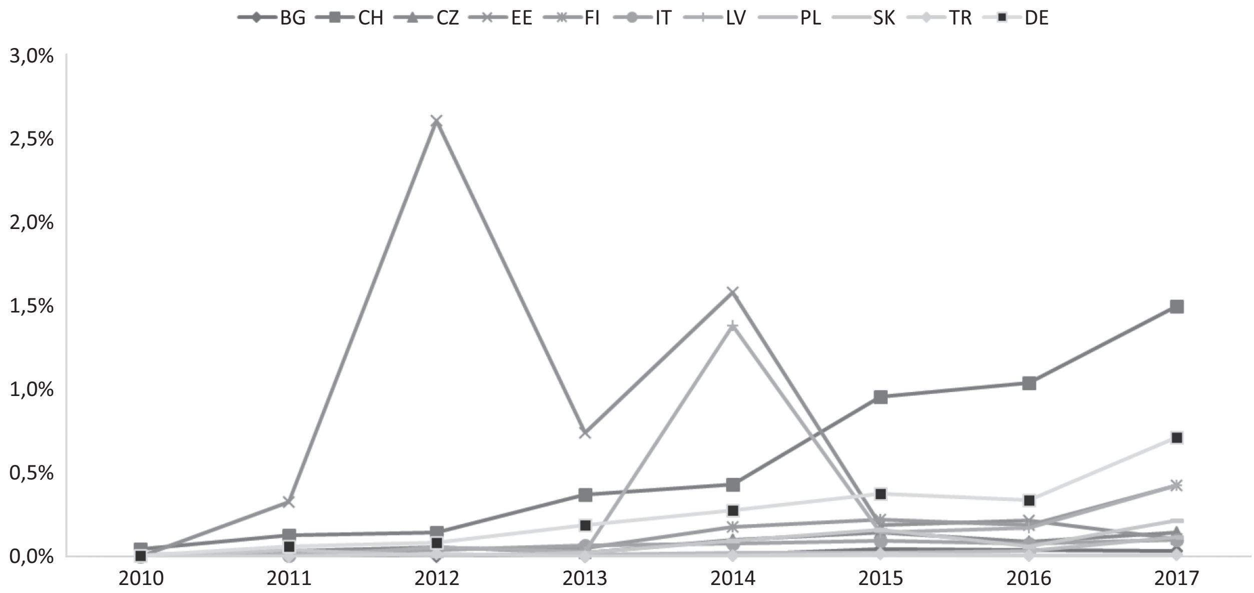


Figure 5. Share of BEV vehicle registrations in selected countries.

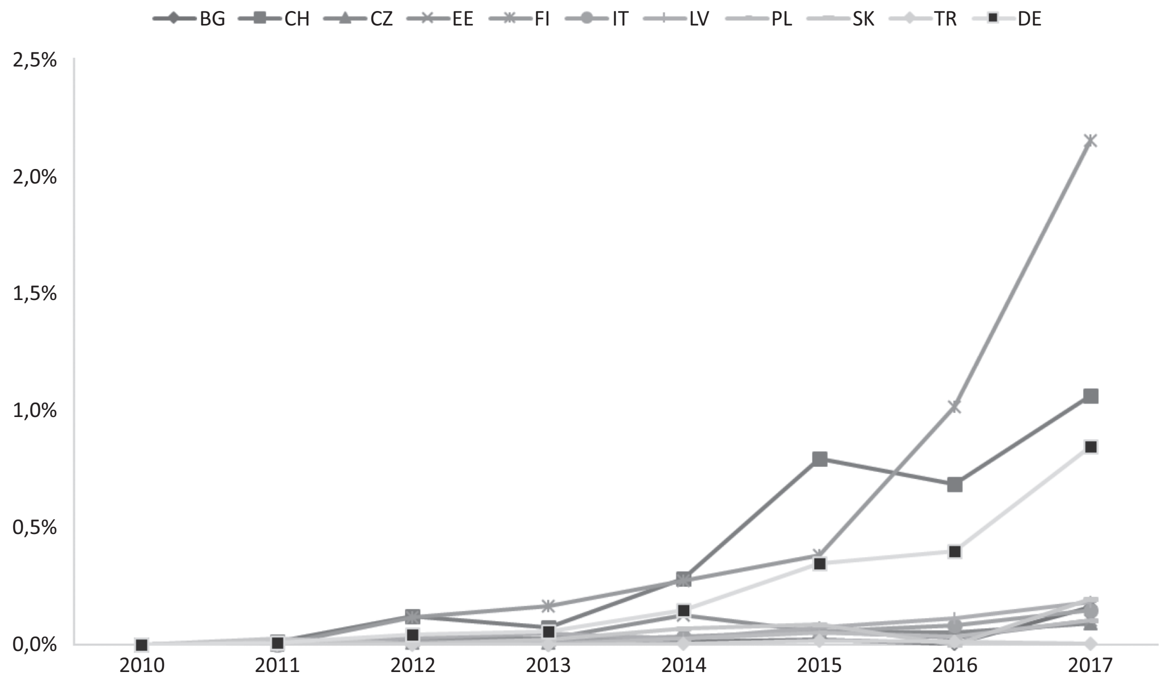


Figure 6. Share of PHEV vehicle registrations in selected countries.

Finland, Italy, Latvia, Poland, Slovakia, and Turkey. Unlike Germany, these countries have very limited or no subsidies for the purchase of EVs.

The results in Figure 7 (a) and (c) show the generated synthetic unit for both the share of BEV and the share of PHEV together with the vehicles registered in Germany and the gaps between the EV car registrations and the synthetic unit. The differences between the dashed lines show that there is a sufficient match between the trends in the outcome variable for synthetic and treated countries in the pre-treatment period for the share of PHEVs in total registrations. In particular, there was a considerable increase in car registrations of this type of vehicles from 2015 onwards for PHEV but a very low increase in the case of BEVs. This increase denotes a positive effect on sales of PHEV that can be associated with the introduction of the purchase subsidy because no other factor affected the German PHEV market during 2016 and 2017. In both cases, we observed that the countries of the synthetic unit are composed of the same countries with different percentages (Table 2). The unit includes Finland, Switzerland, Poland, and Slovakia, a mix of countries with developed but small EV markets and countries with much smaller markets than Germany.

Table 2. Donor pool weights for synthetic control units.

Example	Share of BEVs	Share of PHEVs
Bulgaria	0.000	0.000
Switzerland	0.279	0.335
Czech Republic	0.000	0.000
Estonia	0.014	0.000
Finland	0.269	0.090
Italy	0.000	0.000
Latvia	0.000	0.000
Poland	0.209	0.230
Slovakia	0.229	0.345
Turkey	0.000	0.000
losss w	0.115	0.083

Since the synthetic control does not provide classic standard errors for making statistical inferences, Abadie and Gardeazabal (2003) suggest performing placebo or permutation tests. The underlying idea is to estimate counterfactual emission trajectories for countries in the donor group. In an ideal world where the perfect analogue of the treated country is available in the donor community, no treatment effect would be found for any country in the donor group independent of the years after treatment. However, in practice, effects of the placebo treatment will always be found, at least to some extent. As a result, only the actual effect of the treatment is considered to be statistically significant if it is significantly greater than the effects of the treatment within the synthetic control unit. Figure 7 (b) and (d) include a series of placebo-tests, calculated using the control unit

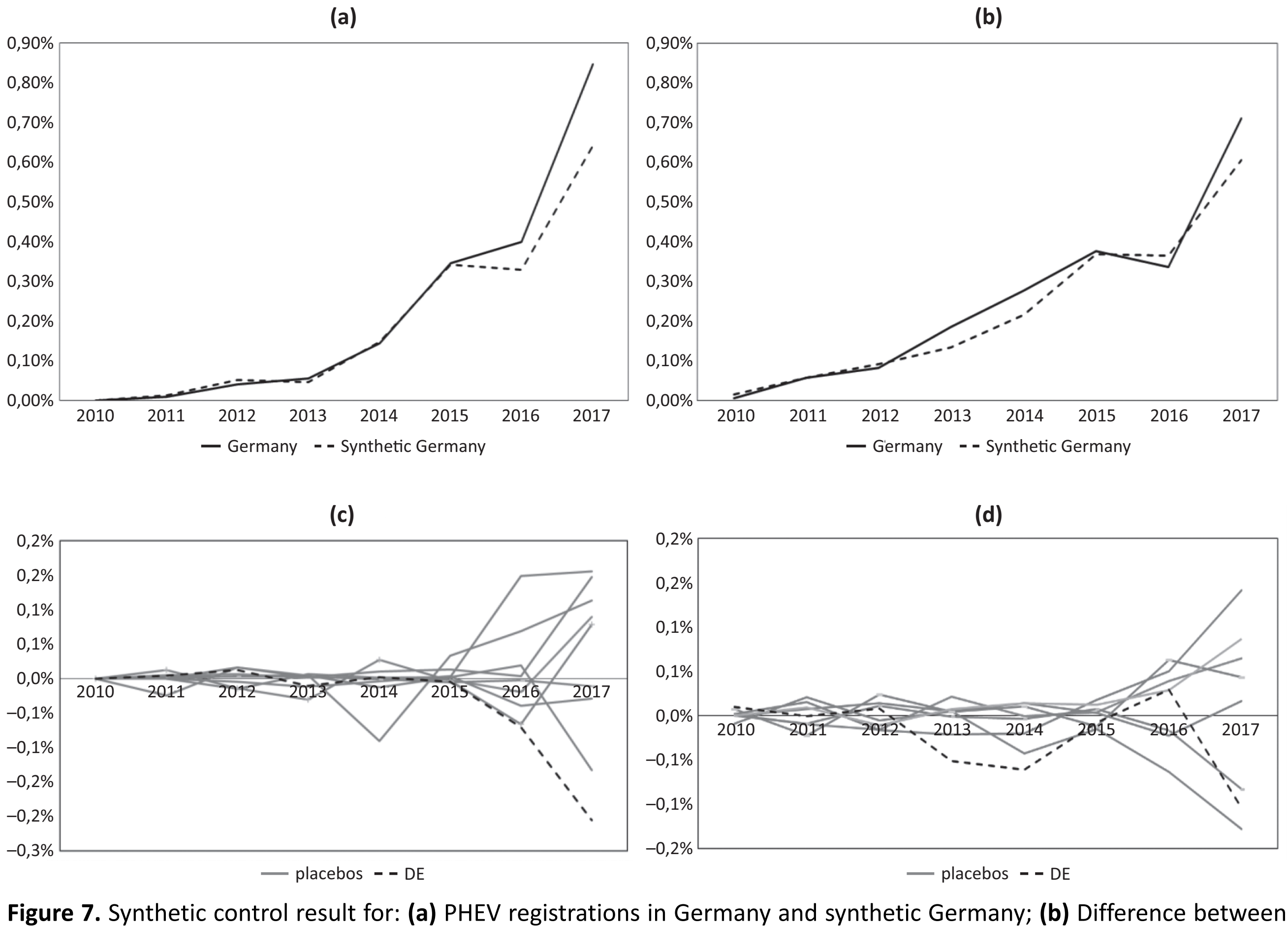


Figure 7. Synthetic control result for: **(a)** PHEV registrations in Germany and synthetic Germany; **(b)** Difference between placebo test for PHEV registrations, synthetic Germany, and actual Germany PHEV registrations (x axis line); **(c)** BEV registrations in Germany and synthetic Germany; **(d)** Difference between placebo test for BEV registrations, synthetic Germany, and actual Germany BEV registrations (x axis line).

for PHEV and BEV registrations respectively. The results show that none of the other countries display results as significant as those in Germany for PHEV sales. They thus reinforce the hypothesis that the positive effect from 2015 onwards is due to the introduction of the subsidy and not due to any other intervention.

These results stand in contrast with BEV results. The pre-treatment periods of the synthetic control unit do not provide such a good fit as in the case of PHEVs. For the post-treatment period, the results show a much lower increase in sales than in the case with PHEVs, which means that the subsidy has not had such a positive effect as expected. One important factor to consider is the role of the private sector. In 2010, consumers in the European market could choose between 15 BEV models but only one PHEV model. In 2017, the number of PHEV models available on the market increased to 33, while there were 28 BEV models. This low increase in BEV sales may be partly due to a combination of causes such as the private sector's increased ability to integrate new technologies into production chains, to exploit existing know-how or to address barriers to acceptance. Nevertheless, the limited availability of overall EV models affected the whole European market.

Another possible reason for these results has to do with the technical characteristics of both cars. PHEV drivers are not affected by the lack of a recharging infrastructure or the long charging times of the electric batteries thanks to the incorporation of a combustion engine together with the electric motor. The analysis presented in Section 3 shows that in most cases the available recharging infrastructure is reduced to the private household CSs. This is due to the lack of fast CSs at locations with higher parking demand, encouraging the use of PHEV models with which customers can compensate for the lack of a complete and geographically well-distributed charging network. At the same time, the need for a home CS creates a potential entry barrier for urban users who do not reside in single-family residential neighbourhoods. This, in turn, reduces the profitability of existing EVs and discourages investment in new infrastructure.

5. Conclusion

The use of EVs is presented as the main option to reduce CO_2 emissions in the transport sector. The transition to a model of mobility not based on the use of fossil fuels requires replacing the vehicle fleet and therefore a high level of investment to encourage change in both the infrastructure and vehicles. To this end, since early 2010, Germany implemented a series of measures to promote the use of EVs, including purchase subsidies and the development of charging infrastructures. In order to understand the effect of these incentives, this article analyzed the impact of the purchase subsidy for both, the BEV and PHEV market sectors by analyzing the spatial distribution of CSs. The results show that the subsidy has had a limited impact on the growth of the EV market. It has mainly affected the purchase of PHEVs rather than the purchase of BEVs. Moreover, the distribution of the CS infrastructure installed does not correspond to the results of the calculated spatial distribution model but seems to be based more on image marketing.

This poses a number of implications for public policy. Firstly, the current incentives are mainly dedicated to subsidizing EV buyers who would have bought EVs anyway. The cost of EVs in Europe was in 2019 at least 40% higher than combustion engine vehicles and the high price compared to common fossil engines is one of the identified barriers for EV adoption in Germany. In our analysis, the German counterfactual shows that in the case of BEVs, sales without subsidy would have been very similar to sales after the introduction of the subsidy. Also, the increase in the PHEV market is relatively small compared to the case of no purchase subsidies. This limited effect may be explained by the small size of the subsidy compared to the total price of the EV. Secondly, with the analyzed subsidy, the government is encouraging the use of PHEVs at the cost of EVs. PHEVs, however, have a much lower greenhouse gas reduction potential than EVs, which reduces the positive effect sought by the policy. Previous studies have shown that EV buyers make their purchase decisions based on ideological grounds relating to environmental sensitivity. Simultaneously introducing a subsidy for the purchase of BEVs and PHEVs might indicate to the purchaser that both types of EVs have the same 'environmental bonus' associated with the transition. The overall goal of the purchase subsidy is a reduction in emissions resulting from the road transport sector by fostering the adoption of EVs. However, such a transformation of the vehicle fleet can only contribute to this goal if the electricity consumed by EVs is generated through renewable sources. In the case of Germany today, more than 30% of electricity still comes from coal. Therefore, only if the electricity transition towards more renewable energy carriers is supported can a reduction of emissions from the road transport sector, and thus the overall goal of the policy under investigation, be achieved.

Regarding the development of charging infrastructures both, municipalities and companies are hesitant when it comes to expanding an adequate electric charging infrastructure in public spaces. Although, numerous concepts of how the new supply infrastructure will look like in the future exist, investments are not being made due to the lack of economic profitability of CSs. The expansion is usually limited to model projects marketed in the media or to a few very innovative companies and municipalities. Moreover, as CSs are subsidized, companies may be using the installation of charging infrastructures primarily for image and marketing purposes to meet the social need for increased environmental awareness. This result is especially important because the development model of the load-bearing infrastructure is characterized by being decentralized and spatially dispersed. As nationwide supply for a large number of EVs is not yet available, an underdeveloped network of these characteristics may be nourishing negative synergies. It is, therefore, necessary to understand the extent to which the uncoordinated installation of the CS system moves away from the location models and how it may be affecting the adoption of EV.

PHEVs can moreover cause the nationwide vehicle fleet's conversion to have a much lesser impact on greenhouse gas emissions than BEVs are likely to. If so, the renewal of the fleet would have a minor negative effect on the automobile industry, which could continue to sell combustion engine cars and continue to make a profit on their investment in models with combustion technology. On the other hand, this could make it more difficult for new competitors to enter the market and for new mobility concepts to be developed, based on a more radical and profound transformation of both consumer habits and the transport infrastructure. As far as CS infrastructure is concerned, the increase in PHEVs may generate a negative effect which must be taken into account and which may appear in the next few years. These vehicles do not need the use of the CS network so they may be discouraging its use, as well as its expansion and the expected benefits of the transition.

From these conclusions, one can deduce that neither an increasing charging infrastructure nor an EV subsidy policy are likely to be sufficient to accelerate a transition *per se* in Germany. Both policies must be integrated into a broader vision of energy transition and should avoid positions that reduce the anticipated effects to trade-offs between EV or CS support. The combination of an important network of actors and interests makes Germany very different from other European countries where the EV transitions are faster (for a review, see Sovacool et al., 2020). Further research is necessary to generate and analyze more data concerning the dynamic impacts of both subsidies and other influencing variables have and the role of these actors on the impact of these policies. The current lack of data is the main inhibitor to further understanding the dynamically intertwined relationship of the EV market with the charging infrastructure, the electricity market and consumer behaviour. Nevertheless, factors such as the potential sites of electricity generation, its impact on CS development, and the extent to which policies to reduce emissions through electromobility depend on the transition towards renewables should be analyzed in more depth.

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Conflict of Interests

The authors declare no conflict of interests.

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Article

Geostrategic Renewable Energy Transition in Turkey: Organizational Strategies Towards an Energy Autonomous Future

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Abstract

The geographical location of Turkey in the Asia Minor places the country in a delicate geostrategic position determined by its history, ideological structure, politics and energy economy. The Turkish government has defined its main energy strategies with the goal of reaching 30% renewables by 2023. Key strategies declared are the prioritization of energy supply security, the consideration of environmental concerns, and an increase in efficiency and productivity through the establishment of transparent and competitive market conditions through reform and liberalization. This article analyses the renewable energy (RE) transition of Turkey from a fully centralised energy management model towards a system of partially centralization through the unbundling of utility companies. Analysis will utilize Michael Mann's theory on the four sources of social power as an alternative organizational means of social control and the interrelations of ideological, economic, political and military power. The recent history of Turkey's RE transition and government plans for sector development will be investigated from a socio-spatial and organizational perspective. Furthermore, the way in which these socio-spatial relations have been shaping electricity market liberalization and the preparedness of the state to share its power with non-state actors is discussed. The potential of a centralised RE management model to inspire 'decentralised' RE management in other geographies is considered. In conclusion, key factors in the organisation of the (de)centralised electricity transitions are found to be dependent on history, geography, and overlapping relations of social power.

Keywords

decentralization; development; electricity market; energy transition; renewable energy; social power; Turkey

Issue

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1. Introduction

Energy autonomy (or dependency) shapes both the trajectory of a country's socio-economic development as well as the nature of its international relations. Scheer (2007, p. 231) describes the guiding concept of energy autonomy as the goal of making energy available in a way that is self-determined, not heteronomous; free and independent of external constraints, and outside intervention. Scheer (2007, p. 231) also states that in the long run, all these dimensions of energy autonomy are only possible if renewable energy (RE) resources are utilized. Sozen (2009, p. 4827) defines energy dependency as the extent to which an economy relies upon imports to meet its energy needs. The trajectory that a country follows from energy dependency to energy autonomy brings infrastructural, economic, geopolitical challenges from the social power perspective.

Michael Mann develops his theory on the sources of social power in four volumes written between 1986 and 2013. In these works, he takes the reader on a socio-spatial journey, investigating different sources of power throughout human history and suggesting that a general account of societies, their structure, and their history can best be given in terms of the interrelations of four sources of social power: *ideological, eco-*

nomic, military, and *political* (IEMP) relationships (Mann, 1986, p. 2).

A starting point in transitioning to RE systems requires us to consider existing energy management structures and their respective histories. As briefly explained in Section 2 of this article, the Republic of Turkey followed steps similar to those presented in Mann's theory during the establishment of the republic and the formation of a centralised government through its Kemalist ideologies. Later on, the country built upon its national institutions by developing soft geopolitical networks. The military power did not have priority in the early years of the republic.

Therefore, the transition to RE systems was initiated with a centralised approach and formed around an infrastructural power. The social roots of state power had to be preserved, but an energy transition initiated at the same time. The socio-spatial context presented a challenge for existing institutional and regulatory structures in preparing to transition to RE systems. The liberalization of the electricity market had been initiated. The unbundling and privatization of utility companies were taking part both in the liberalization process but also paving the way for new investors. In other terms, it was presenting an overlapping interest for both government (and its institutions) and the new utility company investors as well as private investors.

It is the geographical location of Turkey that has, throughout history, prompted its governments to take geostrategic decisions. When the Republic of Turkey was established in 1923 with 378 deputies by Mustafa Kemal, a republican and secular constitution was adopted. Ankara was selected as capital at the *centre* of the country. As Kili (1980) has noted:

> The immediate objective of the Kemalist reforms and the ideology of Kemalism was the realization of a Modern Turkish state and society. Their ultimate objective was bringing Turkey to a level even above contemporary civilization. The Kemalist principles of republicanism, nationalism, populism, secularism, étaism [statism], and devrimcilik (inkilapcilik) [revolutionism, (reformism)], were to provide the attainment of these objectives. (p. 387)

It is this reformist ideology that has prepared the ground for many geostrategic decisions at the national and international levels. As a result, starting from 1945, Turkey has participated in the United Nations, and has since joined the North Atlantic Treaty Organization (NATO), the Central Treaty Organization, the World Bank, the Organization for Economic Co-Operation and Development (OECD), the G-20 as well as regional organizations such as Organization for Security and Co-Operation in Europe (OSCE), the Organization of the Black Sea Economic Co-Operation (BSEC), the Organization for Islamic Co-Operation (IOC), and made an application to become a member of the European Union (EU). These memberships have provided a worldwide network and consolidated Turkey's geostrategic relevance in world affairs.

1.1. History of the EU Membership Application and Contribution to Energy Reforms

The lengthy accession process of Turkey into the EU started with its membership to the Council of Europe in 1950 as the 13th Member State. In 1959, Turkey applied for membership to the European Economic Community (succeeded by the EU). The Ankara Agreement was signed in 1963, establishing a plan for the development of a shared customs union. In 1993, negotiations between Turkey and the EU began, and the Customs Union took effect in 1996. This gave Turkey a strategic position by allowing for the free movement of goods and excluding agricultural products by eliminating the customs duties and charges (Delegation of EU to Turkey, 1995). In 1987, Turkey submitted a formal application for full membership to the EU. The European Council gave Turkey the status of candidate country in 1999 at the Helsinki Summit, marking the beginning of the accession negotiations (Delegation of EU to Turkey, n.d.).

The Turkish government application to becoming an EU member state has prompted many chapters of negotiation, including Chapter 15 which focuses mainly on the internal energy market, energy efficiency, RE resources, nuclear safety, radiation protection and security of supply. The development of RE policies were encouraged by the EU. Especially, the National RE Action Plan published in 2015 that has the characteristics of a roadmap was prepared in accordance with the EU directive 2009/28/EC (Ministry of Foreign Affairs—Directorate of EU Affairs, 2020).

1.2. Structure of the Government

While Turkey has been continuing its path for membership in European and worldwide organizations, its population reached to 82,886,421 in 2019. It is expected to be 100 million by 2040 (Turkish Statistical Institute, 2018), holding an average age of 32 by the end of 2018. This population has been governed by a secular, unitary, formerly a parliamentary republic which adopted a presidential system by referendum in 2017 (International Business Publications, 2018). This referendum proposed a set of 18 amendments to the constitution of Turkey (International Business Publications, 2018). The new presidency became an executive post with broad executive powers, abolishing the post of the prime minister. It has also called for changes to the Supreme Board of Judges and Prosecutors (International Business Publications, 2018). Another amendment resulted in an increase from 550 to 600 parliamentary deputies, representing 81 provinces and a landmass of over 783,562 km^2.

The new powers given to the president included the right to issue decrees, propose the budget, appoint cabinet ministers and high-level bureaucrats without a confidence vote from the parliament, and directly and indirectly appoint the Council of Judges and Prosecutors (Kirisci & Toygur, 2019, p. 5). These constitutional changes created concerns in the Parliamentary Assembly of the Council of Europe (Kirisci & Toygur, 2019). Beside these concerns, a distinct economic impact was discernible. Although European Commission (2019) stated that the Turkish economy fell into recession in 2018, a total of 0.9% of economic growth was reached by the end of 2019 (Turkish Statistical Institute, 2020). The government of Turkey announced the growth forecast as 5% for 2020 at the Official Gazette as part of the Annual Program of the Presidency.

1.3. Argumentation

Mann (1986, p. 13) defined society as a network of social interactions at the boundaries of which is a certain level of interaction cleavage between it and its environment. In the same volume, Mann (1986, p. 14) states that human beings are social but not societal—they need to enter into social power relations, but they do not need social totalities. Furthermore, in the fourth volume, he explains power as the capacity to get others to do things they otherwise would not do; that people would enter into power relations involving both cooperation and conflict with other people in order to achieve their goals (Mann, 2013, p. 1). Therefore, according to Mann (2013, p. 1) power may be *collective*, embodying cooperation to achieve shared goals—power through others—and *distributive*, wielded by some over others. Moreover, power may be *authoritative* or *diffuse* as well as *extensive* or *intensive* (Mann, 2012b, p. 6).

According to Mann's definition (2013, p. 1), *ideological power* derives from the human need to find ultimate meaning in life, to share norms and values, and to practice in aesthetic and ritual practices with others. Nevertheless, Mann (1986, p. 23) states that ideological organization first arises in a more autonomous form that is socio-spatially *transcendent* and it reaches in this way beyond the existing institutions of ideological, economic, military and political power. Finally, Mann (2012b, p. 7) concludes that institutionalized ideologies indicate a minimal presence of autonomous ideological power.

Mann (2012b, p. 9) defines *economic power* as the power that derives from the human need to extract, transform, distribute, and consume the produce of nature. Furthermore, he emphasizes that economic relations are powerful because they combine the intensive mobilization of labour with extensive circuits of capital, trade, and production chains, providing a combination of intensive and extensive power and, in most cases, of authoritative and diffused power (Mann, 2012b, p. 9). In the fourth volume, Mann (2013, p. 2) argues that the main organization of economic power in modern times has been *industrial capitalism,* a system allowing for the formation of markets into four main categories—capital, labour, production and consumption.

Mann (2012b, p. 11) resumes the definition of *military power* as the social organization of concentrated and lethal violence. It is a type of violence that is mobilized and focused (concentrated) as well as deadly (lethal; Mann, 2012b, p. 11). This form of violence is explained as having both intensive and extensive aspects, as well as the organization of defence and offense in large geographical and social spaces (Mann, 1986, p. 25).

Mann (2012b, p. 12) defines *political power* as centralised and territorial regulation of social life and the basic function of government as the provision of order over this realm. Mann (1986, p. 27) emphasizes that political power heightens boundaries, whereas other power sources may transcend them and can be involved in any social relationships where they are located. Furthermore, he discusses the *despotic* and the *infrastructural* powers of the state (Mann, 2012b, p. 13, 15) and he also states that states project military and political power externally, under the name *geopolitics*. Mann (2012b, p. 15) differentiates between *hard geopolitics* which involve war and *soft geopolitics* which involve political agreements concerning non-lethal matters like, law, economy, health, education, the environment, and so forth.

This approach is seen as an appropriate means for disentangling the complex socio-spatial context of interrelated and overlapping environments, economies and institutions in which RE systems exist. Its application will allow our case to be analysed in respect to the four sources of power that shape human society (Mann, 2013) and to emphasize the ability of human beings to pursue diverse goals and establish new networks of social interaction (Mann, 1986). Furthermore, it will provide insight into when the establishment of new systems (such as RE systems) to attain ideological, economic, military and political power will result in the formation of different network relations.

Turkey's vision and strategy for transition was informed by the following question: "How to achieve this transition for the benefit of all social actors within the RE systems?" Multiple win situations were considered to promote and expand RE systems, but the regulatory framework and electricity market were not ready for such a RE transition. The institutional structure and state-owned enterprises were also not instilling confidence in private investors, especially international investors who could provide the necessary capital to develop the energy sector. The bundling of electricity utilities was not creating an easy process for the realization of future projects. Therefore, unbundling and privatization activities allowed for new ways of doing business and a more balanced sharing of power between the state and other energy market actors and creating new intersecting networks of relations for RE stakeholders.

The transition has played an important role within the energy strategies of the government and that it provides a solution to the key challenges of a growing economy in a developing country. It enhances the security of supply, decreases import dependency, and increases the share if low-carbon energy solutions in the energy mix. Due to Turkey's geostrategic history with its central and unitary state, the RE transition legislation followed a similar centralised path. However, it has incorporated private and public investments by supporting the transition with parallel activities such as electricity market reforms and liberalization. These new steps have always been supported by the political parties in government or those in opposition because they bring new sources of income and jobs for the economy, the investors and the people they are representing.

Other energy reforms took place before the 2015 National RE Action Plan. The first phase in the 1980's and 1990's facilitated a transition from state ownership and control toward a liberal market economy, followed by energy sector restructuring and private sector participation in the power sector (World Bank, 2015, pp. 19–20). Since 2001, the second phase of market-based reforms involved electricity market development, as well as the legal, regulatory, institutional framework. It re-structured state-owned power companies, took transitional measures, placed unbundling of functions, and included provisions for open access to transmission and distribution grids. Furthermore, it created eligible consumers and market openness, centralised balancing, settlement, and trading arrangements, and furthered the development of trading platforms and privatization (World Bank, 2015, pp. 22–26).

This article analyses the geostrategic RE transition of the Republic of Turkey in light of the four sources of social power analysed by Michael Mann. Through the analysis of the socio-spatial relations between ideological, economic, military and political powers, it seeks to understand the transition from a fully centralised energy management perspective towards a partially centralised management model through the unbundling of its utility companies. It begins by briefly reviewing Turkey's current geographical, governmental, and demographic situation with the history of the Republic of Turkey to reflect on the reasons of the current RE development strategy. It analyses the four sources of social power as described by Mann in 1986, 2006, 2012, and 2013. Section 2 describes the unbundling and the privatization of the public electricity companies toward an open electricity market. It investigates and analyses the recent history of RE from an organizational perspective. Section 3 discusses the RE transition strategy and related legislation. Section 4 explains the impact of the unbundling on the development of the RE projects from 2008 until 2018. It investigates the development in the RE systems by comparing the data on the RE installed power plant capacity and its contribution to the energy sector. Moreover, it analyses closely the solar power plant and wind power plant projects' development over time, during the course of the legislative and regulatory development. Section 5 discusses the results of the statistical data derived from Electricity Transmission Company of Turkey (TEIAS) and Section 6 concludes with reflections on the implications of centralised versus decentralised RE project management.

2. Unbundling and Privatization

Mann (2012b, p. 6) reflects on the four sources of social power as the organizational means by which we can efficiently attain our varied goals. In order to achieve these goals and meet the energy needs of the country, a series of restructuring and privatization measures (World Bank, 2015) took place. The Turkish Electricity Authority (TEK) established in the 1970s, and active in Turkey's electricity generation, transmission and distribution, was first split into Electricity Generation and Transmission Company (TEAS) and Electricity Distribution Company (TEDAS) 1994. Later on, TEDAS was unbundled and privatized to reach efficient electricity market operations. From the economic power perspective, TEK was the only handler of this need to extract, transform, distribute the produce of nature as explained in the Section 1.3.

The foreseen value of industrialized capitalism, which is the economic power of modern times, had an intersecting and overlapping interest with both political power (central, institutionalized and diffuse) and ideological power (liberalization). The increased trade of capital, labour, production and consumption was enabled by the unbundling and privatization of the electricity market. For the governing power, this presented a way of attracting foreign investment, encouraging domestic investment and attaining further financial resources while contributing to the energy needs of the country.

This is how, over the course of the electricity market restructuring, new actors appeared. The Energy Market Regulatory Authority (EMRA) was established in 2001 to regulate generation and transmission related activities. The TEAS was unbundled into the Electricity Generation Company of Turkey (EUAS) and the TEIAS. The Electricity Trading and Contracting Corporation of Turkey (TETAS) became the manager of sovereign-guaranteed power purchase agreements and sales to uncreditworthy electricity distribution companies (Deloitte, 2016, pp. 18–19).

One of the biggest steps in this transition was the privatization of the regional distribution activities of TEDAS, resulting with its unbundling into 21 zones—with 21 different private distribution companies—from 2004 to 2013. As the 2015 World Bank report *Turkey's Energy Transition* suggests, privatizing distribution was prioritized to create confidence in prospective investors and facilitate further privatizations and capacity expansion. Nevertheless, TEDAS has retained its regional headquarter for monitoring and supervision purposes.

Mann (2012b, p. 9) quoted what Schumpeter (1942) famously called "creative destruction," whereby growth occurs through the destruction of old industries and organizational forms and through the creation of new ones. This destruction and creation of new structures (Figure 1) in the energy market enabled the introduction

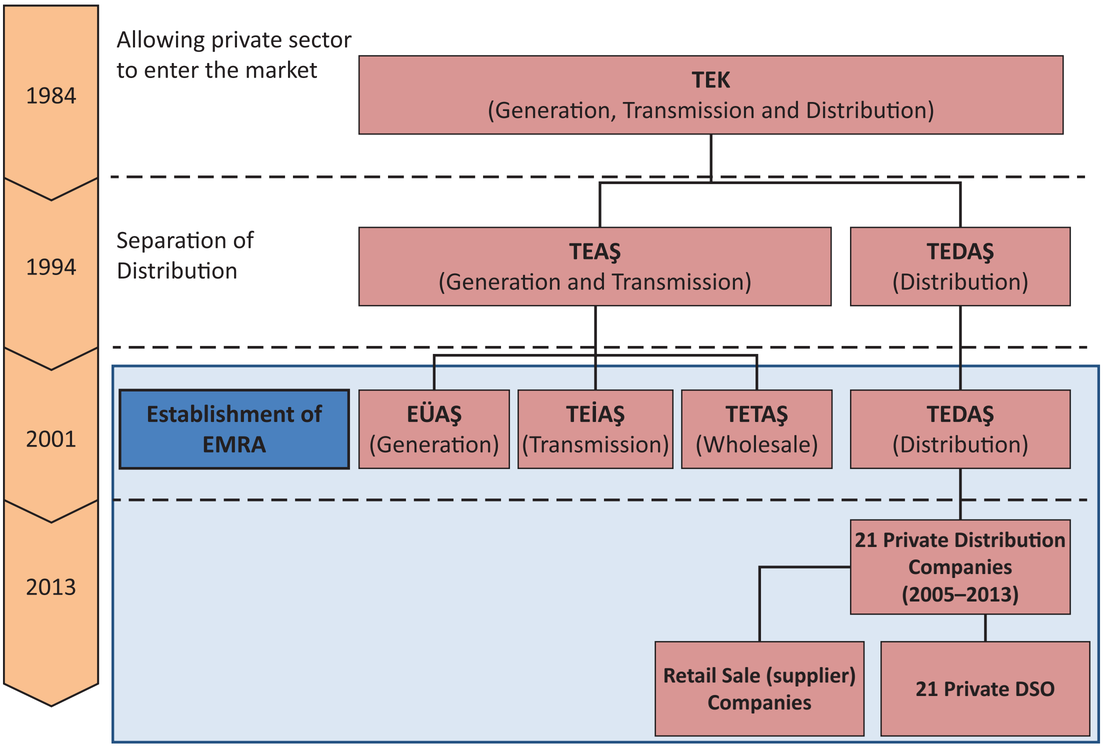

Figure 1. The general structure of the existing electricity sector in Turkey. Source: International Atomic Energy Agency (2018).

of renewable electricity generation by private companies and individuals to be fed into the grid. Beginning with one big state-owned company, twenty-five companies—both state and private—were born. The structural breakdown of one powerful central unit of generation, transmission and distribution has not resulted in the loss of power. Instead, it has created a different model of management, with different energy market actors, without losing the state's control over the energy management of the country.

TETAS, handling the electricity trade and wholesale activities, used BOO (Build-Own-Operate), BOT (Build-Operate-Transfer) and TOOR (Transfer-of-Operating-Rights) models with private companies. In addition, industries were allowed to generate electricity for their own needs and named after auto-producers.

Followed by the unbundling in the electricity market along with the privatization of the utility companies, privatization continued to accelerate. Figure 2 illustrates the change in the ratio of the public versus private ownership of the installed capacity. In 2008, the installed electricity generation capacity in the public sector was 58% versus 42% in the private sector. A breakeven point was reached in 2010 and by the end of 2018, the private sector owned 79.1% of the total installed capacity, with the public sector retaining only 20.9%.

In the geostrategic RE transition path that the Republic of Turkey has chosen to pursue, the liberalization of the Turkish electricity market, the establishment of the necessary market actors and the privatization have built trust for both investors and consumers. Still, TEDAS has not lost relevance and has instead changed its operational structure to enhance RE projects at different scales. Thus, the institutional and organizational power of the state were not dissolved but changed their position through the unbundling of the utility companies. A remarkable point from 2008 until now, is that there was no change in political power. This was one of the reasons why there are lot of interest from both national and international investors along with state and non-state actors in the RE business. A desirable growth in RE investments was reached in 2019 which fostered sectoral and regional economic development. This demonstrates the role that carefully designed, planned and implemented social power actions can have within a successful RE management framework.

3. Renewable Energy: From Strategy to Legislation

The Turkish government has structured its main energy strategies to focus on the following priorities: 1) promoting activities to enhance energy supply security; 2) giving due consideration to environmental concerns throughout the energy chain; 3) increasing efficiency and productivity, establishing transparent and competitive market conditions through reform and liberalization; 4) augmenting research and development of energy technologies, and increasing the ratio of local RE in the energy mix, to increase energy efficiency and diversify supply routes and sources for imported oil and natural gas; and 5) to add nuclear energy to the energy mix (Ministry of Foreign Affairs, n.d.).

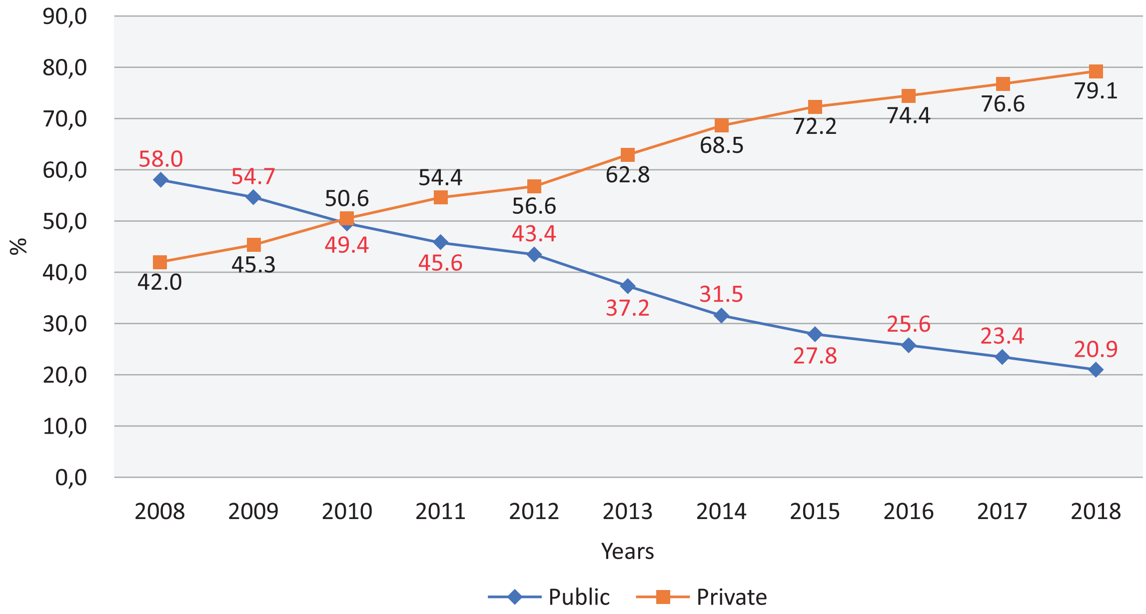

Figure 2. The distribution of Turkey's installed capacity by the public and private sectors (2008–2018). Source: TEIAS (2018).

Geographically rich in natural resources, centralised energy institutions and political structure, in 2009 the country set the goal of meeting 30% renewables by 2023, building on the RE policies which were being developed since the enactment of the Electricity Market Law (EML) in 2001. One noteworthy step was the introduction of prosumers to the electricity market, allowing individuals to act as both RE producers and consumers. The Law on Utilization of Renewables in Electricity Generation No.5346 was passed in 2005, twice-amended and followed by the Energy Efficiency Law No.5627 (Deloitte, 2014, pp. 18–19). The aim of these laws was to support the use of RE resources in order to contribute to the diversification of energy resources, to reduce greenhouse gas emissions and to protect the environment (World Bank, 2015) as well as to develop related manufacturing sector to realize these objectives.

The RE Support Mechanism and unlicensed energy generation regulations were introduced in 2011, allowing for the unlicensed electricity generation from renewable resources of up to 500 kW. Additional feed-in-tariff support for locally manufactured components was added in 2013 for unlicensed electricity generation. The government has acted with precaution in the development of the capacity of RE projects. Unlicensed project capacities were initially capped at 500 kW in 2011. This was increased to 1 MW in 2013 and finally to 5 MW in 2019 under certain conditions. The feed-in-tariff for electricity production from RE sources was guaranteed for 10 years for unlicensed projects. Licensed projects were obliged to follow a competitive tender process for allocated lands in different regions of Turkey.

Beginning in the 1980's, public utilities were privatized and changed their operational models to promote the use of renewables. The utilities were divided in six categories, as seen in Figure 3: (1) Independent Power Producers (IPP), (2) BOT, (3) BOO, (4) TOOR, (5) Energy Production AS (EÜAS) and (6) unlicensed private owners. In 2018, Turkey's total installed capacity reached 88,550.8 MW, with each type of utility maintaining its own stake in thermal, hydro, geothermal, wind, and solar energy capacities. Furthermore, within this energy mix, the unlicensed portion represents 6% of total installed capacity in 2018 (5,352.4 MW), made possible by changes in the regulation of renewables, namely hydro, wind and solar power plants which are up to 1 MW of capacity each.

This ratio of 6% of installed capacity, growing over 13 years, shows the willingness of the private sector to contribute to energy generation when a stable/guaranteed support mechanism is established, in this case feed-in-tariffs. In other words, the changes in the institutional structures, and the integration of an economic value system with the feed-in-tariffs, have led to the establishment of RE sources' economic power by creating an inter-relation with the rest of sources of social power such as ideological and political. Consequently, a win-win situation has been created within a given geography where the electricity beneficiary is the end-user, the institutions monitor the security of supply and planning, and private sector/contractors trade on a liberalized energy market. The economic power (industrial capitalism) chain has successfully been created.

4. Development of Renewable Energy Projects with New Policies

As outlined above, institutional changes to create a liberalized market and fulfil energy demands had a dramatic effect on Turkey's RE sector. The annual development of total renewable installed capacity excluding hydro from 2000 until 2018 has been shown in the Table 1.

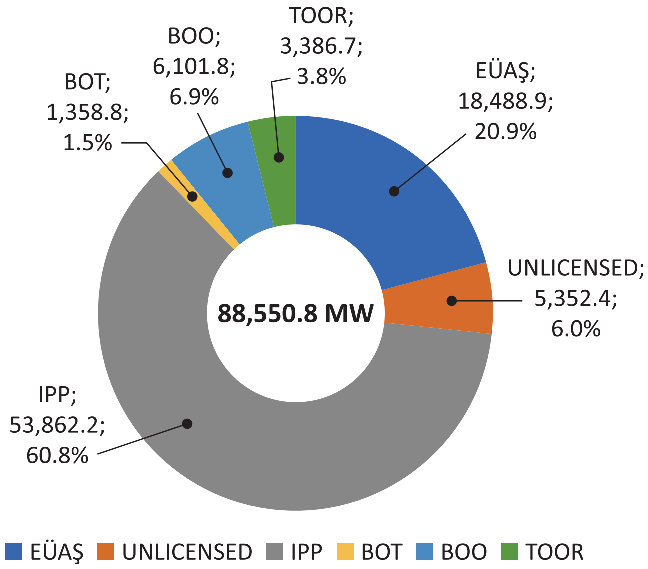

Figure 3. The distribution of Turkey's installed capacity by the electricity utilities in 2018. Source: TEIAS (2018).

Although 28,291.40 MW hydro from the overall capacity of 88,550.80 MW are accounted under the RE category, there is a debate about their sustainability in different geographical regions of the country and moreover, the development of hydro power plants have followed a different set of policies that were developed prior to RE policy. As such, this article will focus only on the increase of wind and solar energy projects since the passing of the 2005 law on RE policy (Law No.5346 on the use of RE resources for generation of electricity).

Although grid-connected solar photovoltaic (PV) power plants were not very widespread in 2011 when the feed-in-tariff based support scheme was first introduced, they have become one of the fastest developing RE types in Turkey (Energy Market Regulatory Authority, 2011). This was facilitated in part by the government price guarantee of 0.133 USD per kWh of generated solar electricity. As an additional support mechanism, producers utilizing local materials are provided with an additional 0.067 USD per kWh, equalling a total sum of 0.20 USD per kWh under optimal conditions. This support scheme acted as an economic power stimulant and added value to local investment, labour and products. When the ambitious involvement of the solar energy

Table 1. Annual development of RE based installed capacity share in Turkey total installed capacity (2000–2018).

Years	Hydro	Geothermal	Wind	Solar	Biomass *	Renewable Installed Capacity	Total Installed Capacity	Renewable Share %
2000	11,175.2	17.5	18.9		10.0	11,221.6	27,264.1	41.2
2001	11,672.9	17.5	18.9		10.0	11,719.3	28,332.4	41.4
2002	12,240.9	17.5	18.9		13.8	12,291.1	31,845.8	38.6
2003	12,578.7	15.0	18.9		13.8	12,626.4	35,587.0	35.5
2004	12,645.4	15.0	18.9		13.8	12,693.1	36,824.0	34.5
2005	12,906.1	15.0	20.1		13.8	12,955.0	38,843.5	33.4
2006	13,062.7	23.0	59.0		19.8	13,164.4	40,564.8	32.5
2007	13,394.9	23.0	147.5		21.2	13,586.6	40,835.7	33.3
2008	13,828.7	29.8	363.7		38.2	14,260.4	41,817.2	34.1
2009	14,553.3	77.2	791.6		65.0	15,487.1	44,761.2	34.6
2010	15,831.2	94.2	1,320.2		85.7	17,331.3	49,524.1	35.0
2011	17,137.1	114.2	1,728.7		104.2	19,084.2	52,911.1	36.1
2012	19,609.4	162.2	2,260.6		147.3	22,179.5	57,059.4	38.9
2013	22,289.0	310.8	2,759.7		178.0	25,537.5	64,007.5	39.9
2014	23,643.2	404.9	3,629.7	40.2	227.0	27,945.0	69,519.8	40.2
2015	25,867.8	623.9	4,503.2	248.8	277.1	31,520.8	73,146.7	43.1
2016	26,681.1	820.9	5,751.3	832.5	363.8	34,449.6	78,497.4	43.9
2017	27,273.1	1,063.7	6,516.2	3,420.7	477.4	38,751.1	85,200.0	45.5
2018	28,291.4	1,282.5	7,005.4	5,062.8	621.9	42,264.0	88,550.8	47.7

Notes: * Includes Industrial Waste; Unit: MW. Source: TEIAS (2018).

investors and prosumers met with the existing transmission and distribution line infrastructures, the institutional structures were not ready to cope with this demand. A few more years were needed to settle associated administrative changes. Neglecting the installations made in 2012 and 2013, the installed solar PV capacity accounted 40.2 MW in 2014 and over 5,000 MW in 2018.

Within five years of the scheme being introduced solar production capacity in Turkey increased by around 12,500%, with licensed and unlicensed projects from the land-based or rooftop solar PV systems feeding into the grid. Open to both private or public sector, unlicensed projects followed a determined permission process by submitting required documents and/or permits from the Ministry of Environment and Urbanism, the Ministry of Energy and Natural Resources, and the Ministry of Agriculture on its case. Several reports, documents and calculations had to be approved by the civil engineers, electrical engineers, and geology engineers to the utility company in the region and/or to TEDAS. This permission process itself was already showing how the state was not giving away its institutional and organizational power. Privatization could make certain processes easier however it was not entirely meaning a true power shift. Furthermore, another striking result is illustrated in Table 2 with the capacity of the unlicensed solar PV projects applied to the authorities totalling 21,592.41 MW in 2017. An additional 14,186.95 MW was rejected by the authorities.

From a spatial perspective, 21,592.41 MW implies approximately 43,184.82 ha of land belonging to at least 21,592 people or to companies who have a land ownership located outside of the urban areas. This constitutes the land in the periphery which is not suitable for agriculture but was accepted for RE installations. Different financing scenarios have been developed for these spaces both for investors and/or for the land owners which resulted in the high number of applications.

This expansion in solar PV projects clearly shows how the use of social power mechanisms can result in multiple win scenarios. The state institutions' benefit has been the generation of electricity generated from RE sources which reduces dependence on energy imports, reduced carbon emissions and creates investment and employment opportunities. This system allows both national and international investors to generate income and energy in this booming sector. At the same time, prosumers are given the opportunity to off-set their consumption while increasing income.

Many wind power plants were established by individual initiative before the RE law was passed. The first wind power plant was built in 1998 in a village in the Izmir province, a region with some of the highest potential for wind power in Turkey. By the time the RE reform

Table 2. The status of unlicensed electricity generation applications by the end of 2017.

Status	Stream	Biomass	Multifuel	Wave	Natural Gas	Solar (PV)	Solar (CSP)	Hydro	Geo-thermal	Wind	Total
Application period for connection agreement has expired		13.44			20.33	593.93		2.21		37.57	667.47
Connection agreement done		17.90	16.92		77.91	3,026.43		12.38		77.73	3,229.27
Connection agreement expired		1.56			5.05	123.26				2.20	132.07
Under evaluation		28.57	6.00		10.41	134.57				1.00	180.56
Installed & Activated		66.72	2.40		8348	2,978.84	1.00	8.69		32.20	3,173.32
Accepted		49.38	2.67		52.04	548.43	0.08	7.57	5.57	79.44	745.17
Rejected	0.50	148.49	11.45	0.40	71.62	14,186.95		47.77		334.26	14,801.44
Total	0.50	326.06	39.44	0.40	320.84	21,592.41	1.08	78.62	5.57	564.4	22,929.30

Note: Unit: MW. Source: EMRA (2018).

was passed in 2005, Turkey's installed wind power plant (WPP) capacity totalled 20.1 MW. As shown in Table 1, this capacity reached 1,728.70 MW in 2011. It further increased to 3,629.70 in 2014 and 7,005.4 MW in 2018 after the announcement of the feed-in-tariffs (Table 1). Similar to solar energy projects, the first project implementations always took longer. Accordingly, the installed capacity has increased drastically in the recent years. In contrary to solar energy projects, however, the majority of wind power plant capacity has belonged to licensed projects. By the end of 2016, the unlicensed commissioned projects were 10.4 MW and permitted but under construction WPP resulted in 81.7 further MW. Once more the impact of secure financial support mechanisms, a stable economy and clear permission procedures is clearly demonstrated in the rapid growth of Turkey's WPP capacity.

An overall assessment of the RE ratio may be derived from Table 1. The RE-based installed capacity is 15.8% of the overall installed capacity by the end of 2018, as compared to the goal of 30% by 2023 (without taking into account hydro capacity which might mislead). With 2023 the centenary of the Republic of Turkey, the ambitious goals are to reach 20,000 MW WPP (Deloitte, 2016) capacity and 15,000 MW solar capacity (as announced in the press release by the president of the Turkish Solar Energy Industry Association on 14th January 2020; GENSED, 2020). Whether these goals are realistic is a matter of ongoing discussion. The potential for the rapid growth of the RE sector in Turkey has, in any case, already been demonstrated.

5. Discussion: Centralization vs. Decentralization and Energy Autonomy

RE systems act as a tool because the development and growth of a country is directly related to its energy administration. Depending on their interest and social power relations, countries may use this power/energy whether as a tool for economic development, by attracting investment and financial income, or as a development-oriented tool to create energy autonomy, energy justice and rural development in a sustainable way.

The integration of RE systems within a centralised system or a completely energy autonomous decentralised system will always be dependent on the given socio-spatial conditions. RE systems incorporate environmental, technological, economic and socio-spatial aspects and link central and peripheral spaces through socio-technical practices in an environmentally friendly way. Prosumers directly consume what they generate, they off-set their energy consumption and sell the extra energy to the grid. Electricity which is generated from renewable resources in peripheral and marginal land may be connected to the national grid network which contributes to grid stability.

This article discussed the centralization and decentralization of RE systems from the territorial perspective of the nation-state. If one should seek to develop and implement a completely energy autonomous system in an existing electricity grid infrastructure, a financial source is needed to buy the equipment and install the system. This presents an intensive economic power. If this financial source is unavailable, moving to energy autonomous scenario is not realistic. However, if this financial source is missing, there may still be a potential way to introduce the RE systems by using political and governmental power in a diffuse way and utilizing socio-spatially transcendent ideologies. This situation may present itself in the form of industrial capitalism with global actors. Nevertheless, this system can only work if the social connectedness and the exchange of power networks in various forms among market actors is well-facilitated. This is the reason why Mann's social power approach explains the dynamics behind the RE systems.

Sovacool (2016, p. 202) stated that transitioning to newer or cleaner energy systems (such as RE) requires shifts not only in technology but also in political regulations, tariffs and pricing regimes and the behaviour of users and adopters. The recent RE transition history of Turkey discussed in this article depicts a transition in a centralised system within a strategic geography. The preparation of the energy market, market actors, necessary strategies and legislation were the key components and a strong base for the implementation of RE projects. However, the capacity of the institutions, the capacity and improvement of the existing transmission and distribution infrastructure needed to be upgraded in order to meet the demand as well.

Within this context of a country with a growing population and economy forecasted in the strategic and development plans, the social demand has been driven mainly by investment and electricity cost-reduction perspectives. From one side, the intention of the private investor was to generate income and energy by harnessing the power of the "free sun" and the "free wind." These investors have not been dissuaded by lengthy permitting or licensing processes which kept on changing along the implementation of the projects. On the other hand, the intention of the government behind the support of RE in Turkey has been the transition to low-carbon technologies, to reduce the import dependency on primary energy sources and to make a step in the energy autonomy by restructuring the centralised system. As Sovacool (2016, p. 202) clearly states, the speed at which a transition can take place—its timing, or temporal dynamics—is a vital element of consideration. And all energy transitions take time.

Indeed, it has taken time in the case of Turkey, from the energy-market preparation and planning phase of the 1980's to the 2005 reform and subsequent RE sector expansion. Bayraktar (2018, p. 26) underlines that many of these ambitious plans prioritize securing energy supply, reducing the adverse economic impacts of increasing energy imports. They also make markets more competitive, and increase investments in RE. Nevertheless, although these liberalization and privatization events may seem promising, in between the lines, the authorities have always been the ones who retain power.

Undoubtedly, while both small/large scale grid-connected implementations were very popular, free sun brought some energy autonomy for some stand-alone system users. Inspired by the free primary energy resource, and with the introduction of the small-scale solar and wind systems in the Turkish market, stand-alone system users at home have benefited by receiving permission to meet their own energy needs, free from the grid and free from undue administrative burdens. They have become the first off-grid prosumers of Turkey, and they have not yet been quantified.

Instead of approaching two separate concrete paths as centralised or decentralised transitions, where an entire energy system and/or institutional structure needs to be revised accordingly, partially managed models could provide faster transitions to RE and enable practical solutions for people. Zuidema and de Roo (2015, p. 71) state that decentralization in urban areas makes municipalities responsible for developing their own environmental policies and to strategically position environmental interests in integrated local policies. Accordingly, such strategic and cross-sectoral working requires competences such as visionary thinking, communicative skills and strategic planning (Zuidema & de Roo, 2015, p. 13). In either type of management system, there exists a degree of responsibility for the continuity of the system and this does not differ much between urban and rural areas. A decentralised transition with any level of government involvement may be seen as a kind of hybrid form or pseudo-decentralization due to its connection to the institutionalised power source. Indeed, whether an absolute decentralization, an island model, is possible or not within the existing governmental and social structures, their individual as well as their collective power is debatable.

6. Conclusion

Michael Mann's *The Sources of Social Power* was translated and published in Turkish in 2012 as *iktidarin tarihi* (Mann, 2012a), meaning the history of the governing power. It clearly explains how, through the use of the combination of these social power sources and their interrelations and intersections, a greater benefit occurs for the governing power. In fact, the overlapping points occurring in this RE transition create a socio-spatial intensity necessitating regulatory means. The intersection of these regulatory means in different organizational networks define the nature of its centralised or decentralised power structures.

More than a decade now, with the latest changes in its energy policies, Turkey's precautionary, partially-liberalised RE landscape paints a promising portrait in this specific geographical, political and institutional space, while demonstrating the power of a centralised government and the role of the state. In this case, the centralised management model in a liberal electricity market represents a grid-connected, feed-in-tariff incentivised RE management transition model in a developing country. From this, an appropriate management or self-organisation model may be derived for the decentralised electricity transition in other places. Indeed, from a technical perspective, a centralised grid-connected energy system is a combination/connection of many decentralised energy systems into a grid. What this means in practice: Depending on the countries' or regions' or governments' sources of social power as discussed in this article, a different model of RE transition with different layers of liberalization or privatization or self-organisation is also possible. This could in some cases facilitate a faster RE transition than purely centralised or decentralised process options.

Moreover, given the institutional structure and economic drivers, RE transition can be seen as a political power tool. While the privatization of state-owned companies in general remains an issue, a national debate for several reasons in the country, the unbundling of the utility companies to improve the RE project developments in a wider scale has proven to be practical. The 2023 vision for RE in the energy mix was another tool to stimulate the infrastructural changes for the government and to encourage foreign investment in the country. Not only the government, but companies, and landowners have all profited in different ways. Nevertheless, the power remained intertwined in the lines of the permission and licensing processes, or under other contractual formats in spite of this unbundled scenario.

In terms of the geostrategic RE transition discussed in this article to contribute to the thematic issue on Governance and Politics of Electricity System Transitions, Turkey's transcontinental position does not allow the country's energy sector to be completely decentralised. The energy reforms necessary to better accommodate electricity generation from RE sources enabled private consumers. The unbundling and privatization of the utility companies, as well as the liberalization of the electricity market helped facilitate Turkey's innovative electricity market. This made Turkey an international hub for interconnected transmission systems between Europe, Asia and Middle East. The economic power in the form of industrial capitalism has been used in connection with political power to promote and expand RE projects. Perhaps, Turkey's approach in expanding the RE use in the energy mix does not represent a spectacular or unfamiliar form of encouragement by introducing feed-in-tariffs. Nor, is the privatization of state companies uncommon. Nevertheless, this geostrategic manoeuvre of the institutional and political power in high collaboration with economic power and the intertwined, overlapping characteristics within the socio-spatial context have resulted in the above-mentioned project successes and continue being promising for the future.

In conclusion, as it is described by Mann (2012b):

> The IEMP Model is not a social system, but rather an analytical tool form of an analytical point of entry for dealing with messy real societies where these four power sources offer distinct organizational networks and means for humans to pursue their goals. (p. 16)

In this way, the organisation of the (de)centralised electricity transitions are dependent on the history, geography and the overlapping relations of these sources of social power. Nevertheless, the answer to the question of who is prepared to take responsibility within the given country will determine how the social power will take place for the (renewable) energy transitions.

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Conflict of Interests

The author declares no conflict of interests.

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Article

Cross-Scale Linkages of Centralized Electricity Generation: Geothermal Development and Investor–Community Relations in Kenya

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Abstract
Based on a study of Kenya's geothermal-energy development in Baringo-Silali, we explore how and with whom government actors and local communities in rural and peripheral areas interact when planning and implementing large-scale power plants. Starting from a comparison of decentralized and centralized energy systems, we demonstrate that the development of this large-scale infrastructure project and the associated investor-community relations are governed by various cross-scale linkages. To this end, we adapt the concept of cross-scale linkages from the literature on natural-resource governance to explore actors, rules, and practices at local, regional, national, and international levels.

Keywords
Baringo; centralized electricity generation; corporate social responsibility; cross-scale linkages; geothermal development; governance; infrastructure; investor–community relations; Kenya

Issue
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1. Introduction

Centralized electricity generation, with large-scale power plants feeding into national grids, is mainly associated with top-down planning, centralized control and negative, often unsustainable local impacts at the generation facilities' sites. In this contribution, we question this dominant narrative. We argue that cross-scale linkages in the implementation and governance of large-scale electricity generation and associated investor-community relations need to be taken into account in order to understand the local impacts of centralized energy systems. Based on preliminary results from an ongoing qualitative study of geothermal-energy development in Kenya's semi-arid north, we show that there are various cross-scale linkages at work that govern the relations between local, county, and national, as well as international actors, rules, and institutions. In our article, we will explore how different types of cross-scale linkages shape the implementation and governance of geothermal development and what potential for local development they (might) entail. The expansion of geothermal-energy provision in Kenya provides an interesting case to study such linkages in centralized electricity generation because it has become the most important source of grid-connected electricity in the country and has a great deal of potential. It is, therefore, one of the main pillars of Kenya's ambitious development strategy, Vision 2030, with far-reaching implications for economic and social development in the country's (semi-)arid and peripheral North where future geothermal development will take place.

Our approach is inspired by recent research on large infrastructure projects which demonstrates that such projects are the result of combining technology with diverse actors, rules, and practices (Harvey, Jensen, & Morita, 2017; Sovacool & Cooper, 2013). Such complex, multilayered, and heterogeneous structures do not follow clear plans and cannot be implemented and governed in a straight-forward and top-down manner. Rather, we follow Li (2005), who, in response to Scott's (1998) seminal work on high-modernist, state-planned schemes, has argued that "(r)ather than emerging fully formed from a single source, many improvement schemes are formed through an assemblage of objectives, knowledges, techniques, and practices of diverse provenance" (Li, 2005, p. 386). Infrastructure projects, such as geothermal power projects, thus can rather be understood as open-textured, large-scale social experiments (Wynne, 1988). This is not to say that power relations do not matter. Yet, to understand how power is exercised within such large-scale projects, we need to take into account the uncertainties and contingencies which can result from the multi-layered nature of their governance.

In the following, we first explore the specificities and governance implications of decentralized versus centralized electricity generation. After situating geothermal development in Kenya's electricity sector and introducing our study region and methodology, we present our empirical results. This will be followed by our conclusions.

2. Governance and Cross-Scale Linkages in Electricity Provision

Governance structures in the electricity sector can take various forms but are usually subject to national legislation and policies. This is due not only to the fact that electricity is regarded as critical infrastructure and a prerequisite for most other activities but also to the electricity sector's network character and its socio-technical nature. These latter characteristics require coordination between different levels and places as well as between technological and social elements to function smoothly (Hughes, 1983). Nonetheless, there is a great diversity of generation technologies, grid architectures, and resulting geographies. An important distinction is made between centralized and decentralized electricity systems and generation facilities. Apart from technical and geographical differences, they also differ in their ownership and financing, thus resulting in specific governance structures and cross-scale linkages (Table 1).

Table 1. Comparison of decentralized and centralized electricity systems from a technology, geography and governance perspective for rural global south contexts.

	Decentralized		Centralized
	Stand-alone	Mini-grid	(National) utility
Grid connection	Off-grid	Isolated (local) network	National grid
Generation facilities' size and geography	Small-scale local Production-site = consumption-site	Medium-scale local Production-sites close to consumption-sites	Large-scale centralized Production-sites far away from consumption-sites
Power-availability challenges	Low electricity volumes		Frequent outages
Local technology challenges	Repair and maintenance		Maintenance, protection against power theft and sabotage
Ownership	Private household or firm, often local	National or other government and/or private firm	National providers (plus independent power producers [IPPs])
Financing	Owners, often with international donor/ Development Finance Institution (DFI) and/or national-state support	Owners, often with international donor/ DFI and/or national-state support	The national state, local-connection charge often paid for by the consumer, sometimes international DFI support
Local governance dimension	Strong, with cross-scale linkages to national and international actors		Small, apart from (possibly) at power-generation sites

Source: Authors' own compilation based on various sources.

In much of the Global South, public electrical infrastructure has until recently mainly been provided in the form of large-scale generation facilities, mostly hydro- and coal-powered, feeding into national grids. Rural and peripheral regions, however, are often not connected to such centralized infrastructure, and electricity can only be provided in a decentralized way. This includes small-scale off-grid electricity infrastructure such as diesel generators and, more recently, solar home systems as well as mini-grids, which have emerged as another alternative in recent years (Alstone, Gershenson, & Kammen, 2015), often donor-driven and provided by non-state actors. Because of the close connection between power-generating facilities and consumers, as well as its flexibility and scalability, decentralized electricity provision is often regarded as advantageous from both a local-development perspective as well as in terms of sustainability (Boliko & Ialnazov, 2019; Bouffard & Kirschen, 2008; Kirubi, Jacobson, Kammen, & Mills, 2009). In contrast, centralized electricity generation is mainly associated with inflexibility, centralized control, and negative local impacts at the power-plant locations (Alanne & Saari, 2006; Boamah, 2020). These often include environmental damage, large-scale population resettlement and the general deterioration of local livelihoods. As connecting people to national grids in peripheral areas is expensive, large-scale power plants might not even provide electricity access to neighbouring, hitherto unserved local communities (Alstone et al., 2015). In sum, decentralized electricity systems are regarded as supporting local development, whereas centralized electricity-generation facilities are not, or are thought to do so to a much lesser degree.

While the governance of decentralized electricity systems has a strong local dimension, the governance of centralized electricity generation is overwhelmingly shaped by cross-scale interactions. Power plants are usually implemented and operated from a distance either directly by national power companies or by government-commissioned IPPs since the electricity has to be transported via national grids to where it is required. Decisions on the location of large-scale plants follow factors such as, in the case of renewable electricity generation, the availability of natural resources (water, wind, solar radiation, geothermal reservoirs). Such power plants are therefore often located far from economic and population centers and entail cross-scale linkages in the realms of planning, development, financing, ownership, and management. These linkages encompass national- and often also international-level investors and local-level communities, they are complex, and bring with them challenges which need careful consideration.

2.1. Cross-Scale Linkages and Multilevel Governance

With reference to Berkes (2002, p. 293), we define cross-scale linkages as interactions of different actors, institutions, and rules "both horizontally (across space) and vertically (across levels of organization)." Scale challenges and cross-scale linkages play an important role in the literature on human-environment relations and common-pool resources (Cash et al., 2006; Ostrom, 2005). These ideas help conceptualize cross-scale linkages in the investor-community relations of electricity-generation facilities. Generally, addressing scale issues is seen as important for sustainable resource management (Cash et al., 2006), where top-down approaches have proved to be "too blunt and insensitive to local const[r]aints and opportunities…[whereas] bottom-up approaches…are too insensitive to the contribution of local actions to larger problems." Instead, Cash et al. (2006) propose "a middle path that addresses the complexities of multiple scales" and distinguishes between three "responses to problems of scale and cross-scale interactions: institutional interplay, co-management, and bridging organizations," all of which play a role in our case study.

Institutional interplay means the vertical interplay of governments and administrations at different levels. In Kenya, this includes, for example, royalty-sharing from natural-resource exploitation and the distribution of government functions as a result of devolution. The creation and empowerment of legislative and executive actors at the county level have increased the options for institutional interplay and, more generally, added complexity to a political system which has been characterized by corruption, patronage, and inter-ethnic competition (Mwangi, 2008). Institutional interplay can range from highly asymmetric to relatively balanced relations. The latter comes close to what Cash et al. (2006) call co-management, i.e., "a continuum of arrangements that rely on various degrees of power- and responsibility-sharing between governments and local communities." We adapt this notion of co-management to denote cooperation between local communities and other actors, as for example in the management of water points associated with geothermal development.

The establishment of bridging organizations as the third response to scale challenges goes beyond intergovernmental or government-community activities. Bridging organizations are deliberately designed to act across (administrative) scales, thereby sidelining administrative hierarchies to some extent. They are similar to what Hooghe and Marks (2003) call Type II multilevel governance. Whereas Type I multilevel governance refers to general-purpose jurisdiction at a limited number of levels as part of a systemwide architecture—thus reflecting traditional government levels and interactions—Type II multilevel governance is characterized by task-specific jurisdiction with intersecting memberships. Its main advantage is that it can respond flexibly to newly emerging or changing stakeholder preferences. In our case study, the Geothermal Development Corporation (GDC) acts as such a bridging organization.

The three forms of multilevel governance organization revolve mainly around the interaction of administrative government levels within a country. However, the role of international actors and communities, as both active participants in and detractors of such governance, needs closer consideration. The concept of context shaping put forward by Hay (1997) helps better understand their roles in the multilevel governance of large-scale power generation projects. We will demonstrate later that local communities have—to some extent—the power to re-define what is possible for the investor and "alter the parameters of subsequent action" (Hay, 1997, p. 51).

3. Study Context and Methodology

Kenya, with its ambition to achieve universal electricity access by 2022, now pursues a national-government strategy to combine centralized and decentralized electricity provision. While, on the one hand, grid access is to be expanded along and through extending and densifying existing grids, the remaining areas, on the other hand, are supported through the development of off-grid and mini-grid systems (Ministry of Energy [MoE], 2018). The comprehensive electrification effort is part of the Vision 2030, which aspires to make Kenya a middle-income industrializing country by 2030 (Government of Kenya [GoK], 2007). It also aims to improve livelihoods in hitherto unserved rural and peripheral areas.

3.1. Overview of Kenya's Power Sector and the Role of Geothermal Electricity

The recent development in the Kenyan power sector is characterized by an impressive growth of grid-connected electricity generation and a transition from hydropower and fossil-fuel to geothermal electricity (Table 2). Geothermal resources have been used for electricity generation in Kenya since 1981 when the first geothermal power station started operation south of Lake Naivasha. Today, there are four geothermal power stations in operation (Olkaria I–IV), all located in Hells Gate National Park, which was created in 1984 (Hughes & Rogei, 2020). Two more are under construction (Olkaria V) or planned (Olkaria VI). The development of Olkaria steamfields has become infamous for the involuntary resettlement and eviction of local Maasai and other communities. Attempts at mediation have been unsatisfying so far and local activists are in contact with the World Bank, the major international funder, regarding their grievances (Hughes & Rogei, 2020; Koissaba, 2018; Schade, 2017; but also see Mariita, 2002).

The further tapping of its rich geothermal resources is Kenya's most important strategy for increasing centralized electricity generation. In 2008, the Kenyan government incorporated the GDC, a parastatal under the auspices of the MoE, to fast-track the exploitation of geothermal energy with the ambitious aim of achieving a geothermal capacity of 5,000 MW by the year 2030 (Eberhard, Gratwick, Morella, & Antmann, 2016). The GDC was established due to the high upfront costs and risks involved in geothermal development, which makes it unattractive to private investors (Klagge & Nweke-Eze, 2020). These include the costs for establishing the necessary ancillary infrastructure, such as roads and water provision, and the risk of not reaching the anticipated steam capacity. The GDC covers these risks and costs, supported by loans and grants from foreign donors and development partners, with the aim of selling the steam generated either to the national power-generation company KenGen or to private IPPs.

The GDC has taken responsibility for the development of geothermal energy production from Lake Naivasha northward along the Rift Valley, starting in 2011 with Menengai, a caldera bordering the northern side of the city of Nakuru (Figure 1). It has an estimated total potential of 1,600 MW, of which 170 MW are realized (GDC, n.d.a). Currently, the so-called Baringo-Silali Block with an estimated total potential of 3,000 MW is being developed. The first three phases will develop 100 MW each with funding from the GoK and the German Development Bank (KfW; GDC, n.d.b). Detailed surface studies were concluded in 2013 at three exploration sites—Korosi, Paka, and Silali. In December 2018, drilling started after a first rig was transported from Menengai to Baringo-Silali, and in September 2019 steam was hit in Paka (GDC, 2019).

3.2. Study Region and Methodology

Baringo is part of Kenya's Central Rift Valley. It is a semi-arid acacia-bush savanna with high inter-annual varia-

Table 2. Grid-connected electricity generation by sources in Kenya in 1995, 2005, and 2015.

	1995		2005		2015	
Energy sources	GWh		GWh		GWh	
Oil	416	10.2%	1645	28.3%	1206	12.4%
Biofuels	122	3.0%	131	2.3%	122	1.3%
Hydro	3163	77.3%	3026	52.0%	3787	39.1%
Geothermal	390	9.5%	1003	17.2%	4479	46.2%
Solar PV			13	0.2%	37	0.4%
Wind					57	0.6%
Total	4091	100%	5818	100%	9688	100%

Source: International Energy Agency (2020).

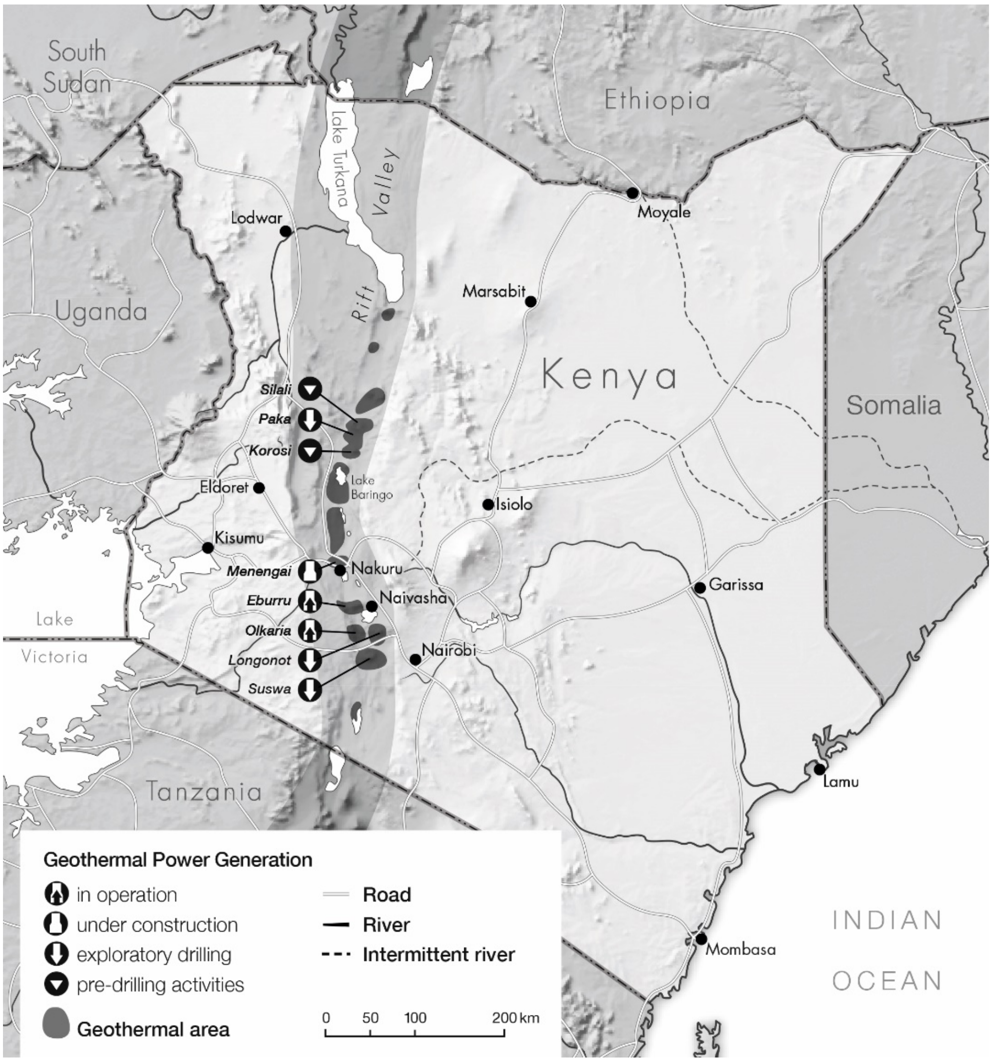

Figure 1. Map of geothermal areas and power generation in Kenya. Source: Authors' illustration based on interview information and Mangi (2017, p. 4).

tions in rainfall and recurrent droughts. Lake Baringo, one of two freshwater lakes in the Rift Valley, is the only perennial water source. The largest part of the Baringo-Silali complex falls into Baringo County, which is inhabited almost exclusively by Nilotic-speaking Pokot. The Pokot in Baringo have practiced semi-nomadic pastoralism for much of the past 200 years and constituted a close-knit, egalitarian, and rather inward-looking community (Anderson & Bollig, 2016; Bollig, 2016). Since about the 2000s, however, an increasing number of households have started to diversify their livelihoods, settling down more permanently and starting rain-fed cultivation. This has caused conflict regarding ownership and usage of the land, which had been almost exclusively used as communal rangelands before, as well as increasing fragmentation of the Pokot into territorially-based communities (Greiner, 2017). The area is remote and has been marginalized in the past with high illiteracy rates (Baringo County Government, 2014), a poor road network, and strong population growth rates. Frequent outbreaks of violence and cattle raids between the Pokot and their neighbours have worsened the situation (Greiner, 2013).

Our findings on geothermal development in Baringo are based on ongoing ethnographic fieldwork in the area (Bollig, Greiner, & Österle, 2014; Greiner, 2020), which includes a multitude of informal interviews with community members and representatives conducted between 2009 and 2020. These are complemented by expert interviews, the analysis of relevant investment and policy documents, and site visits to the Baringo-Silali, Menengai, and Olkaria geothermal fields (2017–2020). We conducted interviews with key experts involved in the development of geothermal energy in Kenya, working at different government levels (MoE, National Treasury, County Commission, County Government), in energy-related and other state agencies (Energy Regulatory Commission [ERC], GDC, KenGen, National Land Commission [NLC]), and in DFIs (African Development Bank, KfW). As many of the interviews were granted on the condition of anonymity, we do not provide further details of the interviewees.

4. Results

In the following paragraphs, we will focus on the actors, rules, and practices in the context of the implementation of infrastructure for geothermal development. Starting with the parastatal GDC and other important actors, we then highlight the most important formal rules and regulations that govern the local and community aspects of infrastructure implementation. Following this, we illustrate some of the practices and institutions that have emerged in the negotiations of the investor (GDC), local communities, and other stakeholders with a focus on corporate social responsibility (CSR) measures, community responses, and local practices.

4.1. The GDC as a Bridging Organization, Its Partners, and Stakeholders

The most important actor in geothermal development in Baringo-Silali is the GDC, headquartered in Nairobi. Incorporated by the GoK in 2008, the GDC performs the function of a bridging organization. Its tasks include exploration and drilling in promising geothermal sites, development and management of steamfields, associated legal processes, and community engagement. The GDC has become a specialist in these activities—even acting as an advisor in neighbouring countries—and involves various partners and stakeholders (Table 3). Partners and stakeholders include public-government actors at the national level, such as ministries and agencies. Private national- or even international-level actors include consultants, contractors and, at a later stage, power-plant developers and operators.

Most important for cross-scale linkages are international as well as local- and county-level actors and stakeholders. International actors include financing institutions, in Baringo the KfW and the GRMF of the African Union Commission (Klagge & Nweke-Eze, 2020). While the financing contract is negotiated and administered by the MoE and the Treasury on behalf of the GDC, KfW is also involved in the project itself and has its own guidelines on environmental, social, and climate standards (KfW Development Bank, 2019), which follow World Bank and International Finance Corporation (IFC; IFC as part of the World Bank Group) standards and which the GDC must meet to continue to receive funding.

Interestingly, there are, to our knowledge as of March 2020, no international, national, or local NGOs or CSOs (Civil Society Organizations) active in Baringo. This stands in contrast to other large renewable-energy projects in the wider region, such as the Bujagali Hydropower project in Uganda (Linaweaver, 2003), Lake Turkana Wind Park in northern Kenya (Enns, 2016), and the geothermal development in Naivasha in southern Kenya (Hughes & Rogei, 2020). The reason for this is related to the low level of international investment until now (Klagge & Nweke-Eze, 2020), the history of the Pokot people, and the marginalization of the region (see Section 3.2). The representation and inclusion of local and community interests in the Baringo geothermal development, therefore, hinges on formal and informal engagement activities by the GDC and government actors as well as on community responses and local practices beyond these activities.

At the regional and local level, the county government and the communities have to grant land-access rights and participate in the ESIA. The local population is involved in community engagement as part of ESIA and the development and implementation of related CSR measures. They also provide labour, mostly unskilled and casual, to GDC and its contractors. This happened primarily in the early implementation stage through locally-based SACCOs as important intermediaries between the

Table 3. GDC tasks, important partners, and stakeholders.

Tasks	Important partners and stakeholders
Sensitization of local communities and management of community relations	Local populations, community representatives (especially elders), Savings and Credit Cooperatives (SACCOs)
Obtain land-access rights	County governments, local communities, and (other) landowners, NLC
Environmental and Social Impact Assessment (ESIA)	National Environment Management Authority (NEMA), local communities, county governments, DFIs, consultancies
Other regulatory issues	Energy and Petroleum Regulatory Authority (EPRA, successor of ERC), MoE, other ministries plus various others
Financing	MoE, Ministry of Finance/National Treasury, external funders (in Baringo-Silali: KfW, Geothermal Risk Mitigation Facility [GRMF])
Exploration and drilling	Consultants (geology, engineering), contractors (construction, catering, guarding), SACCOs, and local labour
Management of steamfields	Power-plant developers and operators (KenGen, IPPs)

Source: Authors' own compilation.

GDC and contractors on the one hand and the local population on the other hand. Furthermore, once electricity is generated, the county and the communities will receive a share of the royalties according to the new Energy Act (from 2019), which stipulates that 75% remain with the national government, while 20% and 5% go to the county and the community respectively, the latter to "be payable through a trust fund managed by a board of trustees established by the local community" (Republic of Kenya, 2019, p. 69). So far, the communities are represented by their informally constituted elders, who frequently meet in the council of elders. These community representatives act as a major contact point for the GDC and the county government and, in turn, communicate community grievances to the GDC.

The importance of interaction with local- and county-level actors is highlighted by the fact that the GDC has community-relations officers and a regional administrator for Baringo-Silali. Furthermore, the GDC's departments for Environment Management and Community Engagement are located in Nakuru, close to both Menengai and Baringo-Silali (Figure 1). The rationale behind this is that the GDC staff members in these departments are able to reach the project sites more easily. In contrast, corporate planning, financing, and dealing with national and international partners are done from the headquarters in Nairobi. The relationships between the GDC and its partners and stakeholders are mainly governed by national legislation or regulations.

4.2. Formal Rules and Regulations Governing GDC's Activities in Baringo

The geothermal development process in Baringo is subject to a variety of laws and other types of regulation, which govern important aspects of investor-community relations such as land access, environmental issues, and community engagement. Negotiation over these issues takes place between different actors, representing an interplay among different levels of formal administrations and agencies as well as between formal and traditional authorities.

4.2.1. Access to Land

Land acquisitions for geothermal operations are complex. To access the resource, pastureland had to be provided for establishing local infrastructure including well pads, water systems, storage facilities and workers' camps. Ownership- and use-rights had to be negotiated with the traditional authorities and in some cases private owners. The construction of the local road network was started 2014 by a local contractor, followed by the levelling of terrain for the well pads, i.e., the actual drilling sites. During all these construction processes, the GDC and contractors were involved in negotiations with community representatives. If, for example, livestock trails were affected by road construction, or the levelling of a well pad required cutting down ritual trees, a negotiation between the parties was facilitated by the GDC community-relations officers to explore changes in route or possible compensation.

Land acquisition happened in a phase of profound legal transformation. The Community Land Act only became effective in 2016. With this act, former community trust land was replaced by community land, which is adjudicated to the respective community. The Community Land Act protects the community land rights, defines the role of counties in land matters, and provides rules for compensation in cases of compulsory acquisition by the state. The process of land adjudication, however, whereby local communities have to be registered as rightful owners of the land, had not yet occurred in Paka, Silali, or Korosi when the GDC started their operations. In this opaque situation, the GDC proceeded to negotiate only where necessary on an informal basis with community representatives and postponed such negotiations where possible.

4.2.2. ESIA and Community Engagement

An ESIA, officially referred to as an Environmental Impact Assessment (EIA), is:

> [A] critical examination of the effects of a project on the environment. An EIA identifies both negative and positive impacts of any development activity or project, how it affects people, their property and the environment. EIA also identifies measures to mitigate the negative impacts, while maximizing on the positive ones. (NEMA, 2020)

The Environmental Management and Co-Ordination Act (from 1999, amended in 2015) regulates that geothermal-energy projects have to undergo EIAs and that there are additional Environmental (Impact Assessment and Audit) Regulations on its scope and procedure, with NEMA as the supervising government agency. Viewed in the light of multilevel governance, ESIA represents an institution imposed on project developers in a top-down manner, thereby constituting cross-scale linkages and requiring institutional interplay of actors at different levels (Table 3). In Baringo-Silali, this includes KfW as a major international funder with its own guidelines, and we were told that the ESIA for Baringo-Silali had to be updated in 2016–2017 due to request by KfW. As the ESIA for Baringo-Silali has not been made available so far, the following information on community-related activities is drawn from other sources, mainly our interview material.

The first ESIA report was submitted to NEMA in 2012 and approved in 2013, which marked the official start of the project. It was followed by the acquisition of land, the construction of roads and other facilities as well as the establishment of a community-engagement framework, which includes, according to GDC representatives, 12 community public meetings per year as open forums where usually around 50–150 people participate. The GDC representatives both in Nakuru and Nairobi regard community engagement as an important and critical part of GDC activities. They say it is important to involve local people from the early stage and step-by-step so that everybody is carried along. This is reiterated by an MoE interview partner who stresses that it is the GDC's responsibility to make sure that they have the buy-in of the communities, which he sees as a critical success factor: To achieve "community buy-in," the GDC has to integrate with the communities in the project operations, ranging from providing local jobs to investing in social infrastructure. Here lies the rationale for various CSR measures implemented by the GDC. It remains unclear, however, to what extent CSR measures are (also) required by NEMA as part of the ESIA process or by KfW as a major international funder.

4.3. Water Points and Other CSR Measures

From 2016 onward, the GDC started with the construction of the water infrastructure to supply water for drilling, including water basins for contaminated water. The water is pumped at high pressure from Lake Baringo into four basins on the volcano tops. From there it is released by gravity to the drilling sites. Additionally, the GDC (2019) has started building a "robust community water supply program with 20 watering points for domestic and livestock use," which includes treatment plants to filter water for human consumption.

The 20 community water points (CWPs) are planned as freely accessible infrastructure, which—according to the NLC county coordinator for Baringo—are one form of CSR by the GDC. This view, however, is not shared by representatives of the local communities, who understand the CWPs as part and parcel of the initial agreement with the GDC. According to GDC representatives, it was community representatives who initially demanded access to water. This request was then taken up by GDC headquarters, where water provision was identified not only as major leverage to buy-in the community but also as a key development factor. This apparently convinced KfW to approve the water-supply program to safeguard the project in the future.

The actual sites of the CWPs were determined by the communities. To manage the CWPs, the GDC has encouraged them to form a committee for each water point. These committees are meant to regulate water access and to prevent sabotage through unplanned usage, which came to be a major problem in some areas. Since repair of leakage and damage caused by illegal tapping is carried out by the GDC or a contractor, these water point committees can be classified as institutions of co-management.

CSR-related institutions and regulations were also introduced to facilitate the recruitment and payment of the temporary workforce of the communities by the GDC and contractors. To this end, the communities were encouraged to form SACCOs to ensure fair distribution of jobs and decide on the usage of an overhead paid to the communities. Another labour-related CSR measure, not as yet realized, is an agreement between the GDC and Baringo County government for the vocational training of 400 youth for equipment maintenance, thereby facilitating a form of human capital investment. Further CSR measures mentioned in the interviews were the donation of two "medical outreach vehicles," classroom renovations, a sponsorship program for students, the establishment of Early Childhood Development Centers, food donations to local schools, and water-trucking during extremely dry seasons.

Overall, there is no public or clear information on CSR measures in Baringo-Silali or on their implementation status. Meanwhile, the local communities have developed their own ways to deal with the challenges and opportunities provided by the GDC.

4.4. Community Responses and Local Practices

As with much of Northern Kenya, Baringo is a difficult area for investors, not only due to the lack of basic infrastructure but also for security reasons (Lind, 2017). For decades, the area has been conflict-ridden, with automatic weapons being widely available (Mkutu, 2007). Disguised as traditional cattle raids, assaults on neighbouring communities are increasingly used to achieve political goals, and more recently the police and army have also become involved and suffered losses (Greiner, 2013). Since the Kenyan state never managed to establish its monopoly on violence in the area, the GDC—like other investors—is vulnerable and has to negotiate their presence with care (Greiner, 2020).

To express their grievances to the GDC, local communities have resorted to roadblocks. Often symbolic in nature, these consist of a few stones or branches, but in the context of the general insecurity, they have proved an effective means to enter into negotiation over the nonpayment of salaries by contractors or the lack of water in CWPs. As roadblocks can become a serious problem for work schedules and sometimes also for the workers' safety, the GDC is usually keen on dealing with these issues quickly, though solutions are often short-term or postponed nonetheless (especially regarding payments from contractors). There are also cases in which GDC vehicles simply take alternative routes to the project sites to avoid such roadblocks. Roadblocks can be initiated by individuals (mostly regarding non-payment), but also together with elders (especially regarding lack of water at schools) or youths (regarding lack of employment). There are also other cases of 'ad-hoc negotiation' during construction, e.g., welders were forced to weld holes in pipes so that a leak could occur through which locals could get water (information provided in this and the following paragraph was gathered and cross-checked in several community and expert interviews, 2018–2020).

While the GDC and the water point committees try to sensitize communities about the intended use of water, unauthorized usage and consumption of unfiltered water are a major problem. Leakages and breakages of pipelines are common and people tend to use the closest water source available, sometimes waiting hours to have water pumped at frequent leakage points. Vandalism, e.g., tampering with pressure-relief valves or cutting the five-inch community pipelines, frequently happens along remote pipelines. Since maintenance by contractors or GDC staff can be slow, people also try to fix community pipelines with ropes or stones, although such makeshift fixes usually cannot handle the pressure for long and have even been destroyed by baboons looking for water (interviews and observation in February 2020). Apart from human and animal consumption, leakage and overflows of livestock water points are also used for farming activities.

Despite the implementation of CWPs, the local population still perceives water as a significant issue and complains, for example, that livestock water points are insufficient for the number of livestock in the area. Apart from more water points, the communities also demand greater employment opportunities and other benefits. Whether the recent striking of steam in Paka will lead to more CSR measures is an open question right now. Notwithstanding, and partly due to the threat of armed violence and resistance, community responses figure highly in the GDC's strategy. This provides a good example of how local communities can—to some extent—"alter the parameters of subsequent action" (Hay, 1997, p. 51) and influence the investor and its strategies. As has been shown, KfW as the international funder is also a player in this context, and is trying to protect its reputation by ensuring adequate consideration of and adherence to environmental and social standards. This demonstrates the importance of cross-scale linkages in geothermal development and the associated investor-community relations.

5. Summary and Conclusion

Geothermal development for centralized electricity generation is still in the exploration and drilling stage in Baringo-Silali. Even in this early stage, its implementation and governance are much more complex than top-down, with various cross-scale linkages ranging from the local community shaping context conditions for GDC activities on the ground to the international funder KfW with its impact on ESIA and CSR measures. The resulting types of multilevel governance in geothermal development in Kenya include institutional interplay, co-management, and the GDC as bridging organization. Our case study also shows that centralized electricity generation can, as with de-centralized electricity systems, have strong local impacts, with local communities playing an active part.

The legal situation in Kenya with its progressive new constitution and environmental legislation, the new Community Land Act and royalty-sharing rules, as well as recent devolution, play an important role in enabling and enforcing cross-scale linkages and multilevel governance. As of now, the county level seems to be less important in geothermal development in Baringo-Silali. This, however, might change with the ongoing implementation of devolution and the progress of geothermal development. While there is evidence that devolution did not dismantle, but rather restructured patronage and rent-seeking in Kenya (D'Arcy & Cornell, 2016), it would be premature to draw conclusions about the county's role regarding geothermal energy infrastructure. This also due to the fact that the regulating Energy Act has only recently been issued (in 2019) and the project is still in its infancy. Most significant, however, is the fact that no royalties have yet been distributed, which could lead to irregularities and conflicting claims. As soon as centralized electricity generation is established in Baringo-Silali, the county receives 20% of the royalties, which could, for example, be used to provide connections to the national grid. Starting electricity generation will also involve new actors such as IPPs and climate finance organizations, thereby making governance structures more complex and international and strengthening cross-scale linkages through further requirements regarding sustainability and community benefits.

Regarding sustainability and local impacts, how—and whether—geothermal development in Baringo-Silali will benefit the local population will depend to a certain extent on the GDC and its management of investor-community relations. So far, it is hard to say whether community engagement and impact assessments are "more about improving legitimacy rather than benefitting local communities" (Sovacool & Cooper, 2013, p. 241). The community in Baringo, however, is not a passive recipient of benefits; rather it actively engages in negotiations as well as in acts of resistance and sabotage if important demands are not met or GDC activities are regarded as unfair. Community action and responses, therefore, have the potential to disrupt project advancement, not only in technical terms, e.g., through roadblocks, but also through legal and political action along cross-scale linkages, as has already happened in Olkaria. Up to now, we could not observe interventions by NGOs and CSOs in these matters. Therefore, the extent to which greater private, international, and civil-society participation would benefit the community remains an open question. This is one among many questions that certainly require further research into the future development of geothermal development in Baringo.

In conclusion, this case study has demonstrated that cross-scale linkages need to be considered to understand how power relations impact the implementation and governance of large-scale electricity generation and in associated investor-community relations. To analyze actor and governance constellations, we applied a concept of cross-scale linkages from research on socio-ecological systems. While the original concept mainly refers to the interactions between state actors and communities, we have adapted and used it for a wider group of actors, also including parastatals, companies, and international agencies. This has revealed the limits of this approach with its focus on institutional interplay, co-management, and bridging organizations, which can only partly reflect the complexities of large-scale energy projects with a multitude of state, community, private, and international actors, as well as their various competing interests and accountabilities.

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Conflict of Interests

The authors declare no conflict of interests.

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