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– A TERRITORIAL PERSPECTIVE ON URBAN AND REGIONAL ENERGY TRANSITIONS: Shifting Power Densities in the Berlin-Brandenburg Region

BENEDIKT WALKER

Abstract

The interdependent development of subnational territories and energy transitions deserves greater attention. Territories demarcate spheres of influence, order relations of energy supply and demand, and offer opportunities and restrictions for local energy autonomy. Nevertheless, territorial perspectives on urban and regional energy transitions are conceptually underdeveloped. Drawing from political geography, this article presents a conceptual framework for understanding how subnational territories shape energy transitions and vice versa. This territorial perspective offers critical insights for research into the (urban) materiality of renewables, energy landscapes and uneven development. First, many cities will rely on renewable energy supply from rural territories to become carbon neutral, due to the low power densities of renewables. Second, governance actors mobilize territorial practices to create and disrupt relations between different energy landscapes. Finally, territorial boundaries are resources in governance processes and structuring elements of uneven development. I use the framework to analyze a case study of a wind energy conflict in three municipalities next to Berlin, which illustrates how Berlin's government asserts its territorial priorities and creates renewable energy hinterlands in a process I conceptualize as hinterlandization.

Introduction

Urban energy transitions have enjoyed much scholarly attention in the past decade (see special issues edited by Rutherford and Coutard, 2014; Rutherford and Jaglin, 2015). In their seminal contribution to the field, Hodson and Marvin (2010) explored the question of how and to what extent urban governance networks can shape energy transitions according to their territorial priorities. Nevertheless, the literature on urban and regional energy transitions rarely makes explicit the analytical value of territory and territoriality (exceptions include Gailing *et al.*, 2020; Poupeau, 2020), even though researchers regularly refer to the concepts (e.g. Hodson and Marvin, 2010; Rutherford and Coutard, 2014; Bahers *et al.*, 2020) and use territorial methodologies (Castán Broto, 2019: 28).

In this article, I argue that subnational territories shape energy transitions in important ways and that energy transitions shape subnational territories in return. Without a theoretical framework, however, these interdependencies remain incomprehensible. As my case study shows, interdependencies between energy transitions and subnational territories are particularly salient in relation to the spatial materiality of renewable energy sources. More specifically, the use of local renewable energy sources presents an opportunity for cities that want to decrease their dependence on energy imports, lower their emissions and participate economically in renewable energy generation (Lee and Kim, 2016). Yet, the materiality of renewables

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also complicates urban energy transitions because cities cannot expand renewables within their territory indefinitely. As Naumann and Rudolph (2020: 97) have indicated, ‘rural regions accommodate the majority of renewable energy infrastructures ... In that sense, urban energy transitions are simply impossible without rural energy transitions’.

Indeed, many cities cannot generate enough renewable energy to meet their energy demand because their jurisdictional territories do not offer renewables enough space, even if renewables would allow those cities to drastically reduce their energy use (Barles, 2019; Ménard, 2019). The reason for this is that the surface power density (hereafter power density) of renewable energy generation does not match the power density of energy use in cities. Here, the power density of energy generation is defined as ‘the amount of territory needed to generate a given amount of power’ (Huber, 2015: 335); power as ‘energy flux per time’ (Smil, 2016: 21); and power density of urban energy use as the energy used over a certain time scale within an urban territory (see Smil, 2016: 191, 200, for some international comparisons).

This perspective does not differentiate between different power sources (such as solar panels or wind turbines) and forms of energy (such as electricity or heat) (Smil, 2016: 22). Although it does not inform us of the particular qualities of renewables or the surface areas they use, this perspective can tell us the total amount of energy a territory can generate with the power density that renewables offer, as well as how much energy a territory uses (Smil, 2016: 22–23). The more urban energy transitions progress, the more important this perspective becomes because initially cities can focus on ramping up local renewable energy generation, but eventually they will need to confront its limits.

Against this background, it is remarkable that the question of how subnational territories shape energy transitions and, in turn, are shaped by energy transitions has not yet received much scholarly attention. To answer this research question, I have developed a territorial account of urban and rural energy transitions by using work from political geography (Sack, 1986; Paasi, 2003). This perspective contributes to the literature by improving our understanding of the uneven consequences of renewable energy use for different subnational territories and their relation to each other.

Throughout the text, I use this territorial perspective to reflect critically on research into the (urban) materiality of energy, energy landscapes and uneven development. This perspective offers several critical insights. First, the framework provides the conceptual basis for considering the ‘urban materiality of energy’ (Rutherford and Coutard, 2014: 1362) in terms of power density. Despite its widespread use in energy geography (Smil, 2016; Huber and McCarthy, 2017; Balmaceda *et al.*, 2019), power density has so far been sidelined in urban energy transition research. Second, the territorial perspective helps to relate and distinguish urban and rural energy landscapes, which the existing literature generally does not do (Nadaï and Van der Horst, 2010a; Leibenath and Lintz, 2018; Castán Broto, 2019). Finally, the territorial perspective offers a productive means for conceptualizing the changing relationships between subnational territories in the course of their energy transition. In particular, I use Sohn’s ‘hinterlandization’ concept to reflect on the production of hinterlands from a territorial perspective (Sohn, 2014: 1705). This concept advances our understanding of how territoriality underpins uneven development between cities and rural areas (Zografos and Martínez-Alier, 2009; O’Sullivan *et al.*, 2020).

I developed the analytical framework in the context of a case study presented in this article. I chose the case for theoretical sampling reasons (Eisenhardt and Graebner, 2007) as it exemplifies territorial conflicts—in this case, around the siting of wind turbines in three municipalities next to Berlin. This conflict is of interest because Berlin’s government commissioned various studies to investigate potential pathways to a carbon-neutral urban energy system. These studies show that rural areas will need to supply at least 10% of the city’s total energy use so that Berlin can become climate neutral (Reusswig *et al.*, 2014a: 94; Hirschl *et al.*, 2011). Therefore, Berlin’s governance

actors are aware of the city's dependence on renewable energy supply from other territories.

At the same time, Berlin's geographical conditions seem ideal for an urban energy transition in terms of power densities because the sparsely populated federated state of Brandenburg surrounds the city. Brandenburg's government plans to use its territory to generate renewable energy for Berlin (MWAE, 2012). Indeed, both state governments imagine a win-win situation because the development of renewable energy sources should foster economic development, increase regional cooperation and establish the region as a front-runner in Germany's energy transition (MWAE, 2012: 30; Parliament of Berlin, 2018: 56–57).

Thus, the Berlin case exemplifies the challenges that the governance of urban energy supply presents and the uneven development that can result, even in a seemingly favorable geographical environment. Moreover, the case offers the opportunity to research the relations between a range of territories (city, rural municipalities, region) with different territorial qualities.

The case study followed a mixed-methods approach. I juxtaposed statistical data, political documents and websites with a range of expert interviews (Flick, 2017). First, a descriptive statistical analysis of data from the Federal Institute for Research on Buildings, Urban Affairs and Spatial Development (BBSR) offered insights into the urbanization process and socio-economic development of the region. Second, analyses of political documents (especially energy transition strategies) and websites informed my understanding of the regional political priorities. Third, I interviewed 16 experts from February 2019 to July 2020. The interviewees included political actors (municipal mayors, policymakers of Berlin), administrative staff of utilities and planning authorities, and employees of wind turbine operators. I analyzed both the expert interviews and the documents using a qualitative content analysis coding scheme (Kuckartz, 2014).

I begin with a review of how the shift in power densities from fossil fuels to renewables redefines different qualities of subnational territories. I use literature on urban and regional energy transitions as well as energy landscape studies to reflect on how territorial priorities and practices change in return. This territorial perspective serves as the theoretical framework for my case study and the findings I discuss. I then draw conclusions and offer an outlook on future research avenues.

Subnational territories in transition

As outlined in the introduction, this article uses the shift in power density from fossil fuels to renewables to conceptualize the material qualities of renewables in relation to subnational territories. Researchers understand this shift as a challenge for the production of space (Smil, 2016; Balmaceda *et al.*, 2019), and for urbanization processes in particular (Barles, 2019; Ménard, 2019), as access to 'space and territory' in rural areas becomes increasingly important in the energy transitions (Huber and McCarthy, 2017: 656). Besides the physical constraints of urban territories, the development of renewables on greenfield land in rural areas is often cheaper than their integration into urban built environments because planning and construction are easier and developers can realize greater economies of scale (Kammen and Sunter, 2016). Thus, the extensive spatial materiality of renewables creates its own spatial economics in urban and rural territories.

Although such research indicates that shifting power densities highlight certain material qualities of urban and rural territories, as well as reconfigure their relations, the cited literature does not address these qualities and changes in much detail. Therefore, I have turned to other branches of literature to identify subnational territories that energy transitions reproduce.

My understanding of subnational territoriality follows the distinguished theorist Robert Sack, who defines territoriality as a process of delimitation 'to affect behaviour by controlling access' (Sack, 1986: 19). Sack not only considers the territorial state but also

conceptualizes any delimitation as a territory that fulfills this definition. Accordingly, different boundaries delimit different territories, and the actors that govern these territories compete for power (Newman, 2003). Even individuals and households produce territories according to their means, which implies that territories are nested and constantly reproduced in relation to each other (Sack, 1986: 15–17).

The literature on urban and regional energy transitions highlights the importance of four types of subnational territories: the city or metropolitan area (see special issues edited by Rutherford and Coutard, 2014; Rutherford and Jaglin, 2015); the energy landscape (see special issues edited by Nadaï and Van der Horst, 2010a; 2010b); rural municipalities (Zografos and Martínez-Alier, 2009; Poupeau, 2020); and the region that encloses all of them (Gailing *et al.*, 2020; Bahers *et al.*, 2020; Poupeau, 2020).

Whereas authors from all four branches of literature argue that the territorial character of these entities shapes energy transitions (e.g. Woods, 2003; Rutherford and Coutard, 2014; Gailing *et al.*, 2020), only Poupeau (2020) and Gailing *et al.* (2020) explicitly explain the analytical purpose of territoriality. In the next section I offer theoretical reflections on the characteristics of the four types of territories in relation to energy transitions and, in the section thereafter, identify how the governance of these territories changes.

– Power densities redefine territorial qualities

As shifts in power density require the spatial extension of energy systems, so they redefine the ‘energetic qualities’ of subnational territories and the relations among them. Political geographers offer analytical distinctions of territorial qualities, which I use in relation to energy transitions. They distinguish ‘material elements such as land, functional elements like the control of space, and symbolic dimensions like social identity’ (Paasi, 2003: 109). More specifically, material elements refer to physical qualities of territories as well as economic activities, functional elements to political organizations and administrations, and symbolic dimensions to visual and cultural aspects (Paasi, 2003; Poupeau, 2020).

Materially and symbolically, major differences exist between urban/metropolitan and rural territories. Energy transition research often conceptualizes these differences in terms of landscape characteristics that result from energy generation and use (Castán Broto, 2017; Pasqualetti and Stremke, 2018). Traditionally, energy landscape studies draw from landscape theory (Wylie, 2007) to investigate how energy supply infrastructures come into being, are socially contested and reproduced, and shape landscapes visually, symbolically and materially over time (see the special issues edited by Nadaï and Van der Horst, 2010a; 2010b; Leibenath and Lintz, 2018).

Albeit often implicitly, studies of renewable energy landscapes usually focus on rural territories, which provide the ample land resources that large-scale renewables require (Woods, 2003). These material conditions also have symbolic and cultural implications, as territorial identities of ‘rurality’ are often bound to landscapes of unbuilt environments (Woods, 2003: 272). Hence, the material transformation that large-scale renewables imply for such landscapes brings about symbolic consequences (Woods, 2003) and can result in conflicts around landscape valuations (Zografos and Martínez-Alier, 2009).

An important distinction in energy landscape studies was put forward by Castán Broto and co-authors. They focus on urban energy landscapes to analyze how different modes of energy use shape the built environment of cities (Castán Broto *et al.*, 2014; Castán Broto, 2017). The energy-use practices that form the built environment of cities mirror cultural life and governance structures (Castán Broto, 2019). Thus, while urban energy landscape studies focus on energy use, (rural) energy landscape studies focus on landscape transformations due to the development of energy supply infrastructures, particularly large-scale renewables.

Whereas energy landscape studies offer a rich understanding of the material and symbolic characteristics of urban and rural territories, they often do not address the functional relation between landscapes and subnational territories. For example, they do not clarify what constitutes the boundaries of landscapes, the role that these boundaries play in the development of the landscape, and whether the landscape coincides with or diverts from municipal or regional boundaries (Castán Broto, 2019: 28). Likewise, energy landscape studies often study landscapes in isolation. Therefore, they lack analytical tools to investigate the relationships between different landscapes—such as urban and rural energy landscapes—and their mutual development.

To address this research gap, I propose an understanding of landscapes as territorial polities (Olwig, 2002; Chezel and Labussière, 2018). Energy landscapes gain political importance if governance institutions or networks define and use their boundaries to distinguish them from other landscapes and develop territorial priorities concerning these landscapes. From this perspective, the functional characteristics of rural energy landscapes differ fundamentally from urban energy landscapes. Rural landscapes can achieve energy autonomy, while urban energy landscapes remain functionally dependent on rural landscapes.

Regarding their scale, urban energy landscapes can represent singular cities or metropolitan areas, which functionally integrate various urbanized territories (Castán Broto, 2019). Similarly, rural energy landscapes can either represent parts of municipal territories or integrate various rural and municipal territories (Stremke and Van den Dobbelsteen, 2013). The scale of administrative regions is even larger, as regional governance institutions and their territory (e.g. planning institutions) functionally integrate urban and rural municipal territories (Coutard and Rutherford, 2010). In this sense, regions functionally integrate urban and rural energy landscapes.

- Territorial priorities and practices in reaction to shifting power densities
As shifting power densities redefine territorial qualities, so do actors with an interest in these territories change their territorial priorities and practices. Different actors and actor coalitions at various scales articulate ‘territorial priorities’ regarding energy transitions (Hodson and Marvin, 2010: 482–83). Regarding urban territories, for example, urban growth and competitiveness are two priorities which actors strive to realize through urban energy transitions (Hodson and Marvin, 2010). Here, I outline territorial practices and interdependencies that reflect territorial priorities and shape subnational territories in transition, following the distinction between material, functional and symbolic elements.

In comparison to urban territories, regional territories offer two advantages for the governance of urban energy transitions. First, regional planning offers opportunities to integrate cities and their surrounding municipalities in energy-efficient ways. Second, regions offer space for large-scale renewables. In this sense, I view urban energy transitions as the pursuit to find the right-sized territory with the right material and symbolic conditions as the functional key to align urban energy use with the spatial requirements of rural energy generation (similarly, see Ménard, 2019).

Many cities want to reduce their energy use today, in order to decrease their dependence on energy imports from other territories (Coutard and Rutherford, 2010). To this end, they need to address their symbolic, material and functional integration into the region, particularly at the metropolitan scale. Cities and regional planning authorities often wield jurisdictional authority in building and transit policies (Clark, 2013). Therefore, densification policies to increase energy efficiency and ideally decrease energy use constitute important territorial strategies (Coutard and Rutherford, 2010; Keil and Macdonald, 2016). They are territorial because planning authorities delimit areas of growth from areas that should remain greenfield land. In particular, planning authorities mobilize ‘natural’ (Newman, 2003: 126) boundaries

to create symbolic divisions between ‘urban’ and ‘rural’ landscapes, such as built environments and greenbelts (Keil and Macdonald, 2016). Moreover, densification policies often intend to reconcile concerns around energy use with the urban growth imperative, as they produce preferred living environments for affluent households (Krueger and Savage, 2007). When affluent households move to the suburbs, competition among municipalities to attract them surges, which can ultimately result in social segregation (Miller and Mössner, 2020).

Regions also offer the right material conditions for large-scale renewables. To mobilize these material conditions for their energy supply, cities advocate their symbolic integration into the region. Appeals to such territorial cohesion can foster a sense of identity that utilities use to gain customers (Moss *et al.*, 2015). Cities can also unilaterally try to transform the region into a hinterland for renewable energy generation. This strategy can spark conflicts and power struggles between different governments (Bahers *et al.*, 2020), particularly if cities use it to externalize unwanted land use and environmental consequences (Zografos and Martínez-Alier, 2009).

A region that provides energy to a city does not necessarily need to be adjacent to that city. The analytical distinction between continuous and discontinuous hinterlands is helpful here (Van Cleef, 1941). Indeed, both types of hinterlands provide renewable energy for cities today. On the one hand, cities can be integrated into national and international electricity grids, and receive biofuels from foreign countries (Bahers *et al.*, 2020). However, the reliance on these supply networks does not promise to increase the control of cities over their energy supply or their economic participation. Therefore, cities seemingly prefer to mobilize continuous hinterlands—rural municipalities and the surrounding region—for renewable energy supply because they promise certain advantages (Bahers *et al.*, 2020). Huang and Castán Broto (2018: 39) conceptualize these advantages as ‘territorial proximities’, wherein they distinguish between geographical (spatial proximity), institutional (shared formal rules and informal cultural norms) and knowledge (shared knowledge base) proximities.

Political geography can improve our understanding of the creation of hinterlands. When cities use their jurisdictional boundaries strategically, the boundaries become a resource for the fulfillment of urban interests rather than an impediment. Sohn (2014) developed this idea, arguing that cities can use borders as a resource to foster growth because borders create benefits of position and/or difference. In this sense, borders constitute a resource ‘to delocalize certain activities to the other side ... while still being close enough to profit from them and, if necessary, manage them’ (*ibid.*: 1705). Sohn calls this process ‘hinterlandization’ and refers particularly to the ability of cities to dislocate ‘space-gobbling’ activities (*ibid.*). To apply the concept to my field of research, I adapt its definition. In my research context, hinterlandization means territorial practices by which actors delocalize space-consuming renewable energy sources to the other side of a border to support urban growth.

From a normative point of view, functional mechanisms should ensure that governance institutions integrate different territorial priorities within regions to counteract the uneven development that results from hinterlandization. Whether regional governance actors, such as spatial planning institutions, genuinely manage to integrate the interests of cities and rural municipalities remains questionable, however (Miller and Mössner, 2020). Under contemporary conditions of intra- and inter-regional competition, both cities and municipalities might rather strive to advance their own priorities (Coutard and Rutherford, 2010; Miller and Mössner, 2020).

Consider the material-economic elements of large-scale renewable energy generation on greenfield land. In this context, the siting process of renewables constitutes a territorial practice itself, as planning authorities delimit land areas for energy generation. The sites of renewable energy sources reflect territoriality in different ways. Landowners usually enjoy the functional right to determine the use

of their land and appropriate land rents. Nevertheless, private land is embedded in municipal territories and other levels of government that tax landowners depending on their ability to raise and adjust taxes (Bulkeley, 2010).

Besides land rents and taxes, the value chain of renewables consists of many other parts.¹ The spatial division of labor that these value chains imply is one particularly important factor in the production of territories and their uneven power relations (Paasi, 2003: 112). In the past, large parts of energy use and generation took place in cities or metropolitan areas more broadly, so the fossil energy system reproduced uneven geographical development (Fridgen *et al.*, 2020; O'Sullivan *et al.*, 2020). In the renewable energy system, the location of industries that take part in the value added by renewables will influence which governments can tax them and where they will create jobs and invest (Heinbach *et al.*, 2014). Because important parts of the value chain—such as R&D, finance, the operators of electricity grids, and large energy providers—are located in cities, some authors conclude that energy transitions will reproduce uneven development between urban and rural territories (Johnson and Hall, 2014; O'Sullivan *et al.*, 2020).

The wealth of literature on conflicts around the installation of renewables in rural areas seems to confirm this hypothesis (see various contributions to the special issues by Nadaï and Van der Horst, 2010a; 2010b). However, rural actors can resist these developments or use them to their advantage. One particularly salient strategy of rural actors is the delimitation of landscapes and the promotion of certain valuations of the landscape that are incompatible with the development of renewable energy sources (Zografos and Martínez-Alier, 2009). To achieve this, rural actors need to resist the symbolic integration into a city region. This strategy is particularly successful in mobilizing local support because the symbolic delimitation reproduces cultural differentiation between, for example, urban and rural landscapes (Woods, 2003: 280).

At the same time, other authors highlight the opportunities for rural territories to profit from renewable energy transitions (for a critical discussion, see Naumann and Rudolph, 2020). These authors argue that actors in rural areas can reterritorialize the value added by the energy system according to the decentralized geography of renewable energy sources. For example, researchers have identified a trend to remunicipalize energy utilities and grid operators in some rural areas (Moss *et al.*, 2015). Ideally, value added would remain locally, if local landowners, financiers, developers, and operators of grids and renewables would all pay taxes to the local state, which could support local territorial coherence and growth in exchange (Heinbach *et al.*, 2014). Indeed, local clusters of renewable energy companies have emerged in some rural areas (Beermann and Tews, 2017), and the creation of renewable energy municipalities or regions reflects these rescaling and reterritorialization processes (Mattes *et al.*, 2015).

In short, the territorial approach to urban and regional energy transitions calls into question implicit territorial methodologies and demands their explicit consideration. It provides analytical tools to differentiate between territories in vertical (multi-scalar territoriality) and horizontal (different territorial qualities) ways. I include here material, functional and symbolic territorial qualities. Moreover, the territorial approach highlights the function of borders as a political means of territorial distinction and control. Finally, this approach helps to theorize territorial (power) relations—for example, as hinterlandization unfolds or territories strive for independence.

Case study

Having outlined my theoretical framework, I now turn to my empirical case. I begin with an introduction to the energy transition policies of the national government and the spatial planning of the two states Berlin and Brandenburg. This provides insights

1 The distribution of the value added in different parts of the value chain varies from technology to technology, and country to country (Heinbach *et al.*, 2014).

into how the national policies reproduce uneven development between urban and rural territories because they do not take the power density of renewables into account. I also describe changing territorial relations and conflicting priorities inside the region as it becomes a territory for the spatial planning of renewables. I then highlight the territorial boundary between the landscapes of the metropolitan area and the rural region around it. Against this background, I explore the conflict between the city of Berlin, three municipalities and regional actors in more detail.

– Territorial priorities of the federal state and the federated states

The national government's energy transition strategy rests on two pillars: increasing energy efficiency and renewable energy generation (Kuzemko *et al.*, 2017). The second pillar is supported by Germany's Renewable Energy Sources Act (EEG), whose feed-in-tariff legislation provides the economic incentives to make renewable energy generation profitable (Klagge *et al.*, 2016).

The relative importance of the two pillars reproduces uneven development between urban and rural areas because it does not incentivize greater coherence between energy use and generation at the local scale. The energy efficiency policies receive much less political attention and economic support than the EEG (Kuzemko *et al.*, 2017). Because cities concentrate energy use and renewable energy generation takes place mostly in rural areas, the uneven economic incentives target urban and rural spaces unequally, as local governments are aware (interview 4, mayor). Hence, a latent conflict exists between the local state in rural areas and the national state.

Furthermore, the EEG increasingly supports large corporations. The national government introduced tenders for renewable energy projects in 2014 to increase competition between operators and thereby achieve greater economic efficiency at the national level. In addition, larger projects should provide further efficiency gains due to their economies of scale. As a result, small-scale operators from rural areas, particularly energy cooperatives, often cannot compete for projects, whereas institutional investors—which are usually located in cities—have increased their share of ownership (Klagge *et al.*, 2016).

Whereas the territorial priorities at the national level provide the economic context for Germany's energy transition, the federated states, planning regions and municipalities develop their own priorities in terms of spatial planning (Klagge, 2013). In this regard, the Berlin-Brandenburg region constitutes a special case in two ways. First, Berlin is a federated state, so its government wields the same jurisdictional power as the federated state that surrounds it—Brandenburg. Second, the only joint planning authority that exists in Germany develops one spatial plan for the two states to integrate their territorial priorities (Kühn and Gailing, 2008).

The planning authority channels the growing built environment around Berlin along radial public transport lines to incentivize the use of energy-efficient public transport (*ibid.*). The result of this urbanization process is Berlin's so-called settlement star. The concept reflects the radial extension of the built environment that connects the city of Berlin with a range of smaller towns in Brandenburg.

Between the radial settlement axes, the joint state planning authority has developed several parks as a greenbelt around the city (*ibid.*). These parks are a planning tool to restrict urban sprawl and provide a symbolic 'urban edge' to distinguish 'rural areas' from the 'city' (Röhring *et al.*, 2014: 30). Hence, they consist mostly of forests, fields and historic villages (State Planning Authority Berlin Brandenburg, 2019: 93).

This 'natural border' demarcates Berlin and its surrounding municipalities from the wider region. Outside this metropolitan energy landscape, with its high power density of energy use, the state of Brandenburg wants to exploit its competitive advantage for renewable energy generation offered by its flat terrain with high wind speeds, low population density and greenfield land. Specifically, Brandenburg's

government intends to dedicate 2% of the state's territory to wind energy generation (MWAE, 2012: 6). The intention is to use Berlin's energy demand to foster economic development in the region around it (MWAE, 2012: 28).

Because Berlin will depend on renewable energy imports from other territories in the future, its government supports Brandenburg's aspirations. Berlin's government even hopes to participate in the economic development, as it owns land outside the city which it wants to use for wind energy generation (Reusswig *et al.*, 2014b: 238). Hence, various territorial proximities provide incentives for Berlin to rely on renewable energy imports from the continuous hinterland, such as institutional proximities (shared knowledge and energy transition goals, joint state planning authority) as well as geographical proximities (which provide the material basis for Berlin's land ownership).

To integrate the territorial priorities of Brandenburg's municipalities into planning processes at the state level, five planning authorities operate at a level between the state planning authority and the municipalities and districts. Each of these planning authorities integrates municipalities from one or two peripheral districts of Brandenburg with one district next to Berlin. This integration seeks to counter uneven development which arises from the urbanization of municipalities around Berlin (Overwien and Groenewald, 2015). The regional assemblies—the decision-making bodies of the five planning authorities—consist of municipal and district delegates (interview 5, joint state planning authority). To reach decisions in the interest of the whole region, the assemblies take majority votes, and its decisions apply to the whole region (interviews 5, 9, regional and state planning authority).

The state government requires that each of the five planning authorities dedicates 2% of its territory for wind energy generation (interview 9, state planning authority). The regional assemblies are free to decide which parts of their territory they want to delimit for wind turbines. In these so-called suitability areas, the installation of wind turbines takes priority over other forms of development (Overwien and Groenewald, 2015). Thus, the regional assemblies bear considerable power because they can ultimately impose their will on both landowners and municipalities.

Problematically, the complementary energy strategies of the two federated states express territorial priorities that differ from those of three municipalities of Brandenburg: Ahrensfeld, Bernau and Wandlitz. These municipalities, adjacent to Berlin, objected to the decision to locate turbines in their territory (see Table 1). The following analysis shows that conflicting territorial priorities exist around functional-institutional, material-economic and symbolic-cultural aspects.

– Conflicting functional priorities of the municipalities

The case study demonstrates how the functional relations between the territories resist and reproduce uneven development between the energy landscapes of the metropolitan area and the rural region as the spatial planning authorities try to make space for wind turbines.

The power of the five planning authorities to articulate their own territorial interests and realize them in delimiting suitability areas is the first point of contention. In late 2016, the regional assembly of the planning authority to which the three protesting

TABLE 1 Characteristics of the three municipalities

	Ahrensfelde	Bernau	Wandlitz
Population	13,000	40,000	23,000
Population density (inhabitants/km ²)	222	350	142
Settlement structure	Five villages	One town & eight villages	Nine villages

municipalities (Ahrensfelde, Bernau and Wandlitz) belong decided to locate suitability areas in two regional parks on the territory of these municipalities (Regional Planning Authority Uckermark-Barnim, 2019). The municipalities' landscape is split in two halves by the urban edge, which runs through the territory of all three municipalities and divides areas dedicated to urban growth from the regional parks.

The regional assembly made the decision to locate wind turbines in the three municipalities against their declared interest. Because the three municipalities next to Berlin constitute only a minority in the assembly, other, more peripheral municipalities overruled their votes (interview 11, mayor). In reaction, the mayors of the three municipalities came together with some local politicians to deliberate over their common territorial interests and to form an actor coalition.

The result was the 'Declaration of Bernau' (Stahl *et al.*, 2018), in which the mayors criticized the state government and planning authorities and formulated several demands. These include greater distances between residential areas and wind turbines and a new tax that operators need to pay to the municipalities in whose territory they develop turbines (Stahl *et al.*, 2018). As the declaration has no legal status, it can be understood as a symbolic act of resistance against the functional integration of the region into Berlin's energy system and as a functional means to organize among the municipalities.

The declaration reflects a conflict of interest and changing territorial relations between not only the municipalities, the regional assembly and the state of Brandenburg, but also the city of Berlin. The mayors felt disadvantaged in relation to Berlin because their territorial authority is limited, whereas Berlin's is not. Berlin could define suitability areas within its own territory but has not yet done so. On the contrary, the responsible administrative unit strives to prevent the development of wind turbines in Berlin (State Parliament of Berlin, 2016: 269). It prefers to develop wind turbines on land that the city owns outside its territory in order to avoid conflicts around different forms of land use as well as aesthetic and environmental consequences (*ibid.*). In this sense, the city mobilizes its territorial boundaries to uphold institutional differences that exist between the city and the surrounding municipalities in planning procedures.

The protesting mayors perceive their marginal position in the planning process as illegitimate given their socio-economic integration into the city and their urbanization prospects. By virtue of proximity to Berlin, the population of all three municipalities has grown by roughly 10% in the past two decades, and the municipalities expect future growth (Statistical Office Berlin-Brandenburg, 2020). Two mayors questioned why they should compromise with peripheral municipalities while the energy generation mostly serves the needs of Berlin (interviews 4, 11, mayors). They refused to become 'energy producers for Berlin' (interview 4, mayor).

Instead of turning their municipalities into urban hinterlands, the mayors prefer to externalize wind energy generation. In their opinion, the responsibility of urban energy supply does not lie with the municipalities next to the city but rather with peripheral areas, 'especially if it [energy generation] means negative environmental consequences ... and limited development options' (interview 11, mayor, my translation). What the municipalities around Berlin could do was ensure their self-supply (*ibid.*).

– Conflicting material priorities of the municipalities

Besides lacking functional control over their territory, the mayors also fear that they will lose control over material and economic developments. From a territorial perspective, the installation of wind turbines on greenfield land conflicts with the economic and material priorities of the three municipalities.

Essentially, the identification of suitability areas competed with plans to develop housing in the same areas in all three municipalities (interviews 3, 4, 11, mayors and local politician). This is problematic for the municipalities because the designation of

greenfield land for development increases the land's value. As a result, the municipalities can collect higher land taxes.

In addition, greenfield development is necessary for the construction of detached houses. Since the municipalities are the zoning authority, they wield functional control over the permitted size and form of housing. Given the rapidly increasing local land and housing prices, only wealthy migrants can afford to rent or buy detached houses (interview 13, zoning department Ahrensfelde). Thus, the municipalities can indirectly control the income level of the new residents by only zoning plots for detached houses (*ibid.*). In this sense, social segregation presents an attractive growth strategy for the municipalities.

In comparison, the economic development that the wind turbines enable does not compensate for the missed opportunity to develop housing. The municipalities did not invest in wind turbines on their territories. Ahrensfelde and Wandlitz do not control utilities that they could use for investments (interview 4, mayor). The government of Bernau did not invest in wind turbines on its territory because its utility feared a marketing conflict if it were seen to contribute to local landscape changes (interview 11, mayor). Therefore, the utility invested in wind turbines only in the wider periphery of Brandenburg (*ibid.*).

The private companies that invested in and operate local wind turbines do not offer models that allow the municipalities or local citizens to invest in them (interviews 2, 6, 8, 10, project manager). Hence, the protesting municipalities conclude that the 'profits flow to where the operators are located, while the negative effects remain here in the region' (interview 3, local politician, my translation). The private companies assemble large parts of the value chain under their roof, from the planning to the operation of the turbines (interview 8, project manager). They pay their taxes elsewhere because most of them are not registered locally (interviews 3, 4, 11, local politician, mayors). The only actors that profit locally are landowners (interview 3, local politician), whom, under existing law, the municipalities cannot tax specifically (interviews 4, 11, mayors).

Moreover, the impending hinterlandization of fast-growing municipalities is not in the interest of Brandenburg's government either. In reaction to local protests, Brandenburg's government passed a law that obligates operators to pay a concession of €10,000 annually per wind turbine to the local municipality (Government of Brandenburg, 2019). Nevertheless, even such a concession does not compensate the growing municipalities (interview 11, mayor). Because the suitability areas interfere with the municipal zoning practice, the municipalities are at risk of losing an important means of functional and material control over the local urbanization process.

In addition, the protesting mayors pointed out that many actors along the renewable energy value chain are based in Berlin and thus the city profits from their taxes, jobs and investments (interviews 3, 4, 11, local politician, mayors). In particular, the nation's largest creditor for wind turbine operators, the German Credit Bank (DKB), is based in Berlin (interview 6, project manager; DKB, 2021). Moreover, Berlin's state government now controls a water and an energy utility after their gradual remunicipalization between 2012 and 2014 (Beveridge and Naumann, 2017). Both companies invested in wind turbines in the three municipalities (interviews 2, 10, 11, project manager, mayor). Especially for Berlin's young energy utility, investments in wind turbines provide an opportunity to rapidly ramp up sales because of their large capacity in comparison to inner-urban, rooftop photovoltaic projects (interview 2, project manager). Finally, Berlin owns land outside the city's territory in Brandenburg. As the landowner, Berlin enjoys the functional authority to choose the company that is allowed to operate wind turbines on its land, if the land lies inside a suitability area. Consequently, the city gives priority to its own utilities (interviews 2, 10, project manager).

- Conflicting symbolic priorities of the municipalities

The development of wind turbines in the regional parks creates symbolic and cultural tensions as well. Symbolically, the wind turbines endanger the rural image of the landscape (interview 4, mayor). As a living environment, the regional parks offer an attractive contrast to the dense built environment of Berlin and serve as ‘green living oases’ (interview 3, local politician, my translation). In their declaration, the mayors explain that the integration of wind turbines into this landscape is becoming increasingly difficult (Stahl *et al.*, 2018). According to the mayors, ‘industrial wind turbines’ disturb inhabitants and tourists (*ibid.*) and appear as urban infrastructures because of their size and their function to generate energy for the city (interview 4, mayor).

Moreover, the wind turbines increase the value of greenfield land (*ibid.*). The higher value lowers the incentive to develop greenfield land. Thus, when wind turbines increase land rents, they can limit urban sprawl (Haan and Simmler, 2018). At the same time, the rising land prices incentivize the development of higher buildings and apartment houses instead of detached houses to increase the use density of plots (interview 4, mayor). When prices increase too much, one mayor stated, ‘we all of a sudden have three or four apartments on one plot—that’s what we want to prevent to keep the character of our buildings’ (*ibid.*).

In Bernau, the government partly welcomes this momentum to promote the densification of the town that constitutes the municipal center (interview 11, mayor). In this way, the municipality can save public expenditures because the increasing spatial density reduces the ratio between infrastructure investments and the use density of those infrastructures (*ibid.*). Moreover, densification can preserve the rural landscape surrounding the town and thus it remains attractive for new residents (*ibid.*). Wandlitz and Ahrensfelde, however, are characterized by a landscape of distinct historic villages and settlements. Their mayors want to prevent the construction of apartment buildings to preserve the rural landscape (interviews 4, 13, mayor, zoning department Ahrensfelde).

In short, the municipalities might lose their rural appeal if developers begin to construct larger buildings and wind turbines. From this perspective, I understand the Declaration of Bernau as a symbolic act that tries to stop the transformation of the regional parks into an energy landscape. At the same time, the shared rural landscape of the three municipalities creates institutional proximities among them, as they share a common interest in its development.

Discussion

The territorial perspective allows us to think about how the power density of renewables shapes urban and regional energy transition processes in more detail than the literature has done so far (Huber and McCarthy, 2017). The shift in power densities redefines the energetic qualities of cities, metropolitan areas, rural municipalities and regions in specific ways. Urban energy transitions do not only depend on access to rural territories (Huber and McCarthy, 2017; Naumann and Rudolph, 2020); they might also impede rural development, particularly urbanization processes. Moreover, the region becomes the preferential territory for spatial planning (Rutherford and Coutard, 2014) because it can serve cities as a continuous hinterland and offers the advantage of territorial proximity (Huang and Castán Broto, 2018).

The case study findings agree with other research which shows that even under favorable conditions, the power densities of renewables make the accomplishment of urban energy transitions challenging (Smil, 2016). Most importantly, the integration of renewables into the built environment of cities is more costly than their construction on greenfield land (Kammen and Sunter, 2016). In this sense, renewables exhibit a *non-urban materiality* (to rephrase Rutherford and Coutard, 2014: 1362) that resists attempts to increase energy generation within urban territories (a finding that reflects Balmaceda *et al.*, 2019).

The analytical framework also provides a critical reading of energy landscape studies (e.g. Woods, 2003; Zografos and Martínez-Alier, 2009). From a territorial perspective, rural energy landscapes become meaningful in distinction to other landscapes. For example, actors can mobilize boundaries between urban and rural landscapes to disrupt territorial proximities. Furthermore, the functional, material and symbolic qualities of landscapes become visible in relation to each other. Hence, when researchers analyze energy conflicts in rural areas, they should always follow the energy and ask whose demand it supplies because the material and symbolic appearance of landscapes also reflects their functional relation to other landscapes. In this regard, the case study illustrates the interdependencies that exist between politicized urban and rural energy landscapes, which are often overlooked in energy landscape studies that focus on either urban or rural energy landscapes (e.g. Woods, 2003; Castán Broto, 2019).

The case study also shows that the politicization of energy landscapes not only takes place in existing organizational settings but can also result in new polities that use landscapes as a means and an end to political organizing (Chezel and Labussière, 2018). In other words, the development of energy landscapes shapes subnational territoriality and vice versa. However, energy landscape studies are usually not attentive to these territorial interactions. Here, the wider field of landscape studies can offer inspiration but has its limitations, too. While researchers such as Olwig forecasted the repoliticization of landscapes (Olwig, 2005) and paved the way to research the interdependent development of nation states and landscapes (Olwig, 2002), their work focuses on the interdependencies between landscapes and national territories. In comparison, this study argues that subnational territories and their relation to landscapes deserve more attention.

The case study exemplifies how energy transitions reconfigure territorial hierarchies. Governance actors from Berlin and the three municipalities tried to dislocate renewable energy sources because they endangered local growth. In this sense, growth and hinterlandization are two complementary processes. As the built environment of cities grows, so does their energy landscape, which in turn displaces the rural energy landscape. Therefore, the metropolitan border becomes a space in which actors negotiate which areas will become part of the urban energy landscape and which will become part of the rural energy landscape that generates energy for the former.

Moreover, researchers should have the diseconomies and limits of urban energy autonomy in mind when they criticize renewable energy projects. When the different territorial qualities of cities and rural areas and the power density of renewables are taken into account, uneven development between urban and rural energy landscapes seems unavoidable to a certain extent. The question then is, when do they lead to inequalities and social discontent? To answer this question, researchers should develop more specific concepts to differentiate forms of uneven development and to show how uneven development is linked to inequality (Zografos and Martínez-Alier, 2009; O'Sullivan *et al.*, 2020). Sohn's hinterlandization concept (2014) offers such a more nuanced terminology as it relates territories according to their supply and demand function, and questions the value of this relation for both types of territories.

Finally, the hinterlandization concept emphasizes the use of boundaries for territorial development. Boundaries can signal territorial proximities or disrupt them (Huang and Castán Broto, 2018). On the one hand, the three municipalities mobilized their common landscape's boundary as a resource to resist hinterlandization and selectively disrupt the territorial proximities that bind them to the city. On the other hand, the most peripheral municipalities in Brandenburg mobilized the urban edge as a resource to create proximity between the urban energy landscape of Berlin and the territory of Ahrensfelde, Bernau and Wandlitz. Against this background, I conceptualize hinterlandization rather narrowly as a process through which cities gain and control access to rural areas to their benefit. Future research will need to clarify whether cities

in other parts of the world follow more equitable strategies to gain access to rural land resources for energy generation.

Conclusion and outlook

In this article, I set out to contribute to the literature on urban and regional energy transitions by providing a conceptual framework to investigate how subnational territories shape energy transitions and, in turn, are shaped by them. The territorial perspective that I developed offers new insights into the materiality of renewable energies, energy landscapes and uneven development.

Grounded in political geography (Sack, 1986; Paasi, 2003), the territorial perspective emphasizes the importance of city-region planning (Rutherford and Coutard, 2014) in the cities' quest to match the power density of their energy use with the power density of energy supply from rural hinterlands. In this sense, the framework can explain why the region becomes the preferential territory for spatial planning processes of energy landscapes.

At the same time, this definition of urban energy transitions provides a fundamentally relational perspective. I argue that, contrary to popular research practice (Woods, 2003; various examples in the special issues by Nádai and Van der Horst, 2010a; 2010b), a methodological focus on either urban or rural energy landscapes is insufficient because it overlooks their relativeness. In general, urban and regional energy transition research should be more explicit about the territorial dimension of its research objects—specifically, concepts such as landscape and city (Castán Broto, 2019: 28).

Furthermore, the framework explicates why the power densities of renewable energies make urban energy transitions challenging (Smil, 2016; Huber and McCarthy, 2017; Balmaceda *et al.*, 2019). While at first glance territorial proximities between cities and rural areas promise mutual benefits (Huang and Castán Broto, 2018), they can increase land-use competition and impede local development. Therefore, territorial boundaries become key in disrupting these proximities, distance energy landscapes symbolically from each other, and externalize energy infrastructures in a process that I conceptualize as hinterlandization (Sohn, 2014). As the (changing) functions of subnational boundaries in urban and regional energy transitions have not yet received much attention in the literature, future research will need to differentiate various practices and goals of boundary making.

The case study illustrated these arguments as Berlin's administration and utilities symbolically understand the land that Berlin owns outside its borders as a resource. The administration and the utilities materially externalize wind energy generation and its unwanted consequences—similar to urban governance actors elsewhere (Zografos and Martínez-Alier, 2009; O'Sullivan *et al.*, 2020). In reaction, the three municipalities formed an actor coalition around their shared landscape to express their territorial priorities more powerfully, because individually they lack functional control over the planning processes. In this sense, they transformed the landscape into a polity (Chezel and Labussière, 2018).

At the same time, the theoretical framework is limited by the specific historical and geographical setting of the case study. Therefore, the conclusions offered here are tentative, especially because we know relatively little about the interdependencies between subnational territories and energy transitions (Gailing *et al.*, 2020; Poupeau, 2020). Insights into more fragmented energy systems, in countries with different forms of territoriality, as well as the study of different forms of territorialization that result from energy transitions offer fellow researchers a range of opportunities. Likewise, future studies should differentiate processes of hinterlandization and highlight (possible) positive developmental outcomes of hinterlandization.

Overall, my research shows that energy transitions offer subnational territories new opportunities to regain control over their energy systems after decades of

privatization, liberalization and dependency on imported fossil fuels (Beveridge and Naumann, 2017). However, the materiality of renewables also limits urban aspirations for energy autonomy (Barles, 2019; Ménard, 2019). Taken together, energy transitions redefine the material-economic, functional and symbolic dimensions of subnational territories and reconfigure the relations between them. These findings justify the increasing interest that territorial perspectives enjoy in urban and regional energy transition research and the sustainability literature more broadly (see e.g. Gailing *et al.*, 2020; Janos, 2020; Poupeau, 2020).

Looking ahead, my research suggests that the contradictory process of urban growth inside fixed territorial confines reproduces hinterlandization. At larger scales—such as the national territory—the totality of these contradictions results in the hinterlandization of even more distant territories for renewable energy generation. In Germany protests against wind turbines have almost stopped their development on land (Radtke, 2020). Therefore, the national energy transition strategy puts increasing emphasis on the development of offshore wind energy, which will ultimately lead to the development of renewable energy seascapes (Borthwick, 2016)—a concept that has not yet received attention in the social sciences but promises to further advance our understanding of energy landscapes. Moreover, recent studies assume that Germany will not be able to generate enough renewable energy on its territory to satisfy its energy demand (Merten *et al.*, 2020). Accordingly, the national government intends to import green hydrogen produced on foreign territories (Van de Graaf *et al.*, 2020), in a process that will create discontinuous hinterlands.

Last but not least, I propose to adjust the analytical framework to research the interdependent development of the spatial extension of non-energy resources and subnational territoriality. As long as urbanization goes along with expansion of the built environment, takes place in territorial boundaries and relies on an increasingly expansive resource base, it will likely displace infrastructures that produce low-value resources. The increased use of renewable resources—as promoted by advocates of the bioeconomy—could greatly increase the spatial extension of the urban resource base. For example, the substitution of mineral building materials for timber materials would increase the land footprint of cities (Börjesson and Gustavsson, 2000). Likewise, the analytical framework offers opportunities to research the interdependent development of subnational territoriality and the organization of resource flows. For example, the circular city could decrease the urban land footprint (Williams, 2019). At the same time, cities often displace circular economy activities due to their low value added—a spatial dynamic of urban land economics that mirrors the hinterlandization process described in this case study.

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