POWER DISRUPTIONS: ITALIAN DISTRIBUTED ENERGY POLITICS, ENERGY TRANSITIONS AND THE NEW MATERIALISMS

CONCETTI, COSTANZA

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ITALIAN DISTRIBUTED ENERGY POLITICS, ENERGY TRANSITIONS AND THE NEW MATERIALISMS

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by

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ABSTRACT

This thesis follows an energy transition in-the-making. It examines the decentralisation of the power system in Italy, focusing on the material politics of this sociotechnical change. After sketching the outlines of this transition - the proliferation of renewable distributed energy technologies into a conventionally centralised electricity grid, and the circulation of novel energy practices and processes of prosumption amongst the Italian public – it builds on composite literature across the social sciences to show the conceptual and empirical lacunae that spur the rational for this research. The thesis uses the instability of Italy's balance of power between regions and central government as an amplifying lens able to highlight how powerful sociotechnical phenomena assemble and reassemble the social. Following an ethico-onto-epistemology gleaned from New Materialist theories that produces a sensibility to the more-than-human, this thesis enacts different agential cuts to answer how sociotechnical change is imbricated in sociopolitical transformations. It shows the energy transition in-the-making that it follows to be re-assembling the state, influencing energy governance, and contributing to the emergence of new sociotechnical imaginaries of energy in Italy by participating in a critical juncture in time. Its insights come from theoretical engagement with interdisciplinary literatures and from fieldwork research that made use of relational ethnography, semi-structured interviews and tracing the sociomaterial in digital and physical spaces.

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This thesis has been a labour of love, I'd like to take this space to thank everyone who has brought me back to the love of it all when it just felt like labour.

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To Palestine, May We See You Free

And To All My Beautiful Creatures Near And Far

CHAPTER 1 - ENERGY TRANSITIONS:

Sociotechnical Processes With Socio-political Effects

Figure 1: Political Map of Italy showing the 20 administrative regions in different colours. Source: https://i.pinimg.com/

1.1 Beginning In The Middle

February 24th, 2020: Luca Ceriscioli, the President of the Italian region "Marche", has called a press conference in the palace of the regional government. He sits in between

four members of the regional council and begins outlining the region's plan to face the effects of Covid-19, a novel coronavirus whose potency is still unknown at this time. As is convention at such press conferences, he speaks in front of the cameras of several news networks that are streaming the event live, detailing the executive decisions that the regional council has made vis a vis large events and school attendance. He explains that both will be put on pause until the 2nd of March or until his government will have found further clarity about the risks associated with the new virus. Though his demeanour does not betray particularly worry, the measures that Ceriscioli shares suggest a worrisome reality, and many of the journalists that attend the conference start asking questions about recent developments and known cases of the disease. However, the well-oiled machine of governmental communications moves smoothly, and the room's worry is contained in back and forth mediated by an assistant. In fact, for much of the conference, little out of the ordinary happens: representatives of a regional government speak to their constituencies about decisions they made on matters on which they had competency, and their constituents tune in and out through different media formats as is standard.

Then something odd occurs. As press agencies begin publishing the news, which circulate quickly as they impact the traditional Fat Tuesday Carnival in Ascoli Piceno, and families around the region start receiving trilling notifications of school closures, the familiar flow of questions and answers in the regional palace is uncomfortably disrupted by a series of conspicuous phone calls. First rings the personal cell phone of Ceriscioli himself, who awkwardly stops speaking mid-sentence to look at his device, and then do those of several others in the dais. As the Q&A continues in general unease, the president whispers something to the councilman to his left, who picks up his own phone and after a few seconds has to pass it back to the president with a wide-eyed expression. Ceriscioli, at first trying to and then giving up on covering his microphone, starts talking to a mysterious interlocutor, all the while one of his colleagues is still answering a journalist's question.

Figure 2: Snapshot of Live-Stream of Marche Regional Press Conference 24/02/2020. Source: Author

Confused glances are shared on the dais, Ceriscioli takes another phone that is handed to him and excuses himself. He returns minutes after, his breath short as he tries to coherently recount that the call had come directly from the Prime Minister, Giuseppe Conte, who has asked the regional council not to sign the ordinance that it was in the middle of announcing and not to move forward with school closures. As it turns out, the Prime Minister has asked Ceriscioli to retract his official statements altogether and postpone any action on the matter to the next day, when a national decree will be published.

This clumsy press conference ended with the regional president commenting about how comforting it was to know there would be national guidelines to follow momentarily. Nonetheless, the embarrassing series of announcements and retractions uttered in this event would be but the first signals of wide-spread and long-lasting contestation of the chain of command between regional governments and the central national executive during the pandemic in Italy. In fact, this particular interaction would begin an administrative and legal tug of war between the council of the region Marche and the central government, resulting in regional tribunals being consulted on the matter and citizens receiving contrasting communications on the operational status of the regional school system for several days. And just as the region Marche contested the authority of the central

government on domains of public health and education, so did several other regions on multiple issues.

Though since discussed in popular media as a moment of crisis for the Italian Nation State (Corriere Adriatico, 2020), this incident should not be understood as a rupture in the state's structure of power but rather as one of the most indicative moments of its truly unstable nature. And this instability is particularly evident in Italy in the cleavage between central government and the regions, as the country has been operating for two decades under a constitution that embeds uncertainty in its organisation of legislative and administrative power (Mangiameli, 2012, 2017). Though never associated in public discourse with the beginning of a new republic and seldom analysed outside of jurisprudence scholarship, the 2001 reform of Title V of the constitution crystallised the Italian Republic into a hybrid federal system with irreconcilable internal tensions. Passed during a time of political stability never experienced since then, the long-drawn and controversial reform residually distributed to the regions all legislative powers outside of 17 enlisted national competences and of a nebulous body of concurrent national/regional authorities (Bettoni, 2017). In so doing, it initiated a yet unfinished period of tentative and incoherent constitutional implementation, which, due to a lack of both textual clarity and practical indications (Rolla, 2019), the Central Government, the Regions, and the Courts are all approaching contrastingly (Mangiameli, 2017). The uncertainty emerging from such heterogeneity in constitutional application produces breaches in the stability of the political balance of power between state actors, breaches that intruding actors like a virulent pandemic highlight and complicate like in the anecdote above.

In fact, the snapshot of some of the messy management of governmental responses to the initial spread of Covid-19 in Italy presented above, which may be a surprising preface to a thesis on changing relations of power in energy transitions, serves a double purpose in this introduction. It highlights the labour of the more-than-human in materialisations of governance, politics, and stateness, and it points to the fragility of the organisation of relations of power in the Italian state. The anecdote above shows how the entanglement of the Covid-19 virus with the semi-federalised state produced embarrassing moments of confusion in the administrative chain of command over school operations, which then

spurred contestation over which administrative body held which power. I introduce this thesis with this vignette to evoke and concretise two ideas: that the state is not a stable, fixed entity, and that change in relations of political power can materialise via the intra-action of more-than-human elements. These ideas function as keystone premises to this thesis, which approaches the world as entangled becoming and energy transitions as sociotechnical processes able to change socio-political relations and re-assemble governance.

It's these keystone ideas that allow me to understand the present in Italy as a time and space saturated with potential for sociotechnical and sociopolitical transformation. Indeed, the country is not only undergoing a moment of ambiguous and inconstant constitutional implementation, but also one of great change in its energy landscape and energy governance, one that I argue amounts to an energy transition in the making. And if the intrusion of a new and powerful virus in the chaotic network of governance of the Italian state contributed to the emergence of a temporary moment of destabilisation in its balance of power, then an ongoing energy transition promises long-lasting power rearrangements. As many before me have argued, and I myself will show in this thesis, an energy transition does not imply a harmless shift from one dominant energy source to another, but rather a profound transformation that reverberates across the "functioning of our human, built, and natural system" (Araújo, 2022: 1). This thesis will show that the ongoing energy transition in Italy implicates the proliferation of new energy technologies, practices, and relations able to reconfigure not only physical infrastructures but speculative imaginaries that structure the realm of what may be considered a possible and desirable future, reconfigurations that affect governance and state re-production too.

The starting point of the energy transition I am mapping is a technical one. Specifically, it is situated in changes in the configuration and regulation of the Italian national power system, the infrastructural assemblage that generates, transports, and distributes electricity. Since the 1960s, electricity provision in Italy has overwhelmingly relied on large, programmable, hydro or thermo-electric power plants that generate electricity and feed it into a national transmission grid. This grid is constituted of electricity

transformers, towers, and cabling that carry high-voltage currents for long distances before reaching lower-voltage distribution networks, to which commercial and residential users are connected. With the end of the first decade of the new millennium, however, the configuration of the power system began to change. Indeed, as small-scale renewable energy generation technologies such as rooftop solar panels and small wind turbines have become less capital-intensive and have attracted state incentives as tools of de-carbonisation, households and businesses have been installing them directly onto or nearby their homes, shops, warehouses, and factories. In this way, the location and nature of the generating capacity in the grid has started to shift. Alongside the few, large, fossil-fuel based, centralised plants that used to power the entire system, have thus begun operating first hundreds and then thousands of decentralised generators. And differently from centralised power plants, these technologies feed electricity directly into the low-voltage distribution network of the grid, in this way often by-passing the transmission infrastructure entirely. The term Distributed Generation is now used to refer to these electricity generating units that connect directly to distribution grids, and in Italy the share of the country's national electricity production from Distributed Generation has gone from 6.1% in 2006 to 25.3% in 2020 (AEEG, 2009; ARERA, 2022).

Under the latest policy definitions from the European Union, Distributed Generation includes energy generating schemes of all scales as long as they feed into the distribution network. In Italy, however, the term has historically referred to small parks with an installed capacity[1] under 10 Mega Watts of electricity (MWA). These smaller schemes are often based on renewable technologies, like rooftop solar panels, micro hydroelectric screws, or small wind turbines, account for over 80% of all the Distributed Generation in the country, and can be comfortably owned individually or communally (ARERA, 2019). Distributed Generation technologies not only allow passive electricity consumers to become active producers of electricity (prosumers), but also enable electricity production to occur in closer proximity to its spaces of end-use. That is, Distributed

[1] Installed Capacity is a measure often used to categorise electricity generating plants and refers to the maximum electricity that a generating plant can produce under optimal conditions.

Generation allows for both practices and relations of energy production and use to change. Scholarship in the social sciences has shown such changes to be much more than technical (Shove, 2017). Rather, these changes have been shown to hold sociopolitical implications ranging from public enrolment, to social acceptance of specific technologies, to the spread of democratic processes (Batel, 2020; Chilvers et al., 2018; Wahlund and Palm, 2022). Following this tradition, I recognise in the decentralisation of electricity systems and in the proliferation of prosumption a new mode of relating to electricity. In this thesis, I turn to map some of the socio-political and socio-material implications that this transformation brings with it.

To be precise, this thesis conceptualises the fast proliferation in Italy of Distributed Generation as a disruptive sociotechnical process able to re-assemble the socio-material structures of the unevenly centralized Italian Nation State and to inform the emergence of specific governance strategies. I make such a claim in conversation with scholarship that has shown the very large built environments and infrastructures of energy systems to be carriers of imaginaries of centralised national legitimacy (Harris, 2012) and "encod[ers] and reinforc[ers of] particular conceptions of what a nation stands for" (Jasanoff and Kim, 2009: 123). Indeed, the disruptive political potential of a power system transitioning from an entirely centralised configuration to one that is permeated by decentralised technologies is especially striking in the context of two key interventions within literatures on the geographies of energy and on the political geographies of the state. Nominally, that energy infrastructures hold "particular potency for constructing or reproducing national consciousness" (Bridge et al., 2018: 41) and that they participate in producing state effects both as built environment and as objects made legible through prosaic practices of "control of nature and citizenry" (Harris, 2012: 25). That is to say, the transformative potential of this transition-in-the making is particularly notable if read through the diffractive double lenses that I have called "keystone ideas" above.

However, though historians and political theorists have shown that energy transitions tend to bring about critical changes in the organisation of statecraft (Mitchell, 2011; Smil, 2010), and that the more-than-human contributes to assembling specific

governance strategies (Bakker, 2012; Bijker, 2007), geographers who have studied the politics of Distributed Generation (e.g. (De Laurentis and Pearson, 2018; Ellsworth-Krebs and Reid, 2016; Frolova et al., 2015; Marcantonini and Labandeira, 2016) have overlooked the potential implications of these disruptive technologies to the political geographies of the state and on governance. I therefore take up the opportunity to explore how changes in the built environment of electricity brought about by a transition to a semi-decentralised power system are affecting such relations in Italy. To do so, I approach the permeation of Distributed Generation in the Italian power system as an energy transition in-the-making.

In using this label, I mean to highlight that ongoing and unfinished sociotechnical developments are in themselves powerful agents of change. Indeed, rather than taking a historical approach and studying energy transitions as events fixed in time that can be entirely completed (and therefore hold both a prior period and an afterward), I am approaching them as continuous processes that encompass several transformations in different and at times even contrasting directions. For this reason, I consider moot the objection that the power system that I am studying has not *fully* transitioned yet: what matters is that it is changing. To be precise, what matters to me is how this ongoing change reverberates outside of the electricity power system itself to interfere with processes of state reproduction, with the assembling of governance strategies, and with the temporalities of energy politics in Italy. In this thesis, I question how the sociomaterial changes of a power system in transition may be de- and re-territorialising the state, assembling an energy governance that benefits specific publics over others, and contributing to catalysing critical junctures in time that propels sociotechnical change. The Italian Republic may be unusually susceptible to such transformations because of the constitutional inconsistency that governs its hybrid regional system (Bettoni, 2017; Crisi and Groppi, 2001; Mangiameli, 2017; Rolla, 2019).

This thesis is rooted in Human Geography, although the scholarship that influences this work is vast and multi-disciplinary. I draw from two large bodies of work within the discipline: energy geographies and political geographies of the state. I read selectively across the two subdisciplines and at times find inspiration in related works in STS, anthropology, and political theory to produce a heterogeneous but coherent scholarly

account able to offer insight into energy materialities' affective and agential capacities to produce sovereign imaginaries and redistribute power. Such an understanding is informed by several scholarly contributions from disparate disciplines dealing with notions of more-than-human agency, affect, relational power, prosaic nation building, socio-technical imaginaries, infrastructure politics, and multi-scalar energy transitions' ability to reorganise statecraft. It is from this body of literature, and its unavoidable conceptual and empirical lacunae, that the questions guiding this research have emerged and that my understanding of the milieu I immersed myself in derives.

In Deleuzian fashion, then, this thesis begins "in the middle" (Deleuze, 1968), in the middle of the Italian state becoming otherwise as its power system changes, in the middle of a global pandemic, and in the middle of my own understanding of energy transitions, politics, and reality. I indeed glean the approach to energy transitions, the state, and their ontic qualities, the disposition that is that subtends this thesis, from an academic background in Science Technology Studies, a commitment to the Political Geographies of environmental change, and a long-lasting enchantment with materiality that has brought me to the metaphysics of the New Materialisms. The arguments presented below should therefore be read as middle points too, as lines of thought that begin in the middle of someone else's ideas and whose "trajectory of becoming consummates at the edge of another middle, which will then become another beginning point for an ever-new process of beginning/becoming" (Yountae, 2014: 288). These arguments, that is, both emerge in contingency with others and do not exhaust their own line of argumentation. Indeed, because of the entanglement of the processes I set out to research and my own ethico-onto-epistemological positioning, which I will introduce in Chapter 2, I cannot claim to have represented in this thesis the full picture of the energy transition in-the-making I will be discussing or its sociopolitical effects. In fact, I cannot claim representation at all, as colleagues in Geography working with non-representational theories remind me that my research practice is part of the active *enactment* of *a* world rather than an abstraction of the functioning of one universal reality (Anderson and Harrison, 2012).

Rather, to use Baradian language, I hereby present a series of "agential cuts" into the research assemblage I participated in for four years (Barad, 2007). In other words, I recognise that both my own entanglement with the research assemblage and the analytical tools through which I make sense of it delineate specific boundaries in the phenomena I am interested in (Barad, 2007: 115). That is not to say that I choose to enact these agential cuts at random. Rather, each cut shares with the other a recognition that any phenomenon that this thesis confronts, from those usually discussed as social, to those framed as natural, or technical, or otherwise, is constituted relationally. This is not a rare approach in Human Geography, with Doreen Massey declaring in 2004 that "'thinking space relationally' has become the theme-tune of our times in geography" (2004: 1). But each cut also works separately to think through the *how* of this constitution, to highlight, that is "the specificity and performative efficacy of different relations and different relational configurations" (Anderson and Harrison, 2012: 16). Effectively, each chapter following this introduction brings attention to the productive labour of both the relations between entangled elements emerging from my empirical fieldwork, and of the relations of my own research practices with such entanglement.

Chapter 2, "For A New Materialist Sensibility To Sociotechnical Change" introduces the ethico-onto-epistemology that frames my research approach and discusses how I was able to cultivate a sensibility to the sociomaterial only when I attuned myself to the affective work of my fieldwork practices. Chapter 3, "Alert! Power Cuts!" is the first of three "empirical" chapters. These analyse data emerging from my fieldwork and documentary data collection. Through the tool of de/re-territorialisation, Chapter 3 draws from Assemblage Theory and discusses how the proliferation in Italy of Distributed Generation technologies, and specifically renewable ones, intervenes in relations of proximity, thus re-assembling the Italian state and imaginaries of both sovereignty and desired/desirable energy transitions. Chapter 4 "Assembling Renewable Energy Communities" takes seriously the regulation and incentivisation of these proliferating technologies as assemblages that make most visible the work of the materialities of the electricity grid in influencing governance. It does so through the analytic method of

"diffractive reading", whereby I read Decree 199/2021[2] alongside and through development plans published by the Italian Transmission Operator. To conclude these interventions, Chapter 5 "Critical Juncture for Sustainable Change" thinks through the temporalities of the changes discussed in the first two empirical chapters. Using the lens of "critical junctures", it argues that sociotechnical change occurs through punctuated moments of contingency, when the performative efficacy of different relations is especially intensified. Finally, the concluding chapter, Chapter 6, brings the discussions in each of the empirical chapters together and sketches the multiplicity that these point to in answering how changes in the Italian energy landscape are affecting political relations. This acts both as a summarising conclusion to the thesis and as a reflection on what I hope will be some of its implications.

The arguments I present in what follows deliberately do not seek a single and uniform narrative able to encapsulate the energy transition I partially map. Instead, they each tease out specific lines of the captivating idea that guides this thesis: that changes in the relations that make up an energy landscape influence socio-political relations within and outside of energy governance. Although each line of argumentation will be introduced and contextualised by reference to both the academic literature and empirical setting, the following section of this chapter (Section 1.2) first sets the scene by explaining where such an idea comes from and why it matters. Section 1.2 reviews the seminal scholarship that inspires this research, delineates useful concepts, and identifies the spaces of missed potential convergence or conceptual neglect among the different literatures it covers. Building on these spaces, in section 1.3 I delineate the Research Aims and Research Questions. In section 1.4, I detail some of the reasons that brought me to conduct this specific research and introduce the policy and institutional context in which the transition I am interested in is taking place.

Before moving on to Chapter 2 and the rest of the empirical chapters, in section 1.5 I will also discuss research design and the methodology I mobilised to collect and

[2] This is the decree through which Italy fully transposed the European Renewable Energy Directive (REDII), whose relevance to this thesis will be further elaborated on in Chapter 4

analyse data for each of the empirical chapters. Indeed, every chapter after this introduction presents only abridged discussions of methods because I wrote them as either articles for academic journals in the social sciences or as chapters to appear within relevant handbooks.

1.2 Literature Review And Conceptual Approach

Small Distributed Generation technologies allow individualised and collective participation in practices of electricity often termed either "self-consumption" or "*prosumption"* — the generation of electricity by individuals and communities who are traditional electricity consumers (Sioshansi, 2017). In Europe, this has become so prevalent that the current EU legal framework establishes clear provisions for the operation of prosumers within its Electricity Directive (EU 2019/944) and that both the European Parliament and the European Environment Agency have published briefs about electricity prosumption (European Parliament, 2016; European Environment Agency, 2022).

The phenomenon of electricity prosumption is largely tied to the commercialisation of renewable energy technologies and, though it may not immediately appear revolutionary, it has captured the imagination of policy makers and academics in the social and natural sciences alike (Parag and Sovacool, 2016). Indeed, when electricity consumers take on the role of producers too, they move from passive users in the energy system to active agents. This is the case for all electricity users in places of end-consumption, from residential buildings to institutional or commercial sites (Wesche and Dütschke, 2021). One of the starting points for this thesis is a recognition that the shift from consumption to prosumption does not only impact users per se but *locations* of electricity consumption too, which implies a new spatialisation of electricity systems as the deployment of small-scale renewable generation technologies is increasingly incentivised. Before delving into this idea and its implications, however, I believe it important to expand on the conceptual value of the term "prosumption", which in anglophone literature and policy has largely replaced the use of "self-consumption", an alternative term largely relevant in the Italian context.

Prosumption

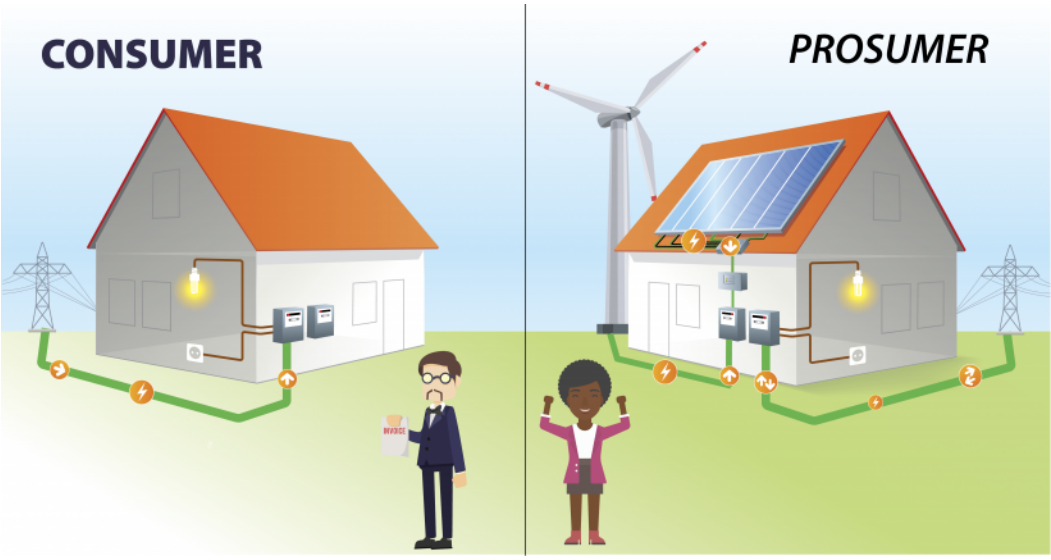

Figure 3: Graphic Summarising the difference between an electricity consumer and electricity prosumer according to the USA's Office of Energy Efficiency & Renewable Energy. Source: https://www.energy.gov

The term prosumption does not originate in literature concerning the generation and use of electricity. Instead, playing on the portmanteau of production and consumption, American writer Alvin Toffler first introduced it in 1980 in his book *The Third Wave* to speak of how he envisioned a future economy characterised by the proliferation of the computer (Toffler, 1980). Indeed, he foreshadowed that the commercialisation of ever more efficient computers and their increasing interconnection would make it so the average person could overcome the "aberrant separation of production and consumption" that he believed distinguished his time (1980: 265). Instead, he hoped that these new technologies would allow people to intervene in production processes (Comor, 2011). Interestingly, then, even if removed from electricity, the concept of prosumption emerged from the start as a potential outcome of technological innovation. That is, as it does in its application in electricity, the term prosumption indicated from its inception a human process mediated and in fact allowed by the non-human: in Toffler's case, by networked computers; in the case of electricity prosumption, by small-scale electricity-generating technologies (such as rooftop solar panels for example) that allow non-expert users to intervene in production processes.

Toffler was not alone in thinking about how Western economies would react to the technological changes brought about by the 1970s. In fact, he was but one part of a larger scholarship that became interested in theorising how the economy would change in times that seemed to many not to be easily captured neither by Marxist writings nor by classic liberal texts inspired by Adam Smith (Ritzer and Jurgenson, 2010). As more convincing voices crowded the field, the concept of prosumption did not receive great success or traction at first. Instead, the scholarship moved increasingly towards expanding the conceptualisation of consumption, a move that followed the lead provided in Jean Baudrillard's 1970 book *Consumer Society* (ibid, 2010). This is not surprising considering how consumerism and its practices took over the 1980s and 90s in the Global North, with places of social aggregation being displaced by large shopping malls and purchasing power for many transforming when gaining access to personal credit (Streeck, 2016). However, as the 2000s brought about the dot com boom and its possibilities to crowdsource, produce and post content online, and network via the internet through social media platforms, blogs and more, Toffler's concept of prosumption found new relevance (Comor, 2011).

In the new millennium, a rich literature on prosumption emerged in parallel with works on co-production and co-provision, and the term gained traction especially in the field of critical sociology (Humphreys and Grayson, 2008; Prahalad and Ramaswamy, 2004; Xie et al., 2008). From this discipline hailed some of the most prominent theorists of prosumption and some of the firmest believers in its revolutionary nature. In a 2010 essay, George Ritzer and Nathan Jurgenson for example temporalized prosumption as the defining characteristic of modern-day capitalism not because of its pre-eminence but because of its ability to co-exist alongside ubiquitous processes of production and consumption (Ritzer and Jurgenson, 2010). In this and other work, these critical sociologists argued prosumption was not only a digital process but extended to several other domains (like assembling furniture when buying from Ikea, using self-check-out and check-in machines, etc.) and was moving the grand trajectory of capitalism towards "prosumer capitalism." This seminal work contributed to returning the term prosumption to the fore and provided it with such gravitas that some have contested it is time to de-

mystify it by contextualising and problematizing both the idea of prosumption and that of the prosumer (Denegri-Knott and Zwick, 2012).

Most significant for this thesis, however, the many theorizations of prosumption and the scholarly buzz generated around it contributed to it perforating the bounds of economic sociology and entering new fields of inquiry. In the case of energy management literature, which urgently needed new terminology for the growing number of domestic consumers who were gaining access to Distributed Generation technologies and could thus produce electricity, the term was adopted with unexpected rapidity (Sioshansi, 2014, 2017). A Google Scholar search of the words "energy prosumer" in articles published between 2010 and 2019 produces 9620 results, nine times more than the 1090 results obtained with a search for the same terms in articles published between 1980 and 2010 (half of which are dated post-2008).

The ongoing use of prosumption terminology in energy management, policy, and regulation literature, however, does not imply the acceptance of the political economic values associated with prosumption so central in the critical sociological literature where the term originated. Rather, a focus on the actor "prosumer" rather than on the action "prosumption" contributes to de-politicising the terminology by focusing on the practitioner rather than on the process (Ellsworth-Krebs & Reid, 2016). On the other hand, as previously mentioned, social scientists interested in engaging critically with the changes occurring to energy landscapes through decentralised electricity generation still frequently choose to use alternative terminology when discussing the individuals and communities who are taking up the roles of simultaneous energy producers and consumers (Koirala et al., 2018; Kunze and Becker, 2014; von Wirth et al., 2018). It is therefore exceptionally noteworthy that Ellsworth-Krebs and Reid published in 2016 a paper titled "Conceptualising Energy Prosumption: Exploring energy production, consumption and microgeneration in Scotland, UK", where they recognized that "in the context of energy, the term prosumption may be used to signal a more radical vision" of energy futures (Ellsworth-Krebs and Reid, 2016).

Ellsworth-Krebs and Reid's 2016 paper is the first, and perhaps more surprisingly remains the only, geographical attempt to conceptualise energy prosumption. Indeed, although in the past few years geographers have demonstrated interest in engaging with early conceptualisations of tangential phenomena and aspirations such as Community Energy (e.g. Creamer et al., 2018; Koirala et al., 2016), Energy Justice (e.g. Fuller and McCauley, 2016; Jenkins et al., 2017; Sovacool and Dworkin, 2015) and Energy Democracy (e.g. Radtke, 2018; Szulecki, 2018; van Veelen and van der Horst, 2018), no reflection on Ellsworth-Krebs and Reid's work has been written to date. While arguably the foundational paper for the geographical theorisation of energy prosumption and brilliant in bridging the literature on prosumption and scholarly work on energy, "Conceptualising Energy Prosumption" needs to be revisited and expanded. Perhaps because of the gargantuan challenge of producing a conceptualisation of energy prosumption from zero, or out of disinterest in doing so, the paper perfectly contextualises energy prosumption but fails to ultimately produce a critical, conceptual, geographical reflection on how energy prosumption contributes to the sociopolitical transformations brought about by low-carbon energy transitions. I embark on this task though this thesis. Specifically, when it comes to electricity, I argue that a useful lens to begin unpacking the socio-political implications of prosumption is that of approaching the new spatialisations that it brings to electrical power systems.

Prosumption As A Spatial Phenomenon

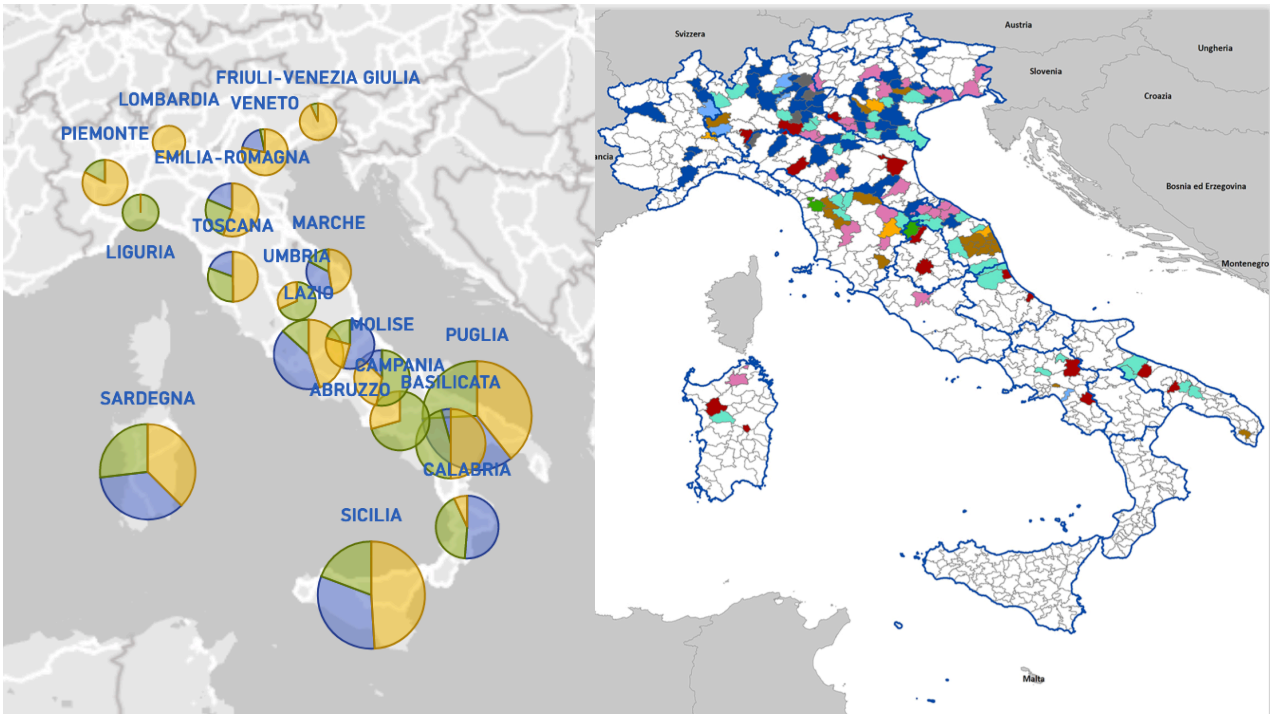

Figure 4: Juxtaposition of requests for renewable energy connections in Italy (left) and spatialisation of industrial production (right). Source: (on the left) https://www.terna.it/en/electric-system/grid/econnextion, (on the right) http://www.istat.it

The technologies that allow prosumption to happen make electricity generation capacity easily installed near places of end consumption, cheap, easily managed, and often low-carbon. This is a big shift from immensely expensive to build and run conventional large power plants, whose smooth operation necessitates expert financial and technical calculations. When these technologies permeate an electricity system, they change both the relations of proximity that characterise it and its spatialisation. This should especially catch the attention of geographers, who have shown energy transitions to be socio-spatial processes (Calvert, 2016) and foregrounded how energy systems both allow specific spatial patterning of social activities and are themselves spatially constituted (Bridge et al., 2013).

However, the spatial shift implied by increasing proliferation of Distributed Generation technologies in mature power systems has largely gone unquestioned by geographers interested in energy, energy transitions, or the political geographies of environmental change in anglophone literature. This scholarship has instead focused

mostly on the potential for collectivised ownership and democratic decision-making held by community energy schemes that take advantage of these technologies and on these technologies' contributions to low-carbon futures. Even Ellsworth-Krebs and Reid, who do take seriously the transformation that small Distributed Generation[3] brings outside of their advantageousness for community schemes or renewability, do not discuss the spatial implications of this phenomenon. Their article brilliantly begins the work of demystifying the concept of energy prosumption and putting it in conversation with wider literature on prosumption more at large. It inspires this thesis by discussing the ways in which energy prosumption practices, often relegated to technical discussion in power system engineering, influence social relations. However, it is limited by its own appreciation of the energy system as socio-technical only in so much as "changes in technologies and physical infrastructures influence, and are influenced by, social conventions that shape energy-demanding activities" (2016: 2002). In their hands the imbrication of energy and society remains confined to the sphere of energy-related practices. Similarly, the authors recognise the spatial effects of prosumption only in terms of bringing production capacity to traditional places of end use, rather than as a reconfiguration of networked systems that subtend several socio-economic and socio-political practices, relations, and domains.

In contrast, scholars publishing in francophone literature have discussed the spatial implications of decentralised electricity generation directly but they have also stopped at the energy system when mapping the materialisation of these changes. There is a tradition in the French Social Sciences of thinking about the concept of "proximity" as spatial but also historically constructed, processual and relational (Zimmermann et al., 2022). This tradition finds its root in the convening in the 1990s of a group of industrial and regional economists around the conceptualisation of how proximity between economic actors, be it geographical, organisational or institutional, impacted territories and industrial processes (Torre and Wallet, 2014). Since then, the concept of proximity has captured the interest of (mostly French) economists and geographers alike. It thus proved to be a useful tool through which to think about the spatialisation of economic and industrial processes but

[3] The authors speak specifically of "microgeneration" technologies.

also to evaluate the strength of other relations, such as shared knowledge bases and interdependence in organisational practices (Balland et al., 2015; Lopolito et al., 2022).

This tradition has led some scholars to take an interest in the proliferation of Distributed Generation technologies and prosumption practices in France. Gilles Debizet and Antoine Tabourdieu, in particular, have published (together and separately) articles that conceptualise electricity generation "in situ", energy communities, and other forms of decentralised electricity generation as what they call "Socio-Energetic-Nodes" (SEN) (Debizet et al., 2015; Tabourdeau and Debizet, 2017). This concept builds on Actor-Network-Theory – which I will further discuss in a dedicated section – to recognise the materiality at work in socio-technical systems like those of electricity and heat provisions. It is useful, therefore, in showing how the spatialisation of energy practices and the properties of energy artefacts contribute to the production of specific institutions. However, though their work does take seriously the geographies of Distributed Generation in inspiring ways, it stops short of asking how the changes in proximity implied by the proliferation of Distributed Generation schemes may be impacting politics that go beyond the energy realm.

This, I argue, is a missed opportunity: prosumption practices and the technologies that allow them to take place offer an exciting starting point to both further empirical understandings of how energy transitions come to be and to conceptualise energy transitions as processes whose spatial reconfigurations reverberate outside of the energy domain. That they can do so is not a revolutionary idea especially when thinking through electricity systems. Indeed, there exists a long-standing tradition in Science Technology Studies devoted to investigating how the (re)-configuration of power systems are both influenced and influence the "social".

Power System Reconfigurations And The "Social"

One of the seminal works that underpins these ideas is Thomas Hughes' *Networks of Power*, which he published in 1983. A historian of technology, Hughes focuses on technological development of electricity in the United States, the United Kingdom, and

Germany to narrate a story of electrification and technological innovation that foregrounds "systems". Indeed, rather than approaching power systems configurations and their transformations as emerging solely out of the possibilities engendered by the hardware of newly invented electricity technologies, Hughes "refuses to deal separately with the technological and the social" and thinks of them as imbricated systems (Bijker et al., 1987: 190). That is, he describes technological innovation as being simultaneously influenced in its construction and functioning by the social conditions of the environments in which it is deployed and, reversely, as influencing and shaping the society that interacts with it (Hughes, 1983).

His "systems thinking" presented in *Networks of Power* has greatly influenced scholars in STS and contributed to inspiring the concept of co-production, one of the lenses that most influences this thesis and which is reviewed below. It also fortified a disciplinary trajectory of exploring the politics that emerge *from* the configurations of large socio-technical systems that have themselves been shaped by the socio-political. That artefacts may have politics had indeed already been posited by Langdon Winner in a famous 1980 article (Winner, 1980) and Hughes himself would soon contribute a detailed exposition of this idea in *The Social Construction of Technological Systems* (Bijker et al., 1987). In "Do Artefacts Have Politics?", Winner provocatively takes up the millennia-long idea that technologies may be inherently political (which he traces all the way back to Plato's concept of *techne)* and, at the same time, problematises it to show it only holds conceptual strength when contextualised and situated. If a ship at sea may well require a single authoritative captain commanding a crew with no agency to challenge orders (as both Plato and Engels suggest in their separate versions of determinism), Winner argues that when that same ship is docked or out of service it may afford very different organisational structures (ibid:135). In taking up both Hughes' focus on large sociotechnical systems and Winner's attention to the politics propagated by specifically contextualised technologies, scholars in STS (and the social sciences at large) have in the past 60 years explored how large infrastructural systems organise social life and enable or constrain socio-political change (Bijker and Law, 1994; Coutard and Rutherford, 2015; Hess and Sovacool, 2020)

As the citations above show, this trajectory has caught the interest of scholars thinking specifically through sociotechnical transitions and transitions to sustainability. Indeed, large sociotechnical systems such as the infrastructures of energy, water and heat provision have been discussed as key sites for changes in socio-political organisation (Miller, 2019). One of the driving forces behind this discussion is Timothy Micthell's seminal work in political theory: *Carbon Democracy* (2011). In this book, Mitchell details how energy transitions, and specifically shifts from one dominant fuel to another, brought about critical changes in governance strategies in the 20th century. The key anecdote from his work that is often cited in articles and workshops on the sociotechnical politics of energy transitions is that of the transition from wood burning to coal and from coal to oil.

In structuring industrial processes around coal, the UK is discussed in Mitchell's opus as opening itself to the union-building capacity of coal miners, who could use the material configuration of coal mines and the bulkiness of coal itself to their advantage when blockading the system and demanding workers' rights. In other words, Mitchell argues, the materiality of coal extraction, transportation, and use contributed to the elements that allowed Keynesian democracy to thrive in Europe in the 19th and 20th century. Instead, when industrial systems and processes began relying on oil, the fluidity of oil and its malleability to pipeline transport diminished the labourers' strength in obstructing the fuel at the basis of a new, globalised economic system. In fact, Mitchell recounts, the first oil pipeline was unveiled in Pennsylvania precisely to overcome the disruption brought about by a coal strike. In recounting this I want to avoid misrepresenting Mitchell's work as reproducing the argument of the "resource curse" or "oil curse" (Ross, 2012), by which an abundance of natural resources and specifically oil have been discussed as favouring authoritarian rule. Rather, *Carbon Democracy* shows how the democracies of the late 20th and 21st century are shaped by oil's materiality and the freedom it allows for capital accumulation at the expense of labour organising.

His argument that different configurations of national and international energy systems profoundly impact relations of power within those very systems – including the fabric of the state and its organisation - echoes throughout interdisciplinary scholarship in the social sciences. In introducing a special issue in *Energy Research & Social Science,*

Bridge et al. (2018) map key lines of inquiry in the literature that highlight how energy infrastructures (re) produce the nation both politically and economically. The insights of political economy on the ability of energy infrastructure to reproduce inequalities at a multiplicity of scales, and those from political science on its role in geopolitical struggles, are indubitably valuable but what this review contributes most to the discussion at hand is a coherent chart of how social scientists have been thinking about the material politics of energy infrastructure.

By material politics, I here refer imprecisely to discussions of the ways in which the physical, speculative and informational elements of energy infrastructure participate to changing relations of power. Bridge et al. recognise three grand conversations in this sense, which they name "Inscribed social values", "Dreamscapes and poetics", and "Materials enrolling publics" (Bridge et al., 2018:41). Within the first group, Gabrielle Hecht's idea of technopolitics features prominently as it provides an analytical vocabulary to a tradition, dating back to Winner's article cited above, investigating the politics *inscribed* in infrastructural systems (Hecht, 2010). As Bridge et al. underline too, what is made apparent through the concept of technopolitics is that infrastructural artefacts are not only designed to serve specific interests but are also themselves powerful reproducers of political stratification that exceeds and escapes the initial political design because of their material configurations (2018:41).

The second broad conversation the authors highlight reverses the investigative lens, turning it away from the intention behind infrastructural deployment towards the consequences of infrastructures' existence for the formation of collective spatial imaginaries. The key texts cited here that also foundationally underlie the focus of this thesis are Jasanoff and Kim's books on *sociotechnical imaginaries* (2009, 2015). What Jasanoff and Kim powerfully argue is that social ideas about energy infrastructures, and large sociotechnical projects more at large, are capable of shaping the speculative in ways that determine what politics are institutionalised as possible or impossible. They coin the term "sociotechnical imaginary" (2009) to speak of how discursive elements allow "vanguard visions" (Hilgartner 2015 in Jasanoff and Kim, 2015) of national technological

advancements to become widely adopted and become codes on the basis of which both future sociotechnical projects are planned and national identities are delineated.

Specifically, in *Containing the Atom,* Jasanoff and Kim define sociotechnical imaginaries as "collectively imagined forms of social life and social order reflected in the design and fulfilment of nation-specific scientific and/or technological projects." (2009:120). This definition is supplemented in their work by a number of delineations of how sociotechnical imaginaries differ from other forms of communal visions. In particular, the authors argue that these collective and ordering forms of imagined national futures emerge from an amalgamation of norms, cultural meanings, metaphors, and visions that are less explicitly formulated than political agendas. Even if in later iterations of their work they expand their use of sociotechnical imaginaries to scales other than the nation state, their initial focus on the state is particularly useful for this thesis. Indeed, it draws a powerful line between collective visions of technological advancement and the re-production of the state. However, the concept of sociotechnical imaginary is limited insofar as it recognises large infrastructural projects only as the end result or manifestation of national visions of development. Instead, the two keystone ideas that subtend this thesis demand to recognise that these material infrastructures can themselves be the starting point of changes to the encoding of national visions. In this the following chapters, I will therefore wield the concept beyond this definitional limitation to draw attention to how changing energy infrastructures can themselves participate to re-writing the norms that institutionalise sociotechnical imaginaries. In other words, the concept in this thesis becomes iterative rather than linear.

Lastly, the third broad interdisciplinary conversation that Bridge et al. sketch out is one interested in the generative force of infrastructure to pattern social life. Indeed, in the last section of their literature review, Bridge et al. face the need to include and categorise the work of scholars who have attended to the "liveliness" of materials in more ontologically innovative ways compared to those previously categorised. If the scholarship reviewed above on technopolitics and sociotechnical imaginaries discusses the relationship between the "infrastructural" and the "social" as deeply embedded, it maintains a separation between the two and recognises the first agency only in so far as a structuring

effect, by which the specific configurations of infrastructure enable or prohibit certain social relations. Instead, in the works reviewed under the heading of "Materials enrolling publics" (Bridget et al., 2018), I would argue that scholars are interested in what Elizabeth Grosz termed "spatial excess" (2001:150), that is an "extra dimension" of the material that escapes questions of structure and grants it dynamic political potential. This is the starting point for many of the works that I will cite below in a section on "sociomateriality".

Geographers reading this section of Bridge et al.'s review would not be surprised in seeing amongst the key citations Ash Amin's work on lively infrastructure (2014), which poignantly synthesizes how infrastructure configuration and re-configuration have powerful effects not only on the lives of an individual but on the organisation of collectives. Amin's seminal article encapsulates the trend in the social sciences, which this thesis participates in as well, of refuting the separation of the material and the cultural and seeing them instead "as hyphenated, each closely implicated in, and part of, the other" (2014:138). He puts forth an argument for the effectiveness of "ethnographies of material culture" and, through his own work in Brazil, shows the agency of human participants to the city, both authorities and their subjects, to be "qualified" by the socio-technical machine that is the city itself, "firstly, as less than supreme, secondly as incorporated in the machinic, and thirdly, as dependent on the latter" (2014:156). This article is therefore a particularly useful foray into the realm of the affective capacities of the sociomaterial and the agency of the more-than-human. The two other scholars that Bridge et al. put in conversation with Ash Amin and his work, Andrew Barry and Jane Bennett, have become renowned specifically because of their interventions in debates on the nature of such agency. What characterises the work of both Barry and Bennett that Bridge et al. pointedly recognise is their interest in tracing how the material excess of infrastructure becomes political, be it through informational enrichment in Barry's *Material Politics* or through an inherent "thing power" in Bennett's *Vibrant Matter* (2018:41). Therefore, though the two books hold indubitable difference in the agency they recognise to "the material", they both work to inspire this thesis towards questioning *how* the sociomaterial becomes political.

Material Politics

The literature that recognises the imbrication of the material and the political is heterogeneous, as I hope the diversity of lines of enquiry above makes clear. It spans disciplines and theoretical frameworks yet, when read with the aim to make sense of infrastructural reconfigurations that involve decentralised energy technologies and politicised publics, it converges around some key principles. Indeed, the body of work in the social sciences that I mobilise in this thesis approaches the politics of infrastructure and its changes, the specificity of electricity decentralisation, and the agency of the "material" in these phenomena, through a relational, processual approach that recognizes the importance of both constructed discourses and physical materialities. In short, its disposition is to suspend essentialist notions and accept the intimate imbrication of apparently separate phenomena. It is this disposition that allows me to read it productively with critical theory that posits the heterogeneity, porosity, and ephemerality of previously-held hermetic divisions like state-society, society-technology, and nature-technology. And it is this same disposition that, like in Amin's article reviewed above, brings many authors to discuss the material and the social as inherently entangled and to speak of the "sociomaterial".

The notion of the sociomaterial is fundamental to understanding this thesis. For this reason, in the next section I will introduce this concept alongside cognate ideas of co-production, co-constitution and intra-action. These all gesture to the interpenetration of physical materialities and social constructs but hail from different traditions and so are mobilised more often in certain scholarship than others. After introducing these concepts, I will dedicate a similar effort to the ideas of more-than-human agency and affect, which are complementary albeit not interchangeable conceptual tools to approach the dynamism of matter.

I believe it necessary to introduce these concepts because for me they function as the building blocks of the cohesion that I notice amongst the very different literatures I bring together, and they are the easiest entry points into the ethico-onto-epistemology that guides this thesis. They are concepts often mobilised in concert with monist ontologies,

that is framings of reality that conceptualise all matter as belonging to one category (mono) rather than as needing to be differentiated into binaries and hierarchies. Monist ontologies undo such categories, with the result that hierarchies that consign agentic capacities only to elements belonging to the superior alternatives (be it humans in human vs non-humans, the organic in organic vs inorganic, or even experts in experts vs laymen) crumble and lose meaning. And as it becomes impossible to allocate agency based on categorical belonging, theorists start tracing instead how agency materialises in the relations that form between the different elements that make up a phenomenon. For this reason, operating from a point of view that speaks of sociomateriality rather than "society" and "materials", implicates recognising that agency is distributed beyond the "usual suspects".

Both of these conceptual moves, a monist approach to sociomateriality and an openness to the agentic participation of the more-than-human, function as the *traits de union* that allow me to bring together literatures from different disciplines and different objectives. Indeed, it is through these lenses that I come to understand insights from political theory and political geographies of the state as intensely relevant to studies of sociotechnical change and its socio-political implications. I will discuss how this is the case under what, once again imprecisely, I call "Infrastructure Statecraft". Under this umbrella term, I present a review of literature that bridges works on the sociomaterial agency of infrastructure with relational understandings of the assembling of the state and its reproduction. Only when having provided this essential background, will I finally review literature that deals more directly with the sociotechnical transformations brought about by decentralised electricity technologies, which I will discuss under the banner of Distributed Energy Politics.

With this review I have sought to familiarise my audience with some of the texts that inform the granularities of the thesis and with some of the cleavages that remain unexplored even when these scholarships are read in concert. It is precisely to fill these unexplored spaces that I have drafted the research questions that have guided my investigation and that I list in section 1.3. Similarly, I have sought to show my reader that apparently disparate scholarships can be approached productively when reading through texts that share important onto-epistemological grounds. I argue, in the case of this thesis,

that these common grounds amount to some of the fundamental starting points of the New Materialisms, a composite ensemble of research frameworks gaining ground in the social sciences (Coole and Frost, 2013; Fox and Alldred, 2019). On these grounds I have centred my research, from design to the analytical stage, as outlined in Chapter 2.

A Neo-Materialist Codebook

As highlighted in seminal publications in the early 2000s (Bakker and Bridge, 2006; Robbins and Marks, 2010), Human Geography has been experiencing a decisive resurgence of materialist analyses across the many facets of its prism. From this 'materialist return' (Whatmore, 2006), the discipline has gained methodological practices (McCann and Ward, 2012) and both gleaned and contributed a number of generative concepts from and to a growing scholarship devoted to flat, contingent, relational ontologies (Braun, 2008; Castree, 2003; Coole and Frost, 2013; Greenhough, 2012; Robbins and Marks, 2010). Amongst these, feature prominently co-production, co-constitution, intra-action and sociomateriality.

The concept of coproduction emerges from the field of STS and, though heavily theorised in Latour's work on the social production of science (Latour, 1987, 1988, 1996, 2005) is most systematically postulated in Sheila Jasanoff's *States of Knowledge* (Jasanoff, 2004) (Sovacool and Hess, 2017). It speaks to the ways in which the social-cultural (norms, understandings, discourses, and hierarchies) and the scientific-technological (knowledges, practices, and artefacts) simultaneously influence, constitute, and stabilise each other (Jasanoff, 2004). Moving through the disciplines of political ecology, anthropology, and geography, coproduction also often becomes 'co-constitution' (Bijker and Law, 1994) and is used to push forward ontological approaches that refute demarcations of the world into impermeable categories like 'the social' or 'the natural' in favour of descriptives underscoring hybridity like 'sociomateriality' (Carlile et al., 2013; Orlikowski, 2007). Sociomateriality is particularly rooted in a tradition of organisation studies, which in the early 2000s faced the need to confront its objects of study as simultaneously all socially constructed and all material as well (Moura and Bispo, 2020).

The most interesting conversations emerging in this scholarship are those surrounding what in fact is the material, not to be confused with simply that which is "physical". In fact, this scholarship credits the cognitive and the speculative with sociomaterial standing too, with Fenwick offering that materials, or sociomaterials, are no less than stuff "that matter", "both organic and inorganic, technological and natural: flesh and blood; forms and checklists; diagnostic machines and databases; furniture and passcodes; snowstorms and dead cell zones, and so forth" (2014:47). This does not mean that the definitional boundaries of the sociomaterial are uncontested, both within the discipline of organisation studies and beyond (Leonardi, 2012, Hultin, 2019), but the heterogeneity that they encompass helps in mobilising ontologies that approach *all* as matter, such as for example Baradian *agential realism* or Deleuzian *assemblage theory.* A sociomaterial approach is in other words a useful cognate to the mobilisation of monist ontologies that refuse the superiority of one category in dualist divisions of reality.

Indeed, a sociomaterial perspective foregrounds the labour of relations in stating that everything is materialised into becoming by the performance of networked relations, which enact matter. In this way, the sociomaterial is "enacted, not inert; [it is] matter and [it] matters" (Fenwick, 2014:47). The idea of sociomateriality is thus coherent with Barad's concept of '*intra*-action' (Barad, 2007) as well, whereby all things are not treated as homogenous separate entities that interact but rather as non-unitary intrinsically entangled co-constitutive forces in complex assemblages (Fenwick et al., 2015). In simpler words, what Karen Barad coins as "intra-action" is a conceptual intervention that foregrounds the intimate nature of relations by showing them to perform the materialisation of difference. Through intra-action, relations are shown to matter not by linking elements with others (inter-action) but in shaping the form and capacity of those linked elements as the linking occurs (intra). Intra-action thus summarily conveys a similar message to that provocatively put forth by another key text that informs the scholarship on sociomateriality: Tim Ingold's "Materials against Materiality" (Ingold, 2007).

In this 2007 article, the anthropologist pushes his readers to think beyond "what makes things thingly", a debate that as mentioned above occupied many interested in the

"materialist return", and to consider instead what properties materials may have. Through his discussion, what emerges is a refusal to distribute capacities previously given to those with thought or soul or another essentialist requisite to entities previously considered to lack these requisites. Ingold in other words foreshadows what will years later constitute one of the strongest critiques levelled against some of the "new materialists", that is a tendency to simply attribute life to the lifeless, an animist disposition to the inert, which recognises to the "non-human" agentic capacity of various sorts (Povinelli, 2016). He pushes a relational understanding of agency, whereby materials are "active" because they are the enmeshed materialisation of a series of processes and fluxes (Ingold, 2007). In this way, agency is not something that can be had or a capacity but rather a networked outcome of contingent relations.

Mobilising a sociomaterial approach thus entails moving past the socio-economic production of nature (Bakker and Bridge, 2006) and recognising the active role of all matter, rather than historical-materialist structures or postructuralist dispositives (Moss et al., 2016), in constituting what is commonly thought of as "social". And similarly, it requires one to understand everyday materials as always relationally constituted by a myriad of factors that escape the social/material binary. Such an ontological disposition, albeit at times not explicitly, also functions as one of the conceptual bases for the literature exploring the imbrications of energy transitions and the state that I will review shortly when discussing Infrastructure Statecraft, which is rooted precisely in acknowledging the everyday relational production of both stateness and energy.

To zoom into literature that more closely matches the empirical focus of this thesis, the concepts of co-production, co-constitution, and sociomateriality have often been applied to studies of energy and energy politics. Heavily used in sustainability transition literature as an evaluative framework and a guidance tool for sustainability policy and governance (Miller and Wyborn, 2018) co-production is also mobilised in conceptual efforts in energy research. Chilvers and Longhurst, for example, muster co-production to theorise participation in energy transitions, suggesting that energy collectives construct "the subjects, objects, and procedural formats of public engagement", which in turn

produce energy visions and participation models (Chilvers and Longhurst, 2016). Instead, the concept of co-constitution appears mostly in literature on the political ecology of resource governance and environmental change. In this body of work, Ahlborg and Nightingale for example intervene to conceptualise *where* power is located in resource governance processes. They build on literature on co-constitution to show that in the electrification process of villages in rural Tanzania human agency is sided by what, following Allen, they call the "constitutive power" of the non-human. They thus show shifts in power relations following the electrification process to be co-constituted by electricity itself, which they claim "destabilizes social hierarchies by opening up new room for manoeuvre" (Ahlborg and Nightingale, 2018: 392).

The concept of the sociomaterial features often in studies that think through the role of the non-human in political participation. In STS, Noortje Marres' engagement with the works of pragmatist theorists such as John Dewey and Walter Lippman, has produced an interesting literature on the role of everyday energy objects in constituting publics (Marres, 2007, 2012, 2013). Marres posits that publics should be understood as sociomaterial entanglements of everyday objects, ideas, practices, and people, building on the notion that publics come together by responding to an issue and by simultaneously making something into an issue. She shows how objects like the ecological kettle allow/enable/afford human participation in environmental politics by enacting such participation physically (2007). Similarly, focusing on "technologies of elicitation" Lezaun and Soneryd have shown how energy technologies, amongst others, enrol publics around specific issues (2007). Lezaun and Marres have in fact been working together on this idea for the past fifteen years, in 2017 publishing together with Tironi a review of "scholarships that […] have developed a materialist, situational and performative understanding of the making of publics in technological societies" (2016).

The scholarship in energy social science that mobilises the idea of materials enrolling publics hailing from this tradition in STS has been explored in literature largely concerned with interactions with the everyday objects of energy consumption (Marres and Lezaun, 2011; Michael, 2016). Instead, excavating the generativity of materials-publics

encounters on a larger scale, geographer Andrew Barry has shown how materials along the Baku-Tbilisi pipeline come to embody information whose circulation then generates publics with specific politics (Barry, 2013). Though this study may appear as similar in objective to the work of Marres on "material publics", it approaches the way in which things come to matter in politics from a different angle. Indeed, if in Marres' work energy objects become agentic through their relations with their users and the ways in which their physical characteristics mediate and enable specific political effects, in Barry's conceptualisation it is in processes of informational enrichment that agency materialises. These differences are subtle, but they speak of larger conversations about how to mobilise ontological approaches that recognise dynamism to all matter through the concepts of more-than-human-agency and affect.

More-than-human Agency and Affect in this Thesis

The pursuit of non-representational theories has pushed the discipline of Geography to attend to contingency, to practices, and to the role of the non-human in processes of change. In the process, geographers have increasingly turned to conceptualisations of more-than-human-agency and affect. The two concepts are indeed often summoned to speak of the ways in which encounters and processes of materialisation form and change orders, influence people and practices, and physically inscribe power relations (Baker and McGuirk, 2017; Barnett, 2008; Coole and Frost, 2013; Thrift, 2008). If *more-than-human agency* has shown to be useful in thinking about the power arising from networked agents in assemblages of people, bodies, things, discourses, practices etc., *affect* has largely been used to foreground the emotional geographies emerging from being in such relational assemblages.

While the two concepts diverge in terms of their focus on the liveliness of the sociomaterial, both speak of a reality populated and produced by active elements, bodies that can be defined as such because of their ability to impact one another, to "affect" (Deleuze, 1988). Affect theory takes seriously not only the sociomaterial's ability to produce emotional responses but also such responses' capacity to materialise realities and produce space (Mehrabi, 2018). In human geography, the mobilisation of affect as agential

capacity was pioneered by Nigel Thrift, whose theories of non-representational geographies deal directly with the political relevance of affective space (Thrift, 2004, 2006, 2007). For this reason, though I do not draw on the rich literature on the "affective" to make the arguments put forth in this thesis, I do often use the language of affect to comment on the propensity of matter to "*work upon"* when encountering other matter (Abrahamsson and Simpson, 2011).

And even if the selection of citations above may misrepresent the practice of recognising agency to the more-than-human as largely attributable to the ontological tradition of immanence originated in the oeuvre of Spinoza and matured in the works of Deleuze (Coole, 2013), this is in fact not a unitary effort or one traceable to a single genealogical point. Rather, distributing agency outside of humans takes on divergent meanings within the literatures in the social sciences, from notions of 'affordances', i.e. "what environments furnish for the purpose of a subject" (Barua, 2016: 730; Ingold, 2002), to atomist theorisations of lively matter in political theory (Bennett, 2010), to ideas of agency as "'doing' or 'being' in its intra-activity" (Barad, 2007:178), to conceptualisations of human actors and non-human actants becoming agentic in "networked intentionality" (Latour, 1993: 261). Mirroring this variance, geographers have resorted to theories and methodologies from disparate disciplines to approach decentred forms of agency, from— perhaps most often— Actor-Network-Theory and Assemblage Theory, to "feminist technoscience, queer ecologies, post-humanism […] and environmental psychology" (Bakker and Bridge, 2020: 50). That Assemblage Theory and Actor-Network-Theory have been widely used in Geography is no coincidence, for both propose a framing of the world that unearths the spatiality of power and politics, questioning how particular orders emerge, become stabilised, and change (Müller and Schurr, 2016). For this reason, they both offer useful framings to operationalise more-than-human agency in order to understand sociotechnical transformations.

However, in this thesis, though more-than-human-agency is a central concept, Actor-Network-Theory and its methodology are conspicuously absent. This is because the texts that inspire my own understanding of more-than-human agency and its analytical

value are the bodies of work of Deleuze and Guattari and Karen Barad, works that though cognate to the postulations on Actor-Network-Theory, amount to ontological theorisations in their own right. I will elaborate on the ontological implications of assemblage thinking and Baradian agential realism more in depth in Chapter 2, but it's now imperative for me to provide a brief sketch of more-than-human agency in Actor-Network-Theory and explain why I choose not to engage with it beyond gleaning some of its vocabulary.

To A-N-T or Not To A-N-T

Actor-Network-Theory is a framework that originated in the field of Science Technology Studies in the 1980s from the independent works and cooperation of Bruno Latour, Michel Callon and John Law. Initially focused on the problematisation of scientific knowledge and production, Actor-Network-Theory suggests a "flat ontology" whereby entities are not identified by their form or scale but are recognised as having the ability to influence outcomes when entering in association with each other. In fact, Latour has described Actor-Network-Theory as a "sociology of association" (Latour, 2005). Importantly, recognising agency in the more-than-human in Actor-Network-Theory does not stem from an ontology that recognises all matter as being the same, but rather from a "material semiotic" (Akrich and Latour, 1992) position, according to which the essence of any entity does not matter, what matters is how these entities come in relation with one another (Law, 2019). In this way, Actor-Network-Theory is already simultaneously concordant and discordant with the approaches to the sociomaterial detailed above. Indeed, if a refusal to reduce everything to the same "stuff", is inconsistent with a monist approach, focusing on the effect of relations betrays a processual approach that is akin to theories of "becoming" and is absolutely consistent with the notion of sociomateriality.

As the name suggests, what matters in Actor-Network-Theory is the *network* of relations between entities, which are at times termed actants if referring to the non-human. In this framework, the more-than-human acts as a mediator, as an element able to translate human actions in surprising ways (Sayes, 2014). In Latour's words "objects are not means, but rather mediators – just as other actors are. They do not transmit our force faithfully,

any more than we are faithful messengers of theirs" (1996:290 in Sayes, 2014). The objective of a scholar mobilising this framework is thus that of tracing the network of relations between different actors and actants and showing how some of these influence the outcome of this association. What has been critiqued as lacking in Actor-Network-Theory, however, is a recognition of the socio-historical-discursive context that operates onto these networked associations and in which such associations themselves operate (Müller, 2015).

For this reason I, like many other colleagues in Geography, choose to stay with the concepts originating from the tradition of assemblage and agential realism to speak of the ways in which agency materialises in the sociomaterial. Indeed, as McFarlane notes, 'unlike network, assemblage […] draws attention to history, labour, materiality and performance. Assemblage points to reassembling and disassembling, to dispersion and transformation, processes often overlooked in network accounts' (McFarlane, 2009: 566). In other words, assemblage thinking is not afraid to deal with the "virtual", with what, that is, cannot be traced as having an immediate effect on perceived associations (Muller, 2015). Moreover, as Muller and Schurr note (2016:220), Actor-Network-Theory focuses on relations that have already formed and become stabilized, whereas assemblage thinking allows investigations into the potentiality of relations. In fact, more-than-human agency is in assemblage thinking *emergent,* a term that foregrounds the "internal effulgence" (Coole, 2013:456) of matter. This approach recognises a disposition of all things toward nomadism and movement, a vibrancy which allows them to "be social agents, making things happen" (Fox and Alldred, 2019: 3). Similarly, in Baradian agential realism, agency is conceptualised as "the very possibilities for reworking and opening up new possibilities, for reconfiguring the apparatuses of bodily reproduction" (Juelskjær and Schwennesen, 2012:17).

This is why I use assemblage thinking and agential realism as theoretical frameworks that support this thesis rather than actor network theory. I do so because it allows me to focus on processes in formation rather than what is already formed and stable. This thesis speaks of an energy transition-in-the-making: doing so signals how the process

it is mapping is not complete but rather in motion and thus full of potential. This is a terminology used before in studies on the production of the future (Adam and Groves, 2007) that gestures to the emergent becoming of the processes of change under study, a status that makes it so the assemblage in which the researcher operates is not stabilized into a clear "new" version of an older system but rather still undergoing instability and uncertainty.

This thesis gestures to the materialities of the energy transition in-the-making constituted by a move to a power system permeated by renewable distributed generation and allowing collectivised prosumption to account for the role of events of disruptive sociotechnical change in shifting relations of power, transforming imaginaries of sovereignty, and enabling moments of change in otherwise recursive temporalities.

Infrastructure Statecraft

What I term "infrastructure statecraft" is a collection of works that brings the recognition that infrastructure is political in conversation with the literature that highlights the co-constitution and assembled-ness of statecraft and stateness. This is not a scholarship defined by clear disciplinary boundaries, nor is it really a coherent field populated by scholars constantly in conversation with one another. Rather, I am under this banner bringing together the works of scholars that share important references from the much more well-defined realm of infrastructure politics and engage with the material reproduction of the state. Therefore, my first task is that of sketching the key lines of thought of the literatures that constitute the theoretical foundations of the works I review in this section.

The concept of infrastructure politics has provided fertile soil for scholars in the social sciences. It has allowed many to think through infrastructure as complex socio-technical systems whose elements *recursively* relate with their users, collective visions, logics of population control, and more (Harvey and Knox, 2016). In other words, it posits that infrastructures are not systems that exist outside of the socio-political but rather inside of it, constantly shaping it and being shaped by it. Though this idea has travelled widely, its genealogy can be traced specifically to the disciplines of anthropology and STS. This is

beautifully done in the Routledge Companion *Infrastructures and Social Complexity*, where the authors tell a compelling and detailed story of how the politics imbricated in infrastructures came to matter to the social science ((1999). I present below a much barer map, pinpointing only works that have actively contributed to my own understanding of the concept or I have found informing the works that I group under the term "infrastructure statecraft".

In this vein, the key text in anthropology on the politics of infrastructure is Susan Leigh Star's "The ethnography of infrastructure" (1999). In this text, Star de-mystifies infrastructure by delineating how it encompasses myriads of artefacts and processes that provide every-day spaces of encounter and should thus be understood relationally. She considers infrastructure as an entity that takes on different meanings depending on the groups that interact with it. In her words, if the water system is an infrastructure in so much as it provides an integral tool to the act of cooking, that same system may be approached as a variable in city projects by an urban planner or as a site of repair by a plumber (Star, 1999:180). Even in defining infrastructure itself, indeed, Star follows Bateson to argue that what *can* be defined is the relationship that infrastructure engenders rather than "a thing" (Bateson, 1978 in Star, 1999:379). This is a fundamental starting point to the study of infrastructure politics as it foregrounds the impossibility of exhausting the physical, virtual and social configurations of infrastructure and points researchers instead to unearthing *how* infrastructures operate on the "social" and are constituted by it.

Specifically, Star builds on her ethnographic sensibility to suggest three methodological tools for the analysis of infrastructure. The first is that of "identifying a master narrative" (ibid:384), a move to recognising the universalising claims that are encoded in the prosaic elements of infrastructure. This first approach is most akin to the concept of technopolitics reviewed above, as it attempts to discern the political intention initially designed into infrastructure and to trace how such an intention changes as it materialises in encounters with different infrastructure users and mediators. The second tool is that of "surfacing invisible work" (ibid:385), here the focus on information systems in Star's work is particularly evident, as the attunement that the author proposes to discovering the labour that is deliberately or habitually made invisible is particularly

productive when studying infrastructures that are in themselves carriers of meaning. Lastly, the third tool Star puts forth is that of staying with the "paradoxes of infrastructure".

In this case, Star shines a light on what, using the same term as Hughes, she calls the "obduracy" of infrastructure systems. Obduracy however here takes a different meaning as it signs to the idea that infrastructure users may elect to continue using that particular infrastructure even if more efficient alternatives are available simply because the new system may present small complications. She claims that this is the case because what is at hand in the use of infrastructure is not just a "user-with-system" interaction, but also the assembling of a myriad of processes that allow that interaction to take place. This insight is particularly inspiring to me because once again it underscores the prosaicism of infrastructure, its functioning through the coordination of multiple components, human and non, and the resistance that such multitude entails. In fact, the "paradox of infrastructure" that she delineates foreshadows one of the key discussion points in Chapter 3 of this thesis, which shows how changes in power system configurations and the legislation they inspired did not translate immediately into changes in the administrative processes of state bodies. Rather, the chapter argues that the multiplicity of the state assemblage and its reliance on prosaic procedures makes it resistant to change, or as Star put it, "obdurate". A similar insight also most recently appears in Hannah Knox's *Thinking Like a Climate,* where the author's commitment to staying with the artefacts and practices of climate change politics provides a picture of enmeshed elements that resist change (2020).

The other seminal text that informs this thesis and I argue traverses many of the works dealing with "infrastructural statecraft" is Larkin's 2013 "The Politics and Poetics of Infrastructure". Ironically, the most influential notion from Larkin's article to this scholarship comes from his discussion on the "poetics" of infrastructure. Indeed, he shows that though infrastructures often operate in ways that are invisible (an idea put forth by Bowker in 1995), they are also often designed *specifically* to be seen and to awe their viewers. It is through visibility that infrastructures acquire a poetic capacity. And it is this poetic capacity, the ability that is to convey specific visions and symbolic meanings, that allow infrastructure to be intensely affective systems. In highlighting this affective relation in his review, Larkin underscored what some anthropologists had only recently began to

argue (Harvey and Knox, 2012) and one of the most generative ideas for the pursuing of "infrastructure statecraft". Indeed, though it is not a new notion that especially large, centralised infrastructures have participated to the reproduction of state power in making territory legible (Scott, 1998), that infrastructures act as powerful affective elements has more recently allowed scholars to show that they participate in the re-production of stateness in ways that are intimately material.

The authors that I argue are working on "infrastructure statecraft" put this notion in relation to seminal contributions in political geography that have attempted to reconceptualize the state as emerging unevenly in everyday social interactions, state practices, and stories of statehood (Evans et al., 1985; Mountz, 2003; Painter, 2006; Secor, 2007). This is an effort started in political theory, fundamentally working to conceptualise state-formation as an ongoing process (Timothy Mitchell, 1991; Steinmetz & Schaeffer, 2001). This tradition in political theory and the political geographies of the state is more widely reviewed in Chapter 3 of this thesis, under the subtitle "The state in post-structuralist theories: as effect, as prosaic, as assemblage". For now, the text that I would like to highlight is Keller Easterling *Extra Statecraft* (2014).

In this monograph, Easterling convincingly argues that networked infrastructure, in all of its connotations, from speculative to digital to financial to physical, multiplies and distributes sovereignty not only to the state but to other actors too. The "extra" in her *Extrastatecraft* thus hints not at a simple story of power moving from the state to private corporations, but once again to a Groszian "spatial excess", whereby the infrastructural is able to multiply power "both outside of and in addition to statecraft" (Easterling, 2014). Indeed, she shows infrastructure to have "consequential political outcomes" outside of the "dominant stories that portray them" through what she terms "disposition" (Ibid, 71).
She carefully argues that infrastructured space opens up ways to state, non-state, market, activist, and individual actors to participate in governance strategies and attain administrative authorities through a "potential" that is emergent and "immanent in the relationship between components" (Ibid, 72). Through disposition, Easterling speaks of "the character or propensity of an organization that results from all its activity", of a

potentiality, that is, that goes beyond the intent imbued in that infrastructure or in the sum of its designs (2014, 21).

Easterling thus explores how the more-than-human affects and shapes politics because of immanent dispositions. She shows how these arrangements allow territories to emerge where stateness is no longer relevant as the dominant infrastructures that shape the politics allow instead neoliberal control. In this line of argumentation, her work is remindful of Graham and Marvin's influential text *Splintering Urbanism* (2001). Indeed, in this seminal work, the authors show how networked infrastructures are embedded in and co-produce social, political and economic relations at multiple scales, thus contributing to an "infrastructure turn" in urban theory. And, famously, they show how this sociotechnical process of socio-political reproduction allows for the splintering of space into territories capturable by disparate actors and governance logics. Though this work has indubitably inspired a rich and diverse scholarly tradition in critical urbanism and beyond (Mcfarlane and Rutherford, 2008; Rutherford and Jaglin, 2015) the works that approach "infrastructure statecraft" like I do in this thesis draw on another idea implicated in Easterling's work: that infrastructure works as part of the prosaic construction of the state, its apparatuses, and its imaginary.

Once again, in the literature review for Chapter 3, which is specifically dedicated to the entanglement of changing energy infrastructure configurations and the state I will present more scholarship that expands on this idea of "infrastructure statecraft". Nonetheless, I believe it important to discuss an example of such line of thought to showcase how it prompts up this thesis and participates in inspiring its aims and objectives. A good illustration in this sense is Power and Kirshner's 2018 paper "Powering the state". In this article, the authors show how both the material and the symbolic processes of large-scale electrification are powerful tools for state re-production, for the ability of the state, that is, to both wield its power and narrate its presence (2018). They show the state to be enacted rather than to exist categorically, and follow how electricity infrastructures allow it to assemble (or become, come into being) in specific ways. Most importantly to this thesis, they show changes in electricity infrastructures to represent fertile moments for

public enrolment in dominant narratives of citizenship as participation in a movement toward modernity spearheaded by the state (2019). This is an important reminder that the materiality and spatialisation of infrastructural change can incentivise the formation of publics with specific interests who may act disruptively to embedded relations of power (Luque-Ayala and Silver, 2016) as much as they may re-enforce such dominant relations.

When read in concert with literature on the ability of infrastructure space (Easterling, 2014) and energy materialities (Huber, 2009; Mitchell, 2011) to impact the organization of statecraft and determine the "fate of the nation" (Antonsich et al., 2020; Bridge et al., 2018) this emerging conceptualization of the nexus between infrastructure politics and the state appears particularly fertile with untapped potential for research. Indeed, the scholarship remains overly concerned with case studies showing the ability of conventional, large-scale infrastructure to reinforce the legitimacy of the State (Braun and Whatmore, 2010; Harris and Alatout, 2010; Harvey et al., 2016), while ignoring the workings of small-scale, distributed disruptive infrastructures and their latent capacity to re-assemble the State. This project therefore chooses to refocus the wielding of infrastructure politics away from large infrastructures towards the apparently minute of distributed electricity generation. I say apparently because as I will show through the chapters to come, distributed energy politics does not begin and end at the scale of the collective that each decentralised electricity scheme may serve, but rather functions as a multiscalar milieu.

Such an emphasis on decentralised energy infrastructures is meaningful as it allows a line of enquiry into the reterritorialisation of alternative or "nested" forms of sovereignty (Simpson, 2014). Indeed, if state building is approached as continuous, relational, and processual, the power the state exerts cannot be conceptualised as unitary but needs be seen as similarly emerging from transient relations within heterogenous assemblages. Following in the tradition of complicating the spatiality of sovereignty by "seeing like a city" (Amin et al., 2017; Magnusson, 2013; Valverde, 2011) instead of "like a state" (Scott, 1998), I focus on the materialities of regional and municipal energy infrastructures to explore possible reterritorialisations of sovereignty at the subnational scale. Mobilising a relational approach to power akin to theorisations in feminist theory and political ecology (Ahlborg

and Nightingale, 2018), then, a close study of the disruptive decentralised infrastructures of distributed generation opens conceptual space. It allows me to investigate the imbrication of infrastructure politics with notions of the ability of the built environment to—at least temporarily— crystallise power relations (Asher and Ojeda, 2009; Harvey, 2010) and territorialise sovereignty, both in ways that are counterhegemonic (Alarcón Ferrari and Chartier, 2018) (Addie et al., 2020) and in ways that in fact reinforce dominant power structures and the State itself (Power and Kirshner, 2019).

Also inspiring this thesis is a growing literature on the political potential of renewable distributed electricity technologies that foregrounds the way they challenge metabolic flows that have structured politics for years (Mitchell, 2011), the spaces they open for participation (van Veelen and van der Horst, 2018), and the political power they afford (Boyer, 2014). Based in energy geographies but finding new grounds in sustainable transitions studies and energy social sciences more broadly, this literature coalesces around the concept of Distributed Energy Politics to which I now turn.

Distributed Energy Politics

Arguably a resurgence of the scholarly and political traditions surrounding the "ambivalence of technology" traceable back to the Frankfurt school (Alarcón Ferrari and Chartier, 2018: 1758), the 'small is beautiful' agenda tying communitarian politics to small-scale technological deployment (Schumacher, 1973), and analyses of the structuring nature of technological "radical monopolies" (Illich, 1974), the idea of distributed energy politics re-emerged in activist circles in Europe, and especially in Germany, during the initial deployment of renewable energy technologies in the early 2000s (Byrne and Toly, 2006). Most often now mobilising the term "energy democracy" activists across the North Atlantic who speak of distributed energy politics pursue diverse and at times incongruent goals (Burke and Stephens, 2018); they nonetheless share the basic belief that, because of their design, low capital cost, and relatively easy upkeep, distributed forms of electricity generation make space for and afford a more democratic political system, or to put it concisely, that "distributed energy sources and technologies enable and organize distributed political power and vice versa" (Burke and Stephens, 2018: 78).

Only gaining traction in academic circles in the past few years (Becker and Naumann, 2017; Burke and Stephens, 2017), the concept of energy democracy is increasingly applied descriptively to characterise local energy transitions (Allen et al., 2019; Burke, 2018; Delina, 2018; Stephens et al., 2018), mobilised normatively to depict desirable emancipatory forms of such transitions (Becker and Naumann, 2017; Hess, 2018; Thombs, 2019), or discussed reflexively in attempts to delineate conceptual and methodological agenda (Chilvers and Pallett, 2018; van Veelen and van der Horst, 2018). Scholars who engage with the concept take seriously the position that energy transitions contribute to sociopolitical transformations and trace how the very objects (Marres, 2012), visions (Goulden et al., 2014), and processes (Delina, 2018) of distributed generation as well as participation in distributed generation schemes (Pesch, 2019) respectively coproduce normatively democratic structures in ways that are material, constructive, deliberative, and associative (van Veelen and van der Horst, 2018; Chilvers and Pallett, 2018).

This scholarship is particularly enamoured with a specific form of distributed energy: renewable community energy. These are distributed energy schemes that, as I will expand more on in Chapter 4, often involve collective ownership, specific democratic ideals, and profit redistribution tactics aimed at benefitting entire communities rather than only shareholders. For this reason, they are increasingly discussed as holding political potential especially when they are owned or managed by communities. Scholars have identified projects involving collectively owned small electricity generation capacity as endeavours that open new spaces for communal ownership of parts of the electricity system as well as democratic participation in it, as well as possibilities for schemes of wealth distribution (Berka and Creamer, 2018). Accordingly, decentralised energy generation projects are increasingly studied as accelerators of deeply political local energy transitions (Angel, 2017; Burke and Stephens, 2017; Forman, 2017; Koirala et al., 2016; Martiskainen et al., 2018; Morris and Jungjohann, 2016; Mundaca et al., 2018; van Veelen and van der Horst, 2018).

A few geographers and anthropologists are also taking a more STS-inspired approach to trace how the ‘materialities’ of distributed energy schemes affect and

transform power relationships (Blok, 2017). Some of the themes emerging from this newer literature take inspiration from established academic work that has looked at the politics of energy at the microscale. For example, Helen Ahlborg's work on mini community-owned hydropower in Tanzania, which I will review more in depth in 1.2.5, recalls Elizabeth Shove's effort to apply Social Practice Theory to energy use. Shove unearths how energy consumption practices are deeply imbricated with particular gender, household, and community power dynamics (Shove, Pantzar and Watson, 2014; Winther *et al.*, 2017), turning the investigative lens away from the mega structures of political-ecology that portray energy systems as gargantuan and far-reaching. Without discounting the national and international effects of such systems, Shove shines a light onto how deeply powerful these practices are at the household level.

A particularly powerful idea emerging from Shove's scholarship is that of foregrounding social practices when thinking about how to govern transitions and write energy policy (Shove, 2012). This move helps refocus energy social science on the view that energy demand and energy supply are not self-standing phenomena that exist in isolation of social activities (Shove, 2017) but rather processes that follow such activities and whose infrastructures crystallise into space the continuing of the same pattern of practices into the future. To underline practices, in other words, does not mean foregoing how energy systems and their spatialisation have socio-political effects. More so, it foregrounds that such materialities both emerge to serve specific social practices and contribute to embed these same practices in the fabric of the "everyday".

The emphasis in Shove's work on practices rather than artefacts is echoed in another strand of literature that deals with changing energy systems as socio-political and sociomaterial. This body of work points to the agency that emerges not so much in relations with the "materials" of energy systems, but rather in the relational formation of energy *knowledge* practices. This scholarship draws attention to how accounting techniques, economic models, and even fictional expectations impact the realm of possibility of system change (Callon and Muniesa, 2005; Beckert, 2013; Niskanen and Rohracher, 2022). Recently, Envall and Rohracher have contributed to this literature by foregrounding how dominant energy practices "shape the possibility corridor" for renewable energy

communities, determining what is understood as feasible or entirely unattainable even while imagining ways to implement these schemes (2023:6). This is an important line of inquiry because it begins to unravel the ways in which distributed energy schemes and energy communities more specifically function in relation to established technopolitical systems and imaginaries, thus meeting these new energy arrangements in their unfolding becoming rather than speculate about their potential. Rather than look for the ways in which decentralised and collectivised renewable energy schemes may be fulfilling their promises for energy democracy and energy justice, the authors carefully map how renewable energy communities in Sweden are intra-acting with jurisprudence and sociotechnical imaginaries of energy. Envall and Rohracher do not use the term "intra-action", but I believe this accurately represents the relational dynamic they trace as they show that these energy assemblages do not only contribute to the transformation of the wider energy system in Sweden, but are also themselves changed in their configuration and affordances as they become regulated and incentivised.

In this thesis, I adopt a similar standpoint: that energy transitions, even while in-the-making, need to be studied for how they function rather than how they may do in theory. This is not to discredit the virtual or the speculative, both of which have been skilfully shown to participate to the assembling of sociotechnical systems and their futures. Rather, this move helps me stay cognisant of the threat of becoming enamoured with what Byrne and Toly call *centaurian technics* (2006:22), sociotechnical development that is that appears to be revolutionary (like a centaur appears to be human from afar) but stands on old systems (like the centaur on its horse hind). In a 2006 article, "Energy as a Social Project", the authors indeed remind their audience that despite the many aspirations and dreams that have been associated with renewable energy technologies, such artefacts are only part of a wider system, and when implemented through unjust configurations, they may function as the pretty head that disguises a much larger body of extractivism and injustice that remains unchanged. This is a fundamental pillar in the theoretical frame that holds my thesis, as it shifts my focus from potential glimmers of the promises of new sociotechnical formations towards the complex ambiguities of how their deployment is unfolding and participating in the socio-political.

Rather than just attributing to decentralised technologies decentralising capabilities, therefore, I choose to follow the leads of scholars who are increasingly investigating *how* infrastructural systems and their changing configurations impact governance structures. This follows the direction Winner indicated, now sixty-three years ago, in showing an attentiveness to the socio-political productivity of artefacts without a foregoing of their enmeshment in historical and spatial contextualisation. And I am certainly not alone in this effort. For example, Lawhon et al. propose the tool of "heterogenous infrastructure configurations" to think through the granularity of infrastructures as artefacts that embed and are embedded in complex relations of power, involve multitude of actors both human and more-than-human and entail different risks. They start from scholarship and empirical work located in the global South to point to the idea that "existing infrastructural power relations shape conditions of possibility: such relations can enable or constrain new opportunities as well as provide a focal point for new social relationships" (2018:729).

Lawhon et al's work shows how one can avoid romanticising the *potential* of distributed energy schemes while not dismissing entirely how such innovations *are* in fact working on the assemblage of established energy systems in fascinating ways (Lawhon *et al.*, 2018). However, just like published literature concerned with infrastructure politics has tended to focus solely on the large-scale state-legitimising effects of conventional infrastructures, scholarship on distributed energy politics has remained overly concerned with the material coproduction of power dynamics at the individual or community level. Community energy schemes have, in other words, been often assumed to only be disruptive of social relations that envelop the people that participate in them. This presents a blind spot for the energy social sciences, as it ignores the effects that the spatial, social, technical, material, practical changes that deploying decentralised electricity schemes demands and implies are having on wider sociotechnical and socio-political assemblages.

Indeed, by staying with the microscale of distributed energy politics, geographers are falling short of engaging with how changes in the infrastructures of energy provision may materialise new scales (Bouzarovski and Haarstad, 2019) and possibly territorialise new sociotechnical imaginaries that encode sovereignty in ways that reflect the novelty of such scales. This is especially surprising when considering the scholarly tradition

conceptualising technology as "one of the major sources of public power in modern societies" (Feenberg, 2001: 87; Harvey, 2010), the well-established recognition of the works of infrastructures in sociotechnically encoding imaginaries of the nation (Jasanoff and Kim, 2009), and seminal works in the energy social sciences that have explored the historical role of the design of the electric utility system (Reynolds and Hughes, 1984) and of dominant fuels (Dominic Boyer, 2011; Huber, 2015; Mitchell, 2011) in allowing forms of political organization to emerge.

Some of the works that I cite here and elsewhere under the banner of "infrastructure statecraft" and hailing from resource and energy geography have thought through the far-reaching effects of electricity infrastructure change, but have done so by focusing on massive electrification efforts. Scholars have traced how the installation of conventional, centralised electricity networks have crystallised centralised regimes of power (Harrison, 2016), or how modern state formation has always been intimately linked with the "deliver[y of] non-human nature to accumulation" (Parenti, 2015). Smith and Tidwell have even ethnographically shown how practices of energy production and familiarity with their infrastructures "engender[] a local […] sociotechnical imaginary of energy" very different from that which circulates at the national level (Smith and Tidwell, 2016: 344) but their work does not appear interested in connecting how such a bounded sociotechnical imaginary may be challenging the production of national imaginaries for the people involved in the electricity production assemblages under study.

But if accepting that the reproduction of the state and its centralisation have historically been bolstered by large centralised systems of electricity provision, it is only logical to ask what happens to the state when these large systems change and admit moments of decentralisation. It is similarly logical to try to discern how specific policies may emerge as results of the processes of an energy transition in-the-making if accepting that energy transitions impact governance. I have therefore approached the sociotechnical change unfolding in front of me as capable of both crystallising power in dominant structures (re-territorialisation) *and* of disturbing such power structures in interesting ways (de- territorialisation). I have chosen to wield the concept of distributed energy politics to follow how previously physically crystallised/territorialised power relations may be made

malleable by the addition of new infrastructures in the built environment and potentially de- and re- territorialised to benefit new actors, political projects, and imaginaries of the nation.

In doing so, I am inspired by those who have dealt with the material politics of small-scale, decentralised experiments in electricity generation. Even though the scholarship that both focuses on small-scale decentralised electricity generation and deliberately focuses on the agency emerging from "materiality" of these schemes is smaller than the wider conversations presented above, it is certainly influential in inspiring this thesis. The section below therefore reviews some of these works and categorises them according to the ways they approach "materiality".

Materiality in Community Energy Literature

Bakker and Bridge authored a seminal paper on the use of materiality in resource geographies in 2006, which has since informed scholars across the social sciences in their use of the concept (Bakker and Bridge, 2006). In a recent chapter (Ibid, 2021), the authors return to their original contribution and sketch four ways in which materiality has since been mobilised, nominally:

1) Materiality as the constitutive co-presence of the non-human
2) Materiality as ontological politics
3) Materiality as a generative friction
4) Materiality as the potentiality of nonlife

In this categorisation, the works cited are not differentiated in terms of the objects or materials they study but rather, and more meaningfully, in terms of the motivations behind their mobilisation of materiality and the ontological positions that these imply. For this reason, such a classification is more useful to this thesis than others looking specifically at the use of materiality in the energy social sciences that flatten ontological differences in favour of the recognition of convergences around the specific loci of materiality, its composition, its purposes, and its analytical role (Balmaceda et al., 2019). Following Bakker and Bridge, this section thus approaches the literature speaking of materiality in

the study of decentralised energy schemes as a heterogenous field whose most salient demarcations follow the different ontological motivations for which materiality is invoked.

In the camp of "*materiality as the constitutive copresence of the nonhuman*" figure contributions from an interdisciplinary field that approaches the study of decentralised electricity experiments like energy communities relationally by mobilising the concepts of co-production and co-constitution. In these articles, materiality is invoked as a well-defined category belonging to the non-human element of the processes under study. Laurence Delina, for example, uses the case study of a collective working for a sustainable energy transition in Pa Deng, Thailand to show energy democracy to be possible even under non-democratic government structures thanks to public engagement being "co-existent, collective, cultural contingent, co-produced, critical, consequential and connected" (Delina, 2018, p. 42). In his account, materiality is one of the many elements in the community energy project of interest that create the context under which democratic practices can thrive. It is important as far as it is different from the cultural and social factors producing public engagement and thus needs to be taken into consideration separately.

Such an approach to materiality is consistent across the literature in this category, where discussions of "materials", "matter" or "materiality" consist of a recognition of the constituent role of the non-human in sociotechnical processes (see for example (Hodson et al., 2016; Jolivet and Heiskanen, 2010; Sareen and Haarstad, 2018). Though highlighting the co-constituted nature of community energy practices and processes and underscoring how the social is unescapably permeated by the workings of the material, these works mobilise a relational approach that maintains "residual realist" tendencies. Inspired by Chilvers and Kearnes (Chilvers and Kearnes, 2016), what I mean by "residual realist" is an approach whereby the use of relationality is circumscribed to foregrounding the productive work of relations and opening the black box of the category of "the social" rather than expanded to the abolition of all pre-existent categories. Materiality is confined to the evidently material, like battery storage or solar panels, and it matters only as being part of the constitutional elements that relationally participate to community energy

processes and practices; there is no focus on the ways in which it comes to be materialized and no interest in attaching agency to it.

Fewer articles can be ascribed to the "*materiality as ontological politics*" category, where community energy is investigated in terms of the ways in which the production of specific knowledge about energy gives its materials meaning and presence. In a 2017 article, Myles Lennon for example postulates that the concomitance of the proliferation of photovoltaic solar panels and the spread of the intersectional ideology of Black Lives Matter has produced new visions of energy across social sectors in the USA (2017). He shows this to be the case from the technocratic worlds of energy finance to activist circles calling for collectivised investment in such technologies in order to achieve energy democracy. He argues for this to be possible thanks to the formation of a material-discursive node, thus foregrounding the ways in which the powerful materialities of energy are co-constituted of both the physical characteristics of its sources and infrastructure and by the words, narratives and discursive elements that give meaning to what energy is understood to be.

Lennon calls for a decolonization of energy that effectively allows for a new energy ontology, one where black lives are no longer "the fleshy fuel of our first commercial-scale transformations of matter" (2017: 27). His article contributes to a wider literature calling for community renewable energy development where both the definition of community and that of energy are intentionally constructed under a postcolonial lens (Robin and Broto, 2021) to respect indigenous cosmologies and metaphysics (Powell, 2012; Schelly et al., 2021) and to actively produce decolonial work (Luke and Heynen, 2020). A similar postcolonial framework is used by Kumar and Turner to change the conceptualisation of solar waste from the "afterlife" of solar projects to "lives after" such projects, an ontological shift that they argue impacts definitions of justice in the literature and the interventions that may derive from them (Kumar and Turner, 2020)

In the reviewed contributions that approach *"materiality as generative friction*", discussions of community energy veer towards a more directed focus on the potential of

artefacts, objects, landscapes, and sociotechnical imaginaries to affect worlding processes (Ahlborg, 2018; Lai, 2021; Morrissey et al., 2020; Powell and Long, 2010). In these accounts, that is, "matter plays an active role in reshaping society more broadly" (van Veelen and van der Horst, 2018). Materialities are significantly recognized such worlding capacities not thanks to an intrinsic quality but rather thanks to the way in which "they are assembled, positioned within different assemblages and deployed" (Eadson and Van Veelen, 2021, p. 6). Helen Ahlborg, for example, studies a collectively managed electrification project in Leguruki, Tanzania, to show how power relations change in "the encounter between project and local place" (Ahlborg, 2018).

She argues that the "materiality of the technology" implied and spatialised in this project interacts with human agency to de- and re-script relations of power. The notion of the script is borrowed from Akrich (1992) and in this article functions to exemplify the ways in which technologies participate to create the conditions for relations of power to remain stable or change. In Ahlborg's conceptualisation, artefacts not only embody and embed the social biases and intentions of their designers but also actively change the realm of what they make possible through encounters with new actors and new scripts. Whereas Ahlborg uses the heuristic of the script, the idea that the technologies of community energy not only make possible specific behaviours and politics but actively enforce them is elsewhere described through the concept of affordances (Bukovszki et al., 2020), a term originating in environmental psychology (Bakker and Bridge, 2021) but mobilised even in engineering studies of community energy's potential (Bourazeri and Pitt, 2014). Other authors who participate to this scholarship have instead engaged with the agency of more-than-human elements in community energy to think through the ways in which the materialities of these projects contribute to defining the boundaries of what constitutes the "community" involved (Armstrong & Bulkeley, 2014) and acquire capacities (Marres, 2012) to produce "material publics" (Marres & Lezaun, 2011) (Ryghaug, Skjølsvold and Heidenreich, 2018) that would not have existed where it not for their encounter with particular "technologies of elicitation" (Lezaun & Soneryd, 2007) (Martiskainen, Heiskanen, & Speciale, 2018).

Finally, very few contributions may be said to belong to the "materiality as the potentiality of non-life" category. Bakker and Bridge associate to the approach taken by scholars in this category a Bennet-tian vitalism of matter, where things themselves are lively because of a dynamism intrinsic to them (2021; Bennett, 2010). However, I argue that the literature interested in the potentiality of non-life in energy social science is not limited only to the Deleuzian school that Bennet comes from and that instructs her conceptualisation of the vitalism of matter, but it also expands to Baradian approaches too, whose starting point is a metaphysics grounded in Neil Bohr's advance in quantum physics. This difference is a productive one rather than a merely aesthetic demarcation because Barad's agential realism, though also recognizing a dynamism to matter, does so by positioning agency in intra-actions, stipulating, that is, that all matter is agential, but that such agency only emerges in entanglement (Barad, 2009). This does not mean that her approach confines materiality to a networked "social ordering effect" (Bakker and Bridge, 2021) akin to the conceptualisation of agency in the third category, where materials "gain their power in the formation of assemblages from their effect within a given diagram" (Castan Broto, 2019: 69). Rather, it points to the idea that the intrinsic potentiality of all matter does not arise from relations of exteriority, like in Deleuzian theorisations, but from constant and iterative intra-relations that produce powerful materialisations by enacting boundaries.

In a contribution to the edited collection *Lineages and Advancements in Material Culture Studies,* Hannah Knox mobilises this approach to bring into focus how smart meters in a community energy project within an English co-housing site open possibilities for a "newly materialised imaginary of a social and collective future" (Knox, 2020a:113) She recounts how in entanglement with the smart meters, the community under study gets to learn about and grapple with not only the information that the devices immediately reveal but the knowledge that such information requires about the workings of the electricity grid and the potential of community energy in terms of resilience and independence. Her conceptualisation of the digital devices of energy communities thus goes beyond an ontological argument about more-than-human agency; it moves instead towards epistemological engagement with the ways in which these technologies produce

knowledge themselves and actively contribute to the construction of the realm of ways in which publics understand their present and envision their future.

In a similarly innovative chapter in *Inventing the Social,* Wilkie and Michael recount the enactment of a performative methodology to trace the emergence of distinct communities as they encounter an audio device that members of the research team designed, called "the Energy Babble" (Wilkie and Michael, 2018). Building on the feminist tradition investigating the participation of the researcher and her practices in the research event (Haraway, 1988; Stengers, 2005) the authors discuss how the "Energy Babble" devices did not neutrally encounter the communities they were given to but were rather inadvertently enacted by the research team in such a way as to become materialised as instrumental rather than playfully possibilistic. Though the authors frame the outcomes of the research project as partial failures to "invent the social" like they meant to, what is significant to the present discussion is their focus on the materialisation of matter, which points to the idea that artefacts do not intrinsically afford a type of material politics by design but that even design dispositions become material (and take shape) in intra-action. Castan Broto builds on similar feminist scholarship and on Barad's agential realism to conceptualise the idea of *urban energy landscape*, a heuristic that takes seriously the politics of everyday energy material and practices by pointing to the everyday intra-actions that make up the urban environment and contribute to its transformation (Broto, 2019)

Altogether these disparate writings, going from prosumption literature to musings about the imbrication of the social, to the material politics of energy all the way to the specific material politics of distributed energy schemes, inform the design of this research and the discussion I will present in each of the following chapters. Indeed, I understand the work I present in this thesis, which fundamentally explores the entanglement of changes to the electricity built environment with processes of state (re) production and governance assembling, as a corollary to the ideas presented above. This is a thesis that has begun in the middle, the continuation of an ongoing process of sedimentation. Its aims, objectives

and research questions embed vocabulary and concepts derived from the literature above, while also attempting to address some of the literature's conceptual and empirical lacunae.

1.3 Research Aims and Research Questions

With this thesis, my aim is to foreground whether and how decentralised, communally owned and managed, renewable electricity generation schemes in Italy are innovative arrangements that disturb a dominant and entrenched sociotechnical system. I show how decentralised generation schemes, as they enter in relation with this system and become part of it, transform it and are themselves shaped by it, thus setting into motion socio-political change. I devote particular attention to the effects that these system reconfigurations have on the reproduction of stateness and on the deployment of energy governance strategies in the country, processes that I understand to be particularly vulnerable to change in Italy due to the inconsistently decentralized nature of its separation of powers among the central government and the regions. Specifically, this thesis aims to:

1. Trace the agential work performed by the socio-materialities of grid-connected, collectively owned and managed schemes of decentralised renewable electricity generation in enacting socio-political change;
2. Discern the elements that enrol publics in this process and what kind of politics are elicited through it;
3. Interrogate the potential of decentralised infrastructures to generate processes of spatial formation, de- and reterritorialization, and contestation/reinforcement of national sovereignty;
4. Consider how sociotechnical change mobilises socio-political change, especially on established sociotechnical imaginaries; and
5. Demonstrate the significance of mobilising a new materialist ethico-onto-epistemology to approach both energy and the state when interrogating how the decentralisation of the built environment of energy production is affecting state/society relations.

The situation of ambiguous, hybrid federalism in the Italian republic provides an

opportunity to explore the power rearrangements arising from the introduction of disruptive distributed energy technologies in the built environment of an established power system and a socio-juridical milieu favouring centralised energy provision. Rather than writing yet another documentation of how energy infrastructures reproduce and reinforce state imaginaries and nationalism or how participation in particular distributed energy schemes may or may not incentivise democratic structures, this thesis takes a novel approach by combining the concepts of sociomateriality, infrastructure politics, and distributed energy politics to ask:

How is distributed generation and collectivised prosumption shaping (and being shaped) by entrenched sociotechnical imaginaries of sovereignty and energy in Italy, and how does it participate in the reproduction and transformation of the Italian state and the development of energy governance in Italy?

I have moved to address this by asking the following specific research questions:

1. How does the spatialisation of distributed energy schemes influence energy policy and governance in Italy?
2. How do these new assemblages transform socio-political processes beyond energy politics? What effects do they have on the re-production of the state?
3. How do the process and possibility of infrastructural decentralisation impact sociotechnical imaginaries of centralised sovereignty and of state-wide energy transitions?
4. What is the role of the more-than-human in all of the above?

1.4 Why Italy? Research Rationale and Policy Context

My choice of Italy as a focus was influenced partly by the data on the fast expansion of Distributed Generation I cite at the very beginning of this introduction. But it also derives from a personal qualm with the status of knowledge production on energy transitions in the EU. Indeed, scholarship on successful energy transitions and transitions-in-the-making

especially through decentralised electricity generation is heavily focused on case studies coming from the North of Europe. By turning to the Italian experience, I chose instead to take on Frolova et al.'s quest to veer attention towards Southern Europe and the processes of sociotechnical change that are occurring there (Frolova et al., 2015).

But from a personal perspective, the choice of researching Italian distributed energy politics was one I did not make lightly. From the beginning the anchoring point of my trajectory into academia was a will to avoiding performing research that exoticized the sites of that same research (Guasco, 2022). When proposing my PhD project and hoping to affiliate with the discipline of Geography for the first time, I found myself excited about the tradition I would be joining in and the possibilities it would open to me, but also troubled by its imperial history. My contrasting feelings verged especially on the practice of fieldwork, which if conducted mindlessly may code places and communities as "a terra nullius ready for scientific discovery" (Liboiron, 2021: 68) that researchers can access and extract from without any consideration of positionality.

For this reason, before proposing my research project to possible funders, I first dedicated my time to questioning my approach to and motivations for choosing the "field" of my research. Truth be told, focusing on Italy made sense to me because of my ongoing entanglement with the country: I was born and grew up in Italy and long to return there even after emigrating. So not only do I speak the language, but I am also engrossed in the Italian political discourse and familiar with the tropes of Italian politics. And yet my position is still one of an expat writing in English and operating overwhelmingly in anglophone spaces. Researching Italian politics and immersing myself in spaces of energy activism, lobbying and policy-making in Italy is not the same for me as it would have been if I had stayed and gone through school and work in the country. My job prospects are not threatened by the possibility that some of my opinions may not be in line with dominant transition narratives, and perhaps just as importantly my tongue sometimes stumbles on a word I have not used in a long time, and my Italian syntax may betray to my interlocutors a life of a political researcher who is not directly impacted by or involved in Italian politics.

So, from the start, I knew my familiarity with the political milieu in the country would not exclude me from needing reflexivity as I conducted my research, but I hoped it would stop me from taking on the role of a researcher looking in from the outside. Looking back, and wiser to the vocabulary I have learnt through reading for this project, I am happy to say I believe such awareness helped remind me of my active part within the research assemblage I participated in.

Policy Context

The devolution in the Italian republic and the history of contention of responsibilities over energy governance between the central government and the regions acts as foundational background to this research. Indeed, the arguably unfinished constitutional reform of 2001 that put, amongst several other subjects, investment in and regulation of renewable energy deployment in the shared purview of the centralised government and regional councils looms large in energy governance in the country (Bettoni, 2017; Crisi and Groppi, 2001; Mangiameli, 2017; Rolla, 2019). And it makes the Italian state a particularly interesting case study for the exploration of the potential implications of the proliferation of decentralised renewable prosumption technologies on the reproduction of the state and on the assembling of its national governance strategies. To understand how deeply energy governance (particularly the governance of renewable energy technologies) is embedded with cleavages in the distribution of competences between the Italian central government and the regions, it is necessary to have a general understanding of the political and administrative milieu in the country.

Though a unified state and under one constitution since 1948, Italy is semi-federalised and currently divided into twenty regions, each of which elects its own regional government, composed of regional council and regional president. Five of these regions are granted special status, which gives them extra legislative and executive authority. However, even regular regions have extensive administrative powers allocated to them. This has been the case from the start, with the original constitution declaring that:

" For the following subjects, the region issues legislative norms within the limits of the fundamental principles established by the laws of the state, provided that the norms themselves do not conflict with the national interest and that of other regions:

- organization of the offices and administrative bodies dependent on the region;
- municipal districts;
- urban and rural local police;
- fairs and markets;
- public charity and health and hospital assistance;
- artisan and professional education and school assistance;
- museums and libraries of local authorities;
- urban planning;
- tourism and hotel industry;
- tramways and bus lines of regional interest;
- roads, aqueducts and public works of regional interest;
- navigation and lake ports;
- mineral and thermal waters;
- quarries and peat bogs;
- hunting;
- inland fishing;
- agriculture and forestry;
- artisanship;
- other matters indicated by constitutional laws." (Title V of the 1948 Italian Constitution, Art. 117)

Since 2001, however, this clear list of regional competencies no longer exists. It has been replaced by a list of competencies of the central government, competencies often vaguely worded such as "immigration", "general norms of education", and "welfare." In addition to this list, now stands a compilation of 20 subjects of "concurrent competency" between the central government and the regions. These are matters that are recognised to belong to both the decisional power and responsibility of the central government and that of the regional councils, with no clear hierarchy between the interests of the two actors. Outside of these matters, the constitution now declares that:

"The regions have legislative power in reference to any matter not expressly reserved to the legislation of the State" (Italian Constitution, Title V, Article 117, 4).

This residual re-allocation of regional competencies affords the regional councils a much larger scope of action than previously as, in order to declare something outside of the purview of the region, it is now necessary to find it described in the list of competencies of the central government. In this way, the current constitution crystallises "a variable geometry" of administrative power, within which the Constitutional Court is often asked to intervene to decide whose interpretation of the law is in fact correct (Bettoni, 2017:111).

Most significantly for this thesis, amongst the list of "concurrent competencies" of both the central government and the regions figures "production, transport and national distribution of energy" (Italian Constitution, Title V, Article 117). Even if it may seem strange that the administration of a matter described as "national" be split amongst 20 devolved bodies *and* the central government, this codification testifies to a notion not often discussed in research on the politics of energy but central to understanding energy politics in Italy. Indeed, the battle for the distribution of powers between the central government and the regions in Italy has long centred on questions of energy. In fact, though not self-evidently, the history of the expansion of decisional power of the regions is closely imbricated with the management of the power system and the provision of electricity in the country.

A useful starting point for the history of this imbrication is 1962. Before then, as Bevilacqua (2020) notes, the Italian power system was characterised by a heterogeneous configuration, whereby several different private industries, municipal companies, and electricity cooperatives participated in the various stages of electricity provision. With law number 1643 of 1962, however, the production, import and export, transmission, distribution, and sale of electricity in Italy was nationalised under one state body called "Ente nazionale per l'energia elettrica" (ENEL) (Caponetto, 1999). Under this institutional asset, the state held total control of the power system and the regions had no say in the subject as it did not feature in the list of responsibilities devolved to them by the constitution. This centralised monopoly however eventually came at odds with both the

European Union's commitment to protecting commercial competition and with the material interconnectedness of electricity with other spheres of action that were by constitution competency of the regions (Di Gesù, 2020). Indeed, regional competencies going from urban planning to urban transport hinged on the availability of secure and reliable flows of electricity and other energy sources and the regional councils clamoured to be given decision-making power over the energy system.

Interestingly for this thesis, jurisprudence scholarship recognises as the first breaking point in the central government's total control over the power system a 1991 law written specifically to favour the development of renewable energy in the country and to promote energy efficiency measures. Law number 10/1991 instituted the "Rules for the implementation of the National Energy Plan on rational use of energy, energy saving and development of renewable energy sources",[4] and mandated that every region identify the territories that would most favour the deployment of renewable energy technologies (Fraterrigo, 2011). As it will become common practice, this law was submitted to the opinion of the Constitutional Court in the same year. The Court responded with ruling number 483/1991 and, though firmly noting the "national interest" of electricity provision, it also importantly commented that the energy sector was bound to impact other socio-economic sectors, amongst which those administrated by the regions. In this way, the court recognised the legitimacy of the regions in executing administrative power over the energy sector. Thus, administration of renewable energy sources and their deployment opened the way for increasing regional involvement in energy governance in Italy.

In fact, the above-mentioned judicial intervention would be but the first of hundreds of Constitutional Court decisions on the legitimacy of regional interventions in administrating, specifically, renewable energy deployment. And this participation of the Constitutional Court is fundamental to understand the politics that this thesis follows because it heavily influences the constitutional distribution of administrative powers

[4] "Norme per l'attuazione del Piano energetico nazionale in materia di uso nazionale dell'energia, di risparmio energetico e di sviluppo delle fonti rinnovabili di energia"

between the regions and the central government outside of the realm of energy and electricity. Lombardi (2005: 2) even argues that

> "the decentralization process implemented by the Constitutional law no. 3/2001 […] represented the culmination of a path already partially initiated by constitutional jurisprudence according to which the regional administration presents itself as the most suitable level of government to finalize and make concrete the choices of political strategy elaborated, in the appropriate offices, at the national level."

This shows how the intricate relationship between the Italian central government, which in jurisprudence literature is tellingly discussed as "the state", and the Italian regions owes much of its stratification to the judicial system. So much so that the jurisprudence scholarship on the matter agrees that through the judicial battle over control of renewable deployment the regions began a "path toward the acquisition of powers in the field of energy and beyond" (Colavecchio, 2009:10)

And it was precisely in 1991, when the legislature first delineated the role of the Italian regions in favouring the deployment of renewable electricity generation, that the concept of self-production (which elsewhere would be described as prosumption) first enters Italian legislation. Indeed, in law 9/91, the state authorized commercial consumers of electricity to generate electricity for their own needs and share it amongst their satellite buildings when these complied with very restrictive technical specificities, thus codifying the operation of "self-consumers" in the Italian power system (Bevilacqua, 2020). In the thirty years that followed, through market liberalisation of electricity and several reforms initiated at the European level and operationalised nationally, the postulations that regulated self-consumption remained the same as those briefly mentioned in the 1991 law cited above. However, things changed nationally in 2021, during the transposition of European Directive RED-II, and regionally as early as 2018. Indeed, as the following chapters will expand on in more detail, during this period several Italian regions took advantage of the contrast between European energy strategies and Italian national energy strategies to strengthen their hold of administrative power of domains co-held with the central government. As it happened, the pre-eminence of community energy schemes and collective prosumption in European discourses and negotiations around the RED-II stood in stark contrast with a national energy strategy that only relegated the sharing of electricity

generated through prosumption to very limited instances of commercial users. The regional laws on renewable energy communities and the national decree from 2021 that now incentivises them throughout the country are some of the main protagonists of the stories that the following chapters will tell.

1.5 Methodology: The Practicalities of Research

The starting point for my research design was a search for coherence between my research practices and the theoretical framework I had come to embrace in the first year of my PhD. My choice of methods for data collection and analysis is rooted in a need to produce knowledge without reiterating the essentialism of positivist approaches and without negating materiality in the way that a constructivist approach asks one to. In Chapter 2 I elaborate on this point and present the ethico-onto-epistemology that guided me throughout my research for this PhD. I recount how the challenges of conducting research in Italy during the aftermath of the first Covid-19 lockdown (and through the consequent restrictions) affected me and how, in losing my bearing, I was able to finally develop a sensibility to the sociomaterial. I wrote Chapter 2 as a journal article and so it does not include an exhaustive description of the initial research methods I deployed and how these changed in contingency with the reality of my research. For this reason, I will introduce that discussion here.

Research Methods: Initial Design and Fieldwork Changes

When I approached research design for this PhD project, I knew the research strategy I wanted to implement as I had found the choice I had made for my Master's thesis to be very helpful to my own research process. The strategy is one of "abduction", where, following Timmermans and Tavory (2012), I do not feign the need to approach my research assemblage as a carte-blanche but rather deliberately immerse myself in theory that inspires my investigation both before starting data collection and during moments of reflection and analysis. Therefore, when it came to the data collection for this thesis, the first decision I found myself having to make was where to start. I knew I wanted to investigate how changing energy landscapes may be impacting statecraft and governance in Italy, so I

wanted to focus on the technologies that had emerged as changing the Italian energy landscape to begin with: Distributed Generation Renewable Systems. However, part of the difficulty of studying the effects of these technologies is the very thing that makes them disruptive, that is that they encompass multiple configurations and are decentralised in their deployment. Therefore, I operated a pragmatic move and decided to start with a public that had long entangled with these technologies and had already caught the attention of Italian social scientists because of this: a community cooperative situated in Melpignano, a small village in the region Puglia.

Though the focus was no longer on the technologies themselves but on a public, this move allowed me to start *somewhere.* Indeed, the secondary literature I had access to during my desk-based research was largely concerned with the groups that used Distributed Generation technologies to engage in "community energy" and I believed that starting with one of these groups would bring me to places highly affected by the reconfigurations that such technologies allow. In other words, I did not see starting with a group of people to be incoherent with my interest to the more-than-human. Rather, understanding people as "part of a combination of bodies or parts of bodies, resonating around a particular matter of concern" (Thrift and Amin, 2013:50 in Lancione, 2017), was an initial step towards mapping the assemblage I was interested in, a starting point for the main method I had set out to mobilise in my data collection: relational ethnography.

Relational Ethnography

An ethnographic approach is coherent with the epistemological commitments of a methodology rooted in assemblage and in an overall framework of new materialisms because "it delivers in-depth qualitative understanding (to make multiplicity, process and [agency] visible) of situated contexts (to enact uncertainty)" (Baker and McGuirk, 2017:433). Its disposition towards treating "the familiar as strange" (Shove and Walker, 2010:15) allows the researcher to approach her fieldwork with the flexibility that dealing with the flows of materialisations require, though as a research method it has also been critiqued for its excessively bounded focus on predetermined categories (Roy, 2012).

For this reason, I chose to stay with ethnography but mobilise it with a specifically relational approach. Approaching ethnography relationally is something Desmond has done skilfully in his own work on eviction (Desmond, 2014, 2016), and called for in a now widely read article in *Theory and Society* (2014). Here, he argues that the object of many ethnographies, even when apparently vast, is often categorizable as either a "place" or a "group", a symptom that the method has long suffered from what, following Cassirer, he calls "substantialist perspective" (2014:551). Such a perspective is seen by its critics as a fault because of a tendency to make static what is otherwise processual and dynamic and to essentialise categories as if they existed naturally and outside of the working of relations with other phenomena.

I find myself in agreement with this critique, as should not be surprising given the discussion above about sociomateriality. Instead, as Desmond puts it, "relational ethnography gives ontological primacy, not to groups or places, but to configurations of relations" (2014:554), a disposition entirely coherent with my own ethico-onto-epistemology as will be further elaborated in Chapter 2. For this reason, I took up Desmond's call and chose to focus first and foremost on tracing the relations tying the disruptive technologies I was interested in to other actors/sites. In this way, I hoped I would first gain an appreciation of the processes at work and their relation to each other and only then approach such network as the field of the research. I hoped, that is, to honour the appreciation that "in assemblage-inflected studies the spatiality of methodological foci is situated and neither self-evident nor singular" (Baker & McGuirk, 2017:435).

As mentioned above, then, my research started in a community cooperative in Melpignano, but I did not understand this association to be the *object* of my study; rather, I hoped that observing their work would allow me to trace some of the relations that tied them to the technologies I was interested in and to wider political processes in the country. The cooperative that I began my research with is the first example in Italy of a community energy cooperative initiated by the local government and is centred around 33 solar photovoltaic installations on residential rooftops for a production of 180kW (Legambiente, 2019). Before making contact, desk-based research confirmed the exciting inter-

penetration of the cooperative with both municipal and regional government, something that struck me as a promising starting point for a study of distributed energy politics.

After corresponding by email with the cooperative's representatives about my research and its aims, I was allowed to embed myself in their offices for an agreed period of three months. I hoped that this time would allow me to start practicing a relational ethnography, which I would supplement with semi-structured interviews with actors of interest, to answer RQ1, RQ2 and RQ3 *(*"*How does the spatialisation of distributed energy schemes influence energy policy and governance in Italy?*", "*How do these new assemblages transform socio-political processes beyond energy politics? What effects do they have on the re-production of the state?*", and "*How do the process and possibility of infrastructural decentralisation impact sociotechnical imaginaries of centralised sovereignty and of state-wide energy transitions?"*) In fact, when I proposed to do so in my first year progression review I claimed: *"*This will entail conducting participant observation in the offices of the energy cooperative of interest as well as asking to shadow maintenance interventions on the electricity producing technologies; and participating in the mandated annual shareholder meetings, meetings with state representatives, and any outreach community event the cooperative organizes".

However, the reality of a post-Covid 19 lockdown meant that when I arrived in the offices of this community cooperative, their operation was greatly impacted by the restrictions in place and by the memory of the first wave looming large. Several of the employees no longer came to the offices even if technically allowed to because of the fear instilled by the deadliness of the virus in the first months of its spread, and though the cooperative was open, almost all its regular meetings and events were paused. I struggled to make sense of what the best course of action would be and proceeded by inertia for the first month and a half: I commuted to their offices every day from 9 to 5. During this time, I was encouraged to carry out archival research and familiarise myself with the cooperative's physical database of documents detailing its founding in 2011 and its many operations since. I also got to carry out four 1-hour long semi-structured interviews with the founder of the cooperative, its current director, and two of its current employees.

Through these interviews, and longer informal conversations with the cooperative's director, I came to understand that though discussed in the literature as a community energy enterprise (and the first of its kind in Italy), the community cooperative had long moved away from active engagement with electricity or energy at large. Their main line of work had instead become freshwater dispensation through "water houses", water distributors able to microfilter, refrigerate, and carbonise water and meant to displace the wide use of bottled water. This discovery caused me to stumble, as did the halted operation of the cooperative's community benefit events and meetings with sister associations which I had hoped would allow me to map the wider assemblage in which they operated. Before being able to work out what all this meant for my research, a close encounter with the overwhelmed regional health care system pushed me "out" of the field as I understood it then. Thus in December 2020, I felt forced to retreat from the region Puglia back to my mother's house, where I still had access to family medicine and would not be putting further stress onto a struggling healthcare system.

This change forced me to start again. I tried to reach out to some of the groups and associations that the community cooperative in Melpignano had indicated to me as usual interlocutors, but I found little success in this route. I was able to conduct an hour-long semi-structured interview on the phone with the director of a nearby municipal energy community, but attempts to reach out to individual members failed as this organisation had similarly stopped all events and people seemed daunted by the prospect of phone interviews. Instead, I began participating in and observing the only type of events that were still taking place while the country moved to a second lock-down: webinars. Though I knew that six regions had already published laws regulating collective use of renewable distributed generation via the instrument of "renewable energy communities" - and that in February 2020 the central government had set in motion a period of national experimentation with this - little information was actually available at the time about what these schemes would entail in practice and how they would be incentivised. For this reason, I joined two webinars that dealt with this topic in December 2020: one organised by a state agency, and one by a local consumers' association. I initially approached this practice as

continuation of desk-based research, but in the following months I developed an ethnographic practice largely *based* on webinars. In the year and a half that followed, I participated in and took notes on 52 of these online or hybrid meetings.

To do so, I had to familiarise myself with the literature on digital ethnographies. This method brings the techniques of ethnography to online virtual worlds (Taylor *et al.*, 2013), and has been used since the early 2000s by anthropologists who claim it possible to apply an ethnographic sensibility to interactions that take place digitally (Hine, 2000). With the advent of the Covid-19 pandemic and the restriction to personal mobility that it implied for millions of people, more and more researchers, myself included, have mobilised this method in their work (Ghosh, 2020). The literature on digital ethnographies helped me rethink "fieldwork". Though I had set out not to identify the object of my ethnographic practice as a "place" or a "group", in leaving Puglia and retreating back to my town of origin I realised I still understood myself as once being "in" the field and then as having left it. However, the literature on digital ethnographies underscores how fieldsites should be understood as networks of spatialities where social phenomena take place, that is as multiplicities rather than bounded entities (Burrell, 2009). This idea helped me reframe my approach to the field and stay open to mapping the research assemblage I was participating to without creating neat hierarchies between online and off-line spaces (Pink *et al.*, 2016) and without understanding myself through the binary thinking of either in or out of the field.

When attending webinars on renewable energy communities and groups of prosumers, I conducted participant observation. One of the defining traits of ethnography (Mason, 2002; Bourdieu, 2003), participant observation is centred on prolonged engagement with unfamiliar people and settings (Shah, 2017) and is employed to reveal the "social relations of a group of people" (Shah, 2017:51). However, I set out to map sociomaterial relations at large, not to reproduce the humanist bias that has been criticised in conventional ethnographies (Hamilton and Taylor, 2017). Doing so also implied another method, what I call, *Tracing the Sociomaterial* as I will further elaborate in a later section, to attend to how the more-than-human contributed to the phenomena I was studying. But

it also meant speaking with and interviewing human participants to gauge how they were affected by the sociomaterialities of distributed renewable generation systems and to record the possible constructions of national/local imaginaries emerging from the sociotechnical novelty they represented.

I approached participant observation of the webinars I attended armed with a methodological tool that I borrowed from Ruck and Mannion (2019). This is the tool of "theoretically sensitive fieldnotes" (ibid: 1376), whereby the ethnographer is guided to process the information she has observed and the ways she has participated to the research assemblage through a series of prompts that bring her back to the theory she is engaging with. Indeed, in line with the praxis of keen reflexivity implied in participant observation (Shah, 2017), Ruck and Mannion propose a field note-taking processes that entails "develop[ing] a series of questions specific to this study, to prompt my note-taking after each session" (ibid: 1377). This tool was very helpful in maintaining a disposition to active participant observation during long webinars and to guide the successive moments of reflection towards new materialist concepts and theories, which were not always easy for me to maintain front and centre as I listened to people's concerns about transformer stations and policy ambiguity. This tool in other words helped me stay consistent with the abductive strategy that I espoused and that epistemologically guides the thesis. It helped me to move in my entanglement in the research from a place informed by theory and to return to theory for the purpose of theory construction when writing my field notes. Moreover, these notes did not only theoretically guide research reflexivity during the data collection stage but also continued to exist as transcripts to which I could return to "revisit the phenomenon" (Timmermans and Tavory, 2012:176) diffractively as I wrote up my thesis.

Semi-Structured Interviews

A widely used data collection research method (Bryman, 2016), semi-structured interviews complement this research's epistemological premises. They are useful in an abductive research strategy and provide a structure that allows for comparison between individual narratives without eliminating flexibility to follow the natural direction of the

conversation with research participants (Charmaz, 2005; Nicholas Clifford, Shaun French, 2010). In other words, semi-structured interviews provide a basic level of "programming" that allows comparison between specimen (Churchill and Cicourel, 1966) while also making space for the interviewee to derail from pre-set questions into new territories of meaning-making which the researcher may have not considered (Bryman, 2016; Mason, 2002). In the context of this project, they were particularly useful to identify discursive elements that participated in the making up of my research assemblage. I relied on them heavily to collect data on visions of sovereignty and desired energy transitions and on perceptions of the coding of the state as a unitary actor or as an institution paradoxically separated from the regions. After all, as Bryman (2016) writes, semi-structured interviews allow research participants to speak about their experience in their own voice and language.

Conducting semi-structured interviews on the phone and through digital video calls also helped me gather important information about the historical and political processes in which the setting up of renewable energy communities were imbricated and those that acted as the subtending ground for the development of national energy strategies that featured them. Thanks to the uptake in the use of video-calling platforms throughout home and office environments following the first Covid-19 lockdowns, I was able to contact and interview several institutional representatives and members of the general public. Amongst them were 20 stakeholders of a large energy cooperative in Italy, whom I asked about personal motivations for engaging with distributed energy politics and personal visions of the future of energy transitions in the country. I also conducted 20 interviews with members of voluntary associations, trade associations, municipalities, regional governments, and national agencies that held executive functions, and to whom I supplemented questions about their experience with requests for further information about the sociopolitical and historical background that they identified as informing the present of the transition they were participating in.

For this reason, semi-structured interviews enabled me to address more in depth the research questions I was pursuing via relational ethnographies (RQ1, 2, and 3). Moreover, interviews suited the abductive strategy I espoused for this research which was based on testing theories iteratively: rather than sanitizing data into numbers, the interview

continues to exist as a transcript to which the researcher can return to "revisit the phenomenon" (Blaikie, 2007; Timmermans & Tavory, 2012). Similarly to my field-notes, then, the transcripts and annotations I made from the semi-structured interviews I conducted remained a helpful tool throughout the analysis and writing-up process for this thesis.

Tracing the Sociomaterial in Digital Spaces and Documents

Within the reviewed literature on mobilising methodologies rooted in new materialisms (Baker & McGuirk, 2017; Coole, 2013; Fenwick et al., 2015; Fox & Alldred, 2019; Ruming, 2009) there often appear discussions of the importance of 'tracing', 'mapping', 'tracking' or 'following' the various actors, actants, and sites under study. This widespread commitment has concretised in different mapping practices that all deal with the "complex, relational, spatialities" (Baker and McGuirk, 2017) of the research field and assemblage. I personally operationalised some of these practices in my note-taking so as to make sure that throughout my data collection I would keep focused on answering RQ4 ("*What is the role of the more-than-human in all of the above?*"). Rather than labouring to draft pretty charts and graphs that neatly categorise the elements of the research assemblages I participated in, however, I stuck with messy maps that simply featured the different actors in relations to each other and where I did not need to fully represent the multi-scalar relations I was observing. Doing so helped me maintain a neo-materialist sensibility and avoid essentialising the research assemblage (as I believe would have happened by delineating bounded elements in orderly interaction).

I made use of this tracing research tool after attending several of the webinars I observed; after the semi-structured interviews I conducted; and when reading diffractively through documents published by the Italian transmission system operator Terna and Decree 199/2021, which regulates and incentivised renewable energy communities and groups of prosumers in Italy. Because of a commitment to highlighting processes of de- and re-territorialisation during the analysis stage, at times my mapping practices emphasised the processes and relations I recognised to have stabilising or de-stabilising effects on the state and on the coding of distributed energy politics in Italy.

As this discussion of the "practicalities" of my methodology shows, my research practice was very much influenced by constant engagement with a neo-materialist theoretical framework. The next chapter further elaborates on why this was the case and how it impacted both my fieldwork and the analysis of the data I collected.

Before moving to such a discussion, a brief author's note. Though a personal commitment to the metaphysics of the New Materialisms brings me to deliberately include myself in this text and to reference the text itself constantly to highlight entanglement between each one of the arguments I present, this attitude towards diffraction does not exempt me from falling into familiar onto-epistemological patterns when presenting empirical arguments. Indeed, my presence in the text remains limited to the contextualisation of my methodological practices and of my personal encounters with the sociomaterialities of this research. It does not emerge as strongly in the formulation of the arguments, where my presence and therefore my diffracting entanglement is obfuscated by a focus on the "objects" of the research. This inevitably reifies ontological separations between subject and object that are antithetical to the framing of my work. I recognise this as a limitation while also acknowledging that this scholarly effort meets me halfway too. As I trace the Italian state being re-assembled as an energy transition-in-the-making takes place, I recognise that encountering the literature I engage with in the next chapter is also contributing to the re-assembling of Costanza Concetti. My author's voice is thus not a finished project yet but only the beginning of a process of becoming which will reverberate more strongly with the notes of the New Materialisms as my entanglement with their ethico-onto-epistemology continues and strengthens.

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CHAPTER 2 - FOR A NEW MATERIALIST SENSIBILITY TO SOCIOTECHNICAL CHANGE:[5]

Rooting Research Practices and Appraising Methods

Figure 5: Members of an energy cooperative showcasing the importance of collaboration by bouncing a ball on a large tarp. Source: Author

2.1 Introduction

I set out to conduct the fieldwork for my PhD research in October 2020 and though the dominating logic during the prior eight months was one of restrictions to in-person interactions in several places of the world, that autumn felt to me like a time of renewed possibility and openness. I moved to Lecce, one of the southernmost towns in the region of Puglia, Italy to be at a commuting distance to the Cooperativa di Comunità Melpignano (CCM), a community cooperative where I thought I would be an intern for at least three months. This was indeed one of the key sites that had emerged from my desk-based research on the decentralisation of the electricity system in Italy and I thought that being based in their offices would allow me to approach the "field" without pre-delineating the assemblage I planned to study on the basis of administrative borders or social categories. Inspired by Desmond's relational ethnography (2014), I would start there and follow institutional and sociomaterial relations to get to the other powerful loci, people, and things involved in the change I was attempting to trace. This cooperative was after all one of the first schemes of its kind to be founded in Italy (Magnani and Patrucco, 2018), and I

[5] This was prepared as an article to submit to *Qualitative Research*

imagined that learning more about its past, its present and its future would allow me to start telling a compelling story about energy transitions and political change in the country.

As I learnt about the actual work that CCM was conducting at the time and became increasingly bounded by the covid-19 virus taking on new strength, however, I had to face a reality that felt at first the opposite of everything I had hoped for. After two months of living in Lecce, the reality I encountered tripped me up sufficiently that I terminated my internship early and retreated to my usual place of residence. And rather than this instance remaining limited to the well-researched initial obstacle of "accessing the field" (Friedman and Orrù, 1991; Magolda, 2000), a moment of interruption after which I could more seamlessly make progress in my data collection, that difficult encounter in Lecce constituted the beginning of a process whereby different affective elements prompted me to change research course again and again and again.

Though for months I resisted and resented this process as a sure sign of failure for my research project, the abrupt shifts to my fieldwork plans it entailed helped me cultivate and practice a *new-materialist sensibility* that I had until that point only claimed to be wielding. To borrow from Anna Tsing a terminology that I will later explain, this process forced me to respect the *polyphony* of the transition-in-the-making I was trying to capture and drop a need for narrative. It opened my eyes to my participation in processes of *contamination* rather than collaboration, and because of this, I approached my fieldwork practices with greater attunement to my encounters with the more-than-human assemblages involved in my fieldwork, one that allowed me to *notice* the entangled processes in which I was participating.

In this chapter, I recount some of my experiences in conducting fieldwork research during a time of uncertainty and sudden change in the allowed confines of sociomaterial interaction like the one immediately following the first Covid-19 outbreak. I do so to argue that when I finally let these contingencies affect me, I was able to cultivate a sensibility coherent with a new materialist ethico-onto-epistemology based on relationality, becoming and dispersed agency. While mobilising a new materialist research framework has serious methodological implications, the boundaries of this field of inquiry are contested

(Devellennes and Dillet 2018) and, except for some notable exceptions (Fox and Alldred, 2015; Devellennes and Dillet, 2018) methodological literature has tended to focus on presenting the novel tools of analysis that emerge from it before clearly defining the premises onto which these operate. This chapter therefore begins with delineating the common grounds of this research philosophy and their effects on research design. I then present autoethnographic anecdotes to illuminate how, from the entanglement with the research assemblage and my research practices, I was able to trust and nourish a sensibility to sociotechnical change that I similarly call new materialist, which made me comfortable with processes of contamination and allowed me to be content with polyphony without seeking harmony. I reflect on how comfort with polyphony and contamination (rooted in an embracement of diffraction) allowed me to select analytical methods on the basis of their performative work on the research assemblage. I finally evaluate the analytical tools of assemblage analysis, diffractive reading, and critical junctures in their ability to centre lines of inquiry on sociomaterial agency in studies of sociotechnical change.

2.2 New Materialist interventions and a New Materialist Sensibility

New materialist philosopher and physicist Karen Barad stresses that no study of the world can be neutral as "every research design, method, or theory is an 'agential cut' that reflects a particular power-laden epistemological move" (Barad, 2007:185). Responding to this call to attend to the agential entanglement of one's research means multiple things. Most evidently, it requires thinking seriously about the epistemological premises that one's practices imply, much like Haraway had already asked researchers to do when urging us to leave behind a "god trick" approach to science production as objective and neutral (1988:581). But it also asks to contend with the "power-laden" aspect of research, of facing the impossibility of engaging with the world without ethical consequences. To do so, Barad's concept of ethico-onto-epistemology is helpful in framing the interconnectedness of methodological practices not only with narratives about the knowability of reality but with the ethical and political effects of such practices and the metaphysical claims they imply (Barad 2007:2014).

The ethico-onto-epistemology that guides my research practice is one gleaned from several new materialist thinkers, amongst whom are Deleuze, Bennett, De Landa, Barad, Tsing, Thiele, and Connolly. But rather than a self-ascribed qualifier, "new materialist" is a descriptor that I am attaching to many of these scholars and their theoretical frameworks a posteriori. In doing so, I do not simply follow prior definitions of the New Materialisms; rather, I operate a specific cut in recognising a productive common ground amongst them. Indeed, though mentions of the New Materialisms as a field of study began in the 1990s in the separate writings of Braidotti and De Landa (Tuin and Dolphijn, 2012), there is still dissonance between existing definitions of what a new materialist intervention is and does (Connolly, 2013; Coole and Frost, 2013; Coleman, Page and Palmer, 2019; Fox and Alldred, 2019). In the next section of this chapter, I build from this literature to propose an understanding of the New Materialisms that foregrounds as foundational a shared ontological, epistemological, and ethical commitment.

It is this specific delineation of a common ground in the heterogenous field of New Materialisms that then allows me to use concepts from several of its strands in concert rather than in isolation. In later sections of the chapter I argue that there is merit in wielding the analytical tools that emerge from disparate approaches in the New Materialisms in tandem with each other, rather than as sub-discipline-bounded devices, as long as one recognises the performative intervention that each provides. To make this argument, I take inspiration from Diffraction, another tenet of Barad's scholarship.

The term diffraction is not new. In fact, building on feminist scholarship on difference, Haraway introduced it in her writing in the 1990s to signify an "optical metaphor for the effort to make a difference in the world" (Haraway, 1997:273). Here diffraction is an epistemological alternative to reflection. So, whereas reflection claims to represent the world as it is, like a mirror does when it reflects light, diffraction highlights the difference made by the intervention of an observer in representing only *a* version of the world at a time, like a CD does when it beams back different colours of the light that shines on it. Baradian diffraction (Diffraction from now on), however, goes farther, and challenges presumed separability of subject and object by refuting identity *before* observation (2007). In Barad's conceptualisation of Diffraction, positionality in knowledge

production is not enough. Diffraction points instead to the need of "understanding the world from within and inside of it" (2007, 88), to make an onto-epistemological move towards a "performative" mode that goes beyond representation to account for how "practices matter" (2007:90) because they entail processes of worlding. Knowing in Baradian Diffraction, then, is neither restricted to humans nor separate from a reality that can be represented more or less accurately depending on how much one accounts for their own situated history; instead, it is an entangled practice that produces the world. In this way, Diffraction amounts to a non-representationalist approach akin to those developed in Non Representational Theories (NRT), which understand the world precisely as a result of encounter (Greenhough, 2011).

Methodologically, then, Barad's proposition of Diffraction leads to both an attentiveness to the effects of socio-material phenomena entangling and thus diffracting the world in specific ways and to a data analytic method that "[reads] insights through one another" (Barad 2007:71). Though several empirical studies have focused on the latter (for a review see Fox and Alldred, 2021), I argue that attentiveness to diffracting phenomena holds methodological implications that resound throughout all phases of research. Indeed, staying with Diffraction allows one not only to focus her research onto how certain worlds are produced in entanglement, but to also be strategic about the methodological choices she makes, from research strategy to data analysis, knowing that each will have unique diffractive - and so worlding- effects. Diffraction is therefore the basis for encountering the New Materialisms as affective themselves and for coming to terms with the performativity of the tools that emerge from this heterogenous field of studies.

Moreover, defining the New Materialisms along the lines that I will present next, which foreground the performativity of knowing practices and the relational agency of matter— from tangible bodies to abstract conceptualisations — allows me to call new materialist the research sensibility that this chapter discusses too. The term sensibility is herein deliberate. One of the first projects recognised in the literature as unifying the diverse field of the New Materialisms is that of engendering new ways of being in relation with the world, of cultivating a new sensibility (Coole, 2013). Connolly defines sensibility as "a constellation of thought-imbued intensities and feelings" (1999:27) to speak of the

complex corporeality, emotional engagement, and intellectual dimension of approaching the world. Though he has dedicated large space in his scholarship to framing the significance and power of sensibility (Connolly, 2002, 2005, 2013), the discussion of this concept in "White Noise" is particularly useful in understanding the work that sensibility does for this chapter. Here, indeed, he highlights

> "that argument is relevant to philosophy and ethics but insufficient to them. For political argument always has a porous structure, and it is inflected this way or that according to the *sensibility* (emphases added) infused into it by those who present it and those who receive it." (Connolly 2005:28)

In other words, though establishing the boundaries of one's argument, or of one's ethico-onto-epistemology, is important and in fact influences one's sensibility (which per above is 'thought imbued'), such boundaries are reciprocally permeable to the implications of one's corporeal and emotional disposition to others. It is this understanding of the power of sensibility that leads Jane Bennett to push for an "ecological sensibility" in her writing (Bennett, 2010), to "encourage a different repertoire of sense encounters with the assemblages in which we participate" (Watson, 2013:152), and it is this same understanding that justifies the focus on sensibility in this chapter.

2.3 A shared new materialist ethico-onto-epistemology

To return to the task of delineating the new materialist framework informing this chapter, the term "new materialisms" indicates here a field of inquiry that is not unitary but whereby different approaches coalesce around relationality, immanence, and dispersed agency. Others have pointed to a shared "irreductionism" to constitute the "newness" of New Materialisms (Fox and Alldred, 2015), identifying in new materialist texts a project to reject dualist understandings that separate nature from culture, mind from matter, or living from the non-living, and thus disperse agency beyond the human (Tuin and Dolphijn, 2012; Coole and Frost, 2013). If such non-dualism is irrefutably present in the works that I call new materialists, however, it does not suffice as starting point for a shared ethico-

onto-epistemology. Indeed, a flattening of the status of all things and even a distribution of agentic capacities outside of humans or organic forms can occur on the basis of very different ontological positions, as will be further elaborated below. Instead, I argue the shared commitments of the New Materialisms materialise in a refusal of essentialism and transcendence in favour of a philosophy that foregrounds agency as emerging relationally and immanently. This immanent relational ontology presupposes a world that only becomes such *in* relation, whereby no entity, tangible or otherwise, acts alone. It also requires an understanding of ordering as chaotic, as referential only to the contingency of relations in becoming rather than to a transcendental plan imbued by a higher being. In other words, the texts that I call new materialist in this chapter do rethink the ontological status of things and disperse agency outside of the human, but they do so specifically by understanding agency as emerging relationally and temporarily when assemblages/bodies/phenomena become intensified in their ability to affect others, to produce difference.

The framework that ensues centres *relationality,* as the starting point of all differentiation of matter, *becoming* as a recognition of "the potential of becoming 'otherwise'"(Wilson, 2017 p. 455), as a descriptor that is of the ephemerality of perceivable forms and the dynamism of reality, and *dispersed agency* as the only logical consequence to an understanding of the world as produced in contingent, practiced entanglement. Contrarily to other definitions of New Materialisms (Coole, 2013), then, agency in this framework is no longer akin to properties or capacities that single elements may act on but rather to processes that allow causality to emerge "through the non deterministic practices of world making" (Anderson et al. 2012:181). To borrow from Barad again, agency is in these texts "'doing' or 'being' in intra-activity. It is the enactment of iterative changes to particular practices" (Barad, 2007:178).

It should be noted that recognising this orientation as fundamental to applying the qualifier "new materialist" to a text excludes certain literatures that are often described as such, like Object-Oriented-Ontology (OOO) and anti-correlationist Speculative Realism, for example. Indeed, the Heideggerian essentialism that underlines Harman's conceptualisation of object and that serves as starting point for OOO (Leach, 2016;

Umbrello, 2018), whereby objects exist prior to their relations, is incompatible with the focus on immanent relationality cited above. And the adamant problematisation of correlationism posited by those who follow Meillasoux, who seek to speak of an absolute reality prior to thought (Harman, 2019), positions it in stark contrast with an approach that recognises the performativity of knowing practices. But while focusing on relationality, becoming and dispersed agency sharpens the boundaries of the field of New Materialisms, it also brings together approaches that have different genealogies and have for this reason been discussed as incompatible with each other. This is the case, for example, of Bennettian vitalism, which follows Deleuzian assemblage, and Baradian agential realism with its roots in quantum theory.

Colleagues in Geography have argued that the difference in the conception of agency in the works of Bennett and Barad is a significant one (Anderson *et al.*, 2012) something I cannot refute. I indeed agree with their claim that the Spinozist genealogy of assemblage theory makes it attentive to the agency of assembled parts within an assemblage in their capacity to alter the nature of the whole while the quantum physics origin of Baradian approaches makes it so agency in her "diffracting phenomena" emerges in intra-action and thus forgoes prior integrity (Ibid, 2012). This is because the concept of intra-action in Barad's *Meeting the Universe Halfway* is one that disrupts Deleuzian ontological claims as it pushes affectivity beyond relations of exteriority. If indeed in reading Spinoza, Deleuze foregrounds these external relations by pointing out that a body can be defined by its capacity to affect and be affected by others and assemblage as an ephemeral co-functioning of bodies, in building on Bohr's quantum theory Barad speaks instead of phenomena that materialise *in* entanglement. Therefore, though both approaches are indisputably *relational* in foregrounding the contingency of reality on the coming together of the world, they differ in their definition of the nature of such relations. Deleuzian approaches theorise chaotic parts to come in relation to each other in ways that produce orders and thus reality but are incapable of changing their internal composition. Baradian intra-action focuses instead on the performativity of materialisation in practice, thus refuting the existence of a part prior to relations. For this reason, Bennett's conceptualisation of agency, which follows Deleuze, is one where agency is a networked

outcome of proto-elements with vital forces of their own, whereas Barad's framing of agency speaks of entangled processes of productive affectivity that have no prior counterparts.

However, I refute the incommensurability of these approaches that others defend (Hein, 2016) and proceed to argue that outside of treaties on the nature of the world, such ontological nuances only produce difference that *matters* in relation to the epistemological and ethical positions they allow. If Hein accuses Barad of following transcendent principles and a negative theory of difference because agency emerges in her theorisation as enactment of matter in intra-action (2016), I argue the opposite. When met with a more generous disposition (Murris and Bozalek, 2019), indeed, Barad's agential realism all but points to a recognition of the need to refute cartesian duality in favour of monist understandings of all matter as inherently agential, an approach entirely coherent with Deleuzian formulations of immanence.

Indeed, the conceptualisation of assemblage that emerges in the works of Deleuze individually and together with Guattari (Deleuze and Guattari 1987; Deleuze 1988) speaks of a world whereby reality materialises within a "plane of immanence". This is a plane where bodies are not singular but assembled of multiple dynamic parts and not defined by their essence or form but rather by their capacity to affect and be affected by others, capacities that change as bodies themselves change when they interact with other elements (Deleuze and Guattari, 1987). The corollary to such plane of immanence is a refusal of an initial "one," of identity that is as the starting point, in favour of difference as the moving force for all things, of differentiation as the organising principle of reality. Deleuzian immanence is in other words rooted in a philosophy of affirmative difference (Gilles Deleuze Graham Burchell III, 1996) and I argue that Barad also theorises difference affirmatively in stating that "diffraction is a matter of differentiating entanglements" (Barad 2007:381). She thus troubles individual subjectivity as does Deleuze and proposes a metaphysics, agential realism, whose principles are entirely coherent with an understanding of New Materialisms as a philosophy of relationality, becoming and dispersed agency. This commensurability in approaches is testified by the increasing

number of scholars who are finding value in reading Deleuze and Barad together under the banner of a "relational ontology" (for a review see Murris and Bozalek, 2019).

More importantly, doing away with the common ontological ground between Bennetian vitalism and Baradian intra-action dismisses the epistemological, ethical and in fact methodological interventions that this shared 'realism' allows. Indeed, whether through intra-active phenomena in processes of materialisation or through assemblages framing the plane of immanence, both approaches recognise a need to become attuned to the performativity of reality, which is to say to its becoming, a move that has real ethico-epistemological implications.

Such an attunement to becoming indeed means taking a stance not only in ontological disputes in the social sciences between constructivist and realist positions towards a mode that accounts for contingent materialisations, but also in epistemological ones between positivism and idealism (Della Porta and Keating, 2008). If accepting that relations of exteriority or practices of entanglement affect forms towards becoming other, then choosing to build a new materialist research strategy implies a recognition that research practices are part of the wider research assemblage (Baker and McGuirk, 2017). Or to say it with Barad, that research practices diffract the research phenomenon, and should thus be reflected upon in terms of their effects. Epistemologically, then, this means acknowledging the reality of the assemblage while also considering that no entity is allotted ontological integrity on its own and that its entanglement with the researcher's corporeality, interpretation and more is a worlding process that matters. Such a recognition is something that colleagues in Geography working with non-representational approaches have called for before, appropriately highlighting how the use of ontological concepts deriving from Deleuzian theory like assemblage imply real contention with the ethico-epistemology of research (Greenhough, 2012).

Indeed, when one acknowledges that practicing research implies implicating oneself in processes of change and world formation, it is fundamental to contend with research as a "political and ethical act" (Ibid: 202). Researchers who subscribe to this ethico-onto-epistemology, that is, need to come to terms with their working not as "as

separate agents, but 'participant parts' within and of an indivisible, unfolding, stranded, flowing whole" (Shotter, 2013). Embracing a new materialist orientation, then, simultaneously does not allow one to maintain a positivist stance nor to take up an idealist one; a new materialist epistemology requests instead a sort of realism that is "naïve" for Bennett (2004) or "agential" for Barad, an approach to matter as dispersedly agential, relational, and becoming. Moreover, understanding part of the researcher's sedimentation to be her familiarity with previously published literature and theories, such a research strategy also means a refusal of purist inductivism or deductivism. It implies instead a favouring of a Peircean approach to "abduction" (Fann, 1970), whereby the researcher remains open to the affectivity of its encounters but recognises the reflective and diffractive work constantly happening as she processes what she observes in light of the theory and concepts with which she is familiar (Timmermans and Tavory, 2012).

A framework of relationality, becoming and dispersed agency also implies serious ethical implications despite the many doubts that have been levied against the New Materialisms' capacity to do so (Harrison, 2015; Rekret, 2016). As Thiele has written extensively about (Thiele, 2008, 2016), indeed, an onto-epistemology centred on becoming begs constant consideration of the effects of one's actions, starting with thought itself. Though this may appear as a re-turn to anthropocentrism, taking responsibility of one's practices does not do away with a recognition of dispersed agency; it does however respond to the need not to make "the price in recognizing the agency of artefacts [...] the denial of our own" (Suchman, 2007:285). Although scholars who have moved to distance themselves from humanism have struggled to engage meaningfully with ethics (de la Bellacasa 2017), recognising more-than-human asubjective ethical agency cannot do away with the participation of the human entirely. Indeed, refusing essentialism in favour of becoming means that "it matters at every moment *how* (original emphasis) we (en)act (in) this world" (Thiele, 2016:30). If each move is an "agential cut" in Baradian terms, or entirely contingent in Spinozo-Deleuzian ones, no choice can be irrelevant or uninfluential. This does not amount to a formulation of ethics, however, until this attentiveness to positive difference is wielded to *make* a difference, which is what Barad proposes in her 'posthumanist ethics of mattering' (2007). As Mauthner notes, the focus of this ethical

move is not on the intentionality of the human subject but rather on taking responsibility for the ontic effects of knowing practices themselves (2018:4).

The ethics that informs this chapter and I call new materialist, then, expands beyond the Spinozo-Deleuzian tenet of the indeterminacy of affects (Deleuze, 1988) to take seriously the feminist tradition of taking responsibility for one's participation in the production of some worlds instead of others (Povinelli, 2001; Haraway, 2013). In doing so, it also pays homage to the school of American Pragmatism (Barnes, 2008), with which it aptly shares a foundation of anti-essentialism. Indeed, focusing on the effects of research practices in drawing boundaries and producing worlds resonates with one of the key principles of the classical pragmatism of William James and John Dewey, which asks one to evaluate her actions by following their effects. As Connolly reminds us, this produces an ethos that keeps in mind both the microscopic and the global without claiming to engage with it all, all at once, but rather to "adopt a problem orientation, pursuing the contours of an issue up and down the interacting scales" (2013:401). In ethico-epistemological terms, a new-materialist ethics asks a researcher to take responsibility while enacting a world in entanglement, or in other words while participating in worlding processes that enrol the sociomaterial. Keulartz et al. have summarised the overlap between this new materialist sensibility and pragmatism effectively in arguing that "a pragmatist ethics approach asks that we pay special attention to the future worlds disclosed and shaped by different ways of conceiving and enacting sociomaterial arrangements (2004). Through this pragmatist approach, new materialist ethics both escapes humanist biases that centre choice as the justification for ethical responsibility and faces the urgency of becoming accountable for one's participation in worlding processes.

Relationality, becoming, and dispersed agency: these I argue to be the defining characteristics of a new-materialist ethico-onto-epistemology. It is these I have foregrounded in designing, conducting, and discussing the research in this thesis. When designing research, such characteristics request:

1. an ontological commitment to approaching matter— be it inert, alive, tangible, or abstract— as becoming agential in ephemeral and contextual relations;

2. an epistemological commitment to decentring the human as subject and object of productions of knowledge towards focusing on the performativity of knowing practices;

3. and an ethics that expands to the more-than-human and demands responsibility from researchers as agential parts of the materialisation of the world.

After encountering new-materialisms literature, I knew I wanted to mobilise an ontologically monist relational approach to both energy and the state, stay with the materialisations of immanent dispersed agency, and remain aware of the unpredictability of complex heterogeneous assemblages that are constantly re-arranging and whose re-arrangement my own practices would impact. For this reason and to make good on an ethical commitment to specific worlding, I sought out literature that defines both energy and the state as sociomaterial relations and processes – literature, that is, that refuses both essentialist categorisations of phenomena and binaries between nature/technology, state/society, or human/non-human. I therefore ended my desk-based work with an understanding that the new energy schemes I was interested in were themselves assembled, and were only some of the many elements that intervene in complex sociotechnical systems in ways that are entirely context-dependent and too entangled in affective geographies to be predicted. Already before entering fieldwork, then, I knew that I wanted to approach the world as socially produced rather than socially constructed (Fox and Alldred, 2019). This never meant abandoning social construction and its importance in the formations of relations of power. Rather, it pushed me to contextualise social construction in processes of immanent, contingent materialisations so as to honour the idea that "concepts and experience, meaning and matter, emerge historically and reciprocally" (Coole, 2013:455)

This ethico-onto-epistemology guided me towards a research design centred on diffraction, highlighting events of encounter, enquiring along lines of *how* rather than why, and mobilising analysis through the tools of assemblage, diffractive reading, and critical junctures. And partly because of the relative newness of discussions of new materialist methodological tools in social science literature (Fox and Alldred, 2015; Coleman, Page and Palmer, 2019; Brice and Thorpe, 2021), I approached my fieldwork with the naïve conviction that holding onto the theory would have been enough to practice a new materialist methodology. I believed I had read enough so that the metaphysics of relationality, becoming and dispersed agency would have seamlessly translated into a new-materialist *sensibility* through which I would notice sociomaterial affectivity with little effort. This was not the case for me, but I was lucky enough to be affected by my research assemblage in ways that directed me towards intensified *noticing*, openness to *contamination*, and attunement to *polyphony* rather than overarching narratives. The following anecdotes recount these affective intra-actions and serve as a grounding tool for the discussion of the methodological value of the practices I was affected to embrace.

2.4 Anecdotes from the "field": letting the realities of research affect me

My first weeks conducting "fieldwork" moved slowly and repetitively: though the director of the community cooperative with whom I had sought an internship had warned me that their reality would be a small one and perhaps insufficient to exhaust the scope of my research, I was stubbornly resolved to start my data collection in their offices and commuted there five mornings a week. The cooperative was at that time still struggling with staff's anxiety to resume work in-person after months of traumatic experiences of loss following infection from Covid-19, felt both through personal networks and through daily national reporting of the number of deaths associated to it. Very few people showed up at the office, a small space in the centre of the village of Melpignano, so my days often consisted of sharing this space solely with the cooperative's director. Though incredibly generous in her disposition towards me, she was very busy navigating the cooperative's transition to resuming work-as-usual after the first national lockdown and to working with the new local administration that had taken office only a few weeks prior. I therefore mostly sat in the office quietly, spending my time sifting through archival material about the

cooperative and its projects, and welcomed with great gratitude the rare chances to interview about their work the staff members that I would briefly meet.

Though I had imagined I would be observing the cooperative's functioning, what I found myself doing was mostly listening to accounts of what this would be in regular operating times. And when I attempted to start mapping the networks with which they cooperated on the politics of electricity decentralisation in the country, I discovered interesting groups that were similarly not really meeting at the time due to the recent shock of the Covid-19 pandemic. I struggled to commit to tracing sociomaterial networks rather than identifying interesting publics, and discovered in the everyday practices of the cooperative that hosted me cues to their work no longer dealing with decentralised energy generation like it once did. But rather than following the messages conveyed by both my struggle to translate concepts into research practices and by my uneasiness with the narrative I was attempting to build about electricity decentralisation and politics, I continued interviewing those who were interested in speaking to me with desperate obstinacy.

What forced me to break this mulish approach that in hindsight would have led me to much less interesting research outcomes, was a moment of intensified fear of my susceptibility to COVID-19 and its effects on public health provision. A particularly debilitating tonsillitis brought me to seek medical attention, but I discovered that local family doctors were not taking on new patients and urgent care clinics were not seeing patients that showed symptoms akin to those brought on by a COVID-19 infection, neither in-house nor in-clinic. Both measures had been put in place because the region's health care system had become immensely strained by the increase in Covid-19-related hospitalisations in the prior two weeks. Alone and scared, it was ultimately my encounter with a powerful bacteria and the possibility of encountering an even stronger virus that forced me to come to terms with the reality of my condition: I was blindly pursuing a research approach that was not working and simultaneously putting myself at risk by continuing to conduct interviews in person in a region where hospitals were already at capacity.

Once I could drive again after a few days, I chose to leave the lodgings I had rented to take refuge in my mother's house in the region Marche, some 690 km away. I made it out just a few days before inter-regional travel was banned again by the central government in an attempt to curtail the spread of Covid infections. This choice of course impacted the development of my data collection moving forward, as I was no longer "in" the field as I had originally understood it. However, feeling pushed towards this decision by something other than myself or another person shifted something in my disposition to research, and helped me begin nourishing a sensibility to the sociomaterial.

The first effect of such an experience was that I started to *notice* more, both elements of my own entanglement in the research and interesting relations I was missing. I noticed my own reticence to letting the first place of study go and finally processed how the time I had spent there affected me. I noticed the feeling of stagnancy in myself and chose to change course. I moved to attune myself to how electricity politics were "becoming other" and operating in the country in ways that often did not mimic what I had read in my reviewed literature. Only through this ongoing commitment to noticing becoming politics did I retrospectively put into focus the powerful relations at work in Melpignano, which I was overlooking while searching for relations with decentralised electricity generation. I was finally able to take note of the personal relations of some of the members of the community cooperative there with powerful networks and associations, their ongoing relations with members of academia to spread their model, and the relation of their investment both in solar panels and in other non-electricity-focused projects to processes of southern disenfranchisement and injustice as sustainability logics favoured distant publics rather than the communities surrounding the cooperative.

In recognising my deliberate blindness to the happenings of Melpignano, I pledged to remain sensitive to what was happening around me that spoke of changing relations of power as the electricity milieu in the country was changing, and started tuning into webinars about renewable energy communities and groups of prosumers that were increasingly circulating online. In these spaces, I noticed representatives of two companies were often present, one a large energy cooperative and the other the state-owned energy service system operator, both often discussing a key piece of legislation on renewable

energy communities. I decided to attempt interviewing members of both companies via digital interviews on video-calling applications like Zoom and Microsoft Teams while continuing to conduct digital participant observation in webinars on renewable energy communities.

When negotiating with one of these companies access to their membership and internal channels of communication, however, something surprising happened: a key gatekeeper asked me to conduct my research in tandem with a PhD student in social anthropology. At first, I was paralysed by the request: again and again I had been told that a fundamental requirement to obtain my PhD was originality and I struggled to foresee how I could ensure to safeguard this prerequisite while conducting data collection with someone else. I therefore met with the other researcher only because my access to this important public depended on it, but quickly realised that collaboration between us would have been more harmless than I had imagined. After establishing we operated on similar epistemological lines, we developed a protocol that would both guard the originality of each of our research and protect the research participants by limiting the time commitment we required of them. What I did not expect, however, was that working with him would affect me beyond collaboration: our work together contaminated me and my research.

Tsing speaks of *contamination* as the defining characteristic of her own understanding of assemblage as "happening" rather than "gathering" (Tsing, 2015). This is effectively a conceptualisation of assemblages as encounters with worlding effects, a framing that underscores the performativity of assemblages beyond creating collectives. This connotation of contamination is well aligned with the ethico-onto-epistemology of relationality, becoming, and dispersed agency discussed above, but its significance in my research did not strike me until I saw research participants discuss contamination in their own words when reviewing interview transcripts. When I asked them about how they understood the relation between their roles in society and their views on sustainable futures, numerous research participants recounted how encountering social movements, particular energy practices, ethical treaties like the *Laudato Si*[6], or the excitement of other members

[6] Pope Francis' call for a Catholic commitment to environementalism

of the cooperative, contaminated them, infused them with a different disposition towards the world, impacted their actions and changed their imagination of the future. Through their words, I realised that my own research had been contaminated by the collaborative interviewing I had conducted.

I had not just worked alongside another researcher: in the process of conducting interviews together, chatting beforehand and afterwards, and especially waiting for his set of questions to end before I asked my own or listening to his line of inquiry after being done with mine, I had taken on elements of his disposition to research and some of my conceptual thinking had shifted too. For example, his curiosity about the cooperative's project to "scale up" and cooperative members' attitudes towards this possibility prompted me to revisit how I had been thinking about scale in my own project. It contributed to the inspiration that led me to write about the overestimation of scalability in sustainable transitions and to propose to follow the effectiveness of "small scale" elements acting in contingency and producing constitutional moments of change (Concetti, 2023c). Though when I started this collaboration a fixation on originality as dogmatic requirement for the completion of my degree overshadowed the ethico-onto-epistemological premises I had set out to follow, the sensibility I had been nourishing by constantly asking myself what I had been noticing in myself and what most moved me from the data I had collected brought me back to those values. A disposition towards becoming and becoming other, or a new materialist sensibility to diffraction, allowed me to see contamination as performative and in fact inevitable rather than as a variable that I needed to work against in order to produce unadulterated original research.

Though the previous two anecdotes may suggest a frictionless transition from a research design with data collection centred on relational ethnography to one attempting to trace the sociomaterial largely through digital methods, this was not the case. For many months, I felt lost, anxious about the progress of my fieldwork, and disheartened at the thought that I would not have the elements to recount the compelling story I thought I needed to tell. In fact, I lost trust in the story altogether and lost my bearings. But feeling lost allowed me to perform abductivity in my research disposition. Rather than approaching my research looking for something, like I had before, when I finally let the lostness affect

me I was able to be surprised by interesting elements I encountered and to trust a sensibility to the sociomaterial. Indeed, in re-reading my interviews and my notes on the webinars I was attending, I started to become attuned to the multiplicity of the field I was entering. This was not just a multiplicity of actors, things, and interests but also a multiplicity in the at times contrasting effects of things coming in relation with one another. If the proliferation of distributed generation technologies into the grid produced a relation that strengthened the need for a central TSO in managing loads and ensuring the system worked under new strains, the entanglement between these artefacts, their users and investors, and ideas of energy democracy and sovereignty opened speculative scenarios of off-grid resilience (Concetti, 2023a). Though the production of regional laws about the collective use of these technologies was de-coding the state, it was simultaneously re-territorialising it in its centralisation of power. And though the laws discussed spoke of "energy" communities, the boundaries they were drawing most often found reason in electricity constraints (Concetti, 2023b).

Having committed to noticing affective relational flows for a few months, in the lostness of this process I recognised that I was drawn to these moments of intense tensions, that I felt they all *mattered* in producing change in electricity politics in the country. I also found myself understanding these processes through different conceptual frames, and pondered whether I should prioritise one over another for the sake of coherence. Returning to Barad at this time provided me with the clarity I had missed for a while: rather than trying desperately to represent what I had been enmeshed in for the past months, I needed to embrace my part in processes of diffraction. That is to say, I was right in assuming that the analytical tools through which I understood the becoming relations I was mapping were framing them in specific ways, but wrong in problematising this process: every frame constituted an agential cut. And every agential cut spoke of the conjunctures of elements that were most strongly affecting me as I was discovering them and returning to them. This did not mean that such contingencies were operating as separate parallel tracks, but rather that in the intra-acting milieu of electricity politics in Italy each of these phenomena had taken on a particular territory in their entanglement with each other and with my observation.

Understanding my research assemblage this way finally made me comfortable with the polyphony that I had been fighting against in the attempt of manufacturing an overarching narrative of change. In speaking of polyphony, I am once again referring to Tsing, who introduces the concept as a qualifier to her understanding of assemblage. When listening to polyphonic music, one is "forced to pick out separate, simultaneous melodies *and* to listen for the moments of harmony and dissonance they [create] together" (Tsing, 2015:24). This is a process that I have found immensely akin to researching sociotechnical change through an ethico-onto-epistemology based on relationality, immanence, and dispersed agency. Indeed, rather than a unitary process with a harmonising logic, change can only be conceptualised in this framework as the effects of the temporary conjunctures of multiple elements and their agential relations. Attempting to discuss this change as a linear process captured in one neat narrative with a clear start and a clear end was therefore incoherent with a new materialist ethico-onto-epistemology and research design. Rather, what I needed was a story-telling approach that honours multiplicity.

I found a convincing approach in Tsing's comfort with polyphony, and moved to produce my research in a way that makes space for disjuncture and gaps in the retelling of messy processes. Skirting narrative when writing a long text required to form a "coherent whole" (Durham University, 2023) is not simple. I however worked to do so in this thesis by presenting three empirical chapters each framing the research assemblage without claiming full representation of it. Indeed, the following chapters do not attempt to tell one coherent and harmonic story in concert. Rather, they each speak of a world in entanglement and are themselves in entanglement with each other without attempting to exhaust the research assemblage in representational ways. I further highlight and honour the disjuncture in my research assemblage by mobilising a different analytical approach for each chapter, namely assemblage analysis, diffractive reading and critical juncture analysis. The choice to present analyses each rooted in specific genealogies of thought and each performing the research assemblage in specific ways responds to Deleuze and Guattari's call to produce a "map" rather than a "tracing" of the research assemblage (1987:22), that is to perform research in ways that do not neutralise multiplicity by neatly

ordering it. The following section appraises the specific analytical cutting that each of these methods makes.

2.5 How Analytical Tools Frame the Research Assemblage: assemblage analysis, diffractive reading, and critical junctures

Assemblage Analysis

Using assemblage as a methodological tool is a practice whose value is increasingly recognised both within and outside of the discipline of Geography (Baker and McGuirk, 2017). It implies both a "certain ethos of engagement with the world" (Anderson and McFarlane, 2011:126) and particular analysis of the 'data' collected (Feely, 2019). For this reason, it holds implications both for 'approaching the field' of the research and for processing and discussing the information and materials emerging from the research assemblage. Though the first set of implications are most neatly folded into the ethico-onto-epistemological effects of a new materialist research design, the latter require further elaboration in light of the diffractive work of assemblage analysis.

In my experience of researching sociotechnical change, assemblage analysis proved to be particularly useful in providing ways to recognise and describe processes of non-linear destabilisation. Both Feely and Fox (2015) and Alldred (2020) have previously noted that conducting assemblage analysis in the social sciences has meant:

1) working through data collected to identify the powerful elements or relations of the phenomenon under study

2) following how semiotic, material, and social elements flow in the assemblage

3) and mapping how the assemblage in question:

    1. reproduces the orders and hierarchies that regulate itself and the milieu in which it operates through lines of re-territorialisation

2. and destabilises such schema through lines of de-territorialisation (2015; 2020).

Although identifying powerful relations at play and following how elements flow within an assemblage are both fundamental to drawing conclusions about processes of change, I argue that in practice they both act as theoretical precursors to the tool of mapping de- and re-territorialisation. It is this tool that provides an analytic method, and this tool specifically that uniquely frames observed processes of sociotechnical change. Noting powerful relations and their flows points (in Tsing's terminology) to "gatherings" of a sort, as it takes stock of participant actors in the materialisation of certain processes. Focusing on de-/re-territorialisation, however, performs a different cutting – one that points to the ways in which materialisation enacts change.

When performed with a focus on de/re-territorialisation, assemblage analysis centres lines of inquiry on the effects of agential multiplicity and specifically on the effectivity of changing relations in disrupting the status-quo-ante or reinforcing it. Because of Deleuze and Guattari's commitment to the heterogeneity of assemblage, it also foregrounds how such effects can be contrasting as they emerge from multiple lines of flight (towards destabilisation) and of segmentarity (towards re-stabilisation of previous orders) (1987). It pushes the researcher to suspend assumptions about the disruptive capacity of any intervention and map instead how systems are changed in their definitional and operational boundaries through courses that are often tortuous and non-linear, whereby disruption may ultimately lead to the strengthening of temporary orders. In this way, it is a particularly useful tool to evaluate sociotechnical change, especially when questioning the implications of novel configurations that intrude into consolidated systems. For this reason, scholars studying sustainable transitions may find it useful in appraising whether technical, political, or discursive schemes that have been discussed as holding great potential for sociopolitical transformation have in fact materialised such potential in action. In my own research, the analytic tool of de-/re-territorialisation has allowed me to answer the question "what happens to the state, whose reproduction has been so tied to the work of centralised electricity infrastructures, when these infrastructures start to change?" (Concetti 2023a, 1).

Diffractive Reading

As Van der Tuin notes in an article where she herself reads Bergson and Barad diffractively, diffractive reading enacts the methodological potential of Diffraction (Van der Tuin, 2011). It cuts through the opposition of divergent schools of thought by urging scholars to "read important insights […] through one another" and affirmatively linking them in ways that engender new theory production by finding complementarity rather than negation (Barad, 2003:811 in Ibid 2011:27). In this sense, the delineation of a shared new materialist ethico-onto-epistemology presented above is itself a diffractive reading.

Though very generative as methodological praxis that takes seriously the worlding implications of knowledge production and works to create new patterns of understanding, diffractive reading has also been increasingly used in the social sciences as an analytical method to make sense of empirical data (Fox and Alldred, 2021). In these works, data is read diffractively through different theoretical perspectives, through other data, and through deliberate coding practices (Ibid, 2021), but also interpreted differently through the patterning lenses of objects that act as diffractive mechanisms (Fenwick *et al.*, 2015). The latter is the case for Doyle's research about professional learning in healthcare, in which she centres the insulin pump as a diffracting mechanism through which to read interviews and ethnographic fieldnotes on healthcare practitioners' learning practices and in this way reveal the performative work that this object executes on paediatric diabetes management (Doyle, 2018).

Fox and Alldred have recently argued that Diffraction holds little methodological clarity, and that as an analytical method it hyper-centres the researcher whose decision to enact agential cuts singularly impact conclusions (2021). I argue, however, that diffractive reading constitutes a powerful analytical tool in the arsenal of new materialist researchers. Indeed, claiming that Diffraction as data analytic reproduces anthropocentric notions misconstrues Barad's argument that the researcher needs to take responsibility of the worlding effects of knowing practices in entanglement (see above discussion about ethics). Rather, diffractive reading allows one to provisionally foreground what are *apparently* bounded elements in processes of materialisation (such as the insulin pump in paediatric

learning) to begin unravelling the ways in which particular phenomena are produced in intra-action.

Wielding diffraction analytically makes methodological difference. Following Barad, diffraction allows a researcher to overcome some of the pitfalls of "representationalism" (Barad, 2007:88). As a method, it prompts a research practice that refuses voyeuristic tendencies that position the researcher as an external observer of "the" world. It requires one to perform research while remaining cognisant that the very act performs or *enacts* "a" world instead. As Barad summarises in a heuristic table on page 89-90 of her book (2007), practicing diffraction implies an understanding to be working from within and an endeavouring to mark differences from this place of entanglement rather than from a distant view-point. This positioning requires the researcher to take account of the minute ways in which an entanglement materialises and to draw her objectivity from this recognition rather than from a commitment to perfectly reflecting an outside reality. Significantly, this unique methodological disposition to entangle with the world and to perform it in such entanglement, to study from within, and to focus on the difference that matters by tracing the fine details of materialisation processes offers great opportunity to engage with sociotechnical change. Studying sociotechnical transformations through diffraction means being able to engage with the sociomaterial and to trace how the subtle differences materialising in the unfolding of these changes while they are under-study *matter.* This is in quite stark difference to methodologies based on reflection, whose modus operandi is reification and simplification and whose approach to the world implies an irrefutable separation between subject and object.

In studies of sociotechnical change, diffractive reading allows the researcher to start with the more-than-human elements of the "sociotechnical" under study to investigate how publics, policy, and more-than-human systems are affected by such elements. Thanks to diffraction's flattening of ontological boundaries towards an "entangled ontology" (Barad, 2007:89), indeed, the researcher gets to approach the more-than-human as material-discursive. In this way, the sociomaterial no longer needs to include only "things" but rather expands to include words, and ideas, and prefigurations. Through this provisional foregrounding, a researcher may draw conclusions about the location of powerful nexi in

the constitution of the change she is studying. In other words, bringing to the fore specific matters and following how their patterns reverberate in other elements of the assemblage under study allows to identify particularly powerful contingencies at a given moment in the trajectory of change. Diffractive reading as analytic for example allows me to think about the electrical grid as an open system whose requirements shape energy governance in Italy beyond policy that regulates electricity specifically (Concetti 2023b).

Critical Junctures

The concept of critical junctures presented in this chapter originates in Collier and Collier's synthesis (1991) of much earlier work by Lipset (1967), whereby the two authors put forward a framework to investigate how long-lasting institutions both emerge and persevere in time. Not widely mobilised in Geography, this framework has garnered significant interest in Institutional Sociology and Political Science, especially as a tool to trace political change in Latin America (Collier and Munck, 2017). Though honouring this genealogy, the connotation of the concept that I focus on is one gleaned from scholars in Science Technology Studies interested in the governance of sociotechnical transformations (Beck *et al.*, 2021), which presents critical junctures as moments in time when punctuated institutional change happens (Capoccia and Kelemen, 2007). It is precisely this focus on punctuation that makes the concept fertile analytical grounds for new materialist studies of sociotechnical change.

Indeed, when expanding critical juncture beyond a history of institutions and encountering this concept as data analytic, there emerges a diffractive mechanism able to perform non-linear temporalities. In fact, I argue that Critical Junctures as analytical method asks a researcher to foreground moments of heightened intensity when contingent relations come together to transform the temporal rhythm of specific processes under study, thus leading one towards lines of inquiry attuned to temporal discontinuity rather than linear progress. Through this analytical tool, researchers interested in sociotechnical change may represent transformation without falling into narratives of singular harmonious processes and simultaneously think critically about the multitude of elements coming in entanglement to spur a temporary change of pace. In this way, critical junctures centres

lines of inquiry on the temporal dimension of the materialisation of sociomaterial agency, an underrepresented area in the field. In my research, such an analysis rooted in critical junctures has allowed me to echo Tozer et al.'s refusal of deterministic framings of sustainable transitions that misconstrue the dynamics of sociomaterial change as linear transformations based on "scaling-up" processes (2022) and unearth instead how novel sociotechnical imaginaries emerge through temporal contingencies that are brought together by human and more-than-human entanglement.

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CHAPTER 3 - ALERT! POWER CUTS:
Power System Reconfigurations Re-Assembling The State[7]

3.1 Introduction

When riding on the freeway from my childhood home to the centre of town, my eyes rarely used to focus on the winding electricity lines that overlook the fields and suburbs. Apparently immobile and unperturbed by seasonal change or urban development, they seemed to me to be the least interesting element in the colourful composition speeding by. Having been back on that road recently, I was delighted to find them seemingly unchanged, a testament to how little an untrained eye can perceive of the momentous transformation that the electricity infrastructure in Italy has undergone over the past twenty years. In fact, ever since the early 2000s, EU and national renewable energy strategies together with the rapidly declining costs of renewable energy technologies have contributed to the fast proliferation of distributed generation renewable systems that are stealthily and radically transforming the way in which electricity is produced (L'Abbate et al., 2008; Anaya and Pollitt, 2015).

Distributed generation renewable systems function through renewable generation units like rooftop solar panels or wind turbines that feed directly into the distribution system. These new infrastructures change the traditional monodirectional load flow of electricity to a bidirectional one and disrupt the binary between electricity production and consumption, allowing for the emergence of the hybrid process of *prosumption* and stirring excitement among scholars of sociotechnical transitions believing in its democratic disposition. However, despite the rigorous literature discussing the ability of energy transitions to impact statecraft (Easterling, 2014) and tying conventional electricity

[7] I wrote this chapter as a submission to the *Handbook of Infrastructures and Cities,* edited by Olivier Coutard and Daniel Florentin. The chapter here reproduced is an earlier manuscript to that which will appear in the book to be published in April 2024 to comply with copyright restrictions. It will be published under the title "Power Disruptions: power system reconfigurations re-assembling the state".

infrastructures to the production of stateness and state effects (Bridge, Özkaynak and Turhan, 2018), little scholarly attention has so far been devoted to the ways in which the new configurations of power systems that have experienced the proliferation of distributed generation renewable systems are reassembling the state. Contributing to the burgeoning scholarship investigating the democratic potential of these new decentralised forms of electricity generation through a new lens, therefore, this chapter turns to their agentic capacities in the assemblage of the state. The chapter thus asks: what happens to the state, whose reproduction has been so tied to the work of centralised electricity infrastructures, when these infrastructures start to change?

In order to address this question, I mobilise a theoretical framework whose usefulness is highlighted by empirical snapshots from 12 months of fieldwork in Italy and subsequent remote research. From these materials, stories emerge of multi-scaled governance processes in energy transitions, everyday energy practices, and diverse infrastructural encounters that depict a varied and incomplete map of political changes that are still unfolding. I recount these stories in a lexicon borrowed from post-structuralist and neo-materialist thinking. My goal is to capture the heterogeneity and relationality of energy transitions, their infrastructures, and the state. To do this, I bring literature on infrastructure politics and energy transitions into conversation with post-structuralist state theory and *assemblage theory* (AT). I argue that, in reconfiguring power systems, the proliferation of distributed generation renewable systems is transforming relations of proximity embedded in electricity infrastructures and thus eliciting processes contributing to the re-assembling of the state through movements of de/re-territorialisation and de/coding.

In the first section, I present a curated review of interdisciplinary literatures on the politics of distributed generation as a tool for energy transitions and on the concept of proximity through a new materialist lens that privileges dispersed agency, becoming, and multiplicity. I then put this work into conversation with post-structuralist state theory to propose a conceptualisation of the state that makes space for the ways sociomaterial change both reproduces and *reassembles* a porous, processual and heterogenous state. The literature review ends by introducing the analytical tools of re/ de-territorialisation and

de/coding from AT. I use these concepts to map the ways in which the power system reconfigurations brought about by distributed generation renewable systems materially and discursively contribute both rigidity and unpredictability to the organisation and functioning of the state. In the following section I weave stories from my fieldwork in Italy with the conceptual framework to show the assembled nature of the state and the ways in which changing electricity infrastructures are both de-/re-territorialising and de/coding the state and its energy politics.

3.2 Decentralised Energy Transitions, Power, and Proximity

Though previously associated with electricity generating units with limited rated power, distributed generation (DG) has been defined in EU legislation simply as *"generation plants connected to the distribution system"* (2009/72/EC), that is any grid-integrated generation infrastructure whose electricity does not need to travel through the transmission network before getting to an end user. Such technologies are revolutionary for traditional power systems because they work against conventional configurations relying on long transmission cables that carry the electricity produced in large power plants to far away passive users, from higher to lower voltage. This brings about great technical and operational challenges (Ferrandon-Cervantes, Kazemtabrizi, and Troffaes, 2022) and simultaneously opens up possibilities for new and promising energy practices associated with prosumption, the production of energy by traditional consumers. This chapter is interested in particular in distributed generation renewable systems, distributed generation systems that rely solely on renewable energy sources (Wolsink, 2018) and in the spatial shift implied by the prosumption these allow, one where electricity is produced in spaces traditionally associated with consumption.

BOX 1: Distributed Generation Renewable Systems (DGRS) in Italy

In Italy, DGRS account for over three quarters (77%) of total DG, which in 2019 represented around a quarter (24%) of national electricity production (ARERA, 2021). Their proliferation has been recently incentivised with a law in 2021 called Decreto 199, which implements European Directive RED II. The law incentivises the creation of Renewable Energy Communities (RECs) and Collective Self-Consumption Schemes.

Whereas non-renewable DG often mimics the functioning of traditional power plants operating in centralised power systems (Wolsink, 2018), distributed generation renewable systems tend to be smaller and can be comfortably owned individually, like rooftop solar panels, or communally like hydroelectric screws or small wind turbines (ARERA, 2021). They are thus particularly well-suited for prosumption. Generation units can indeed be installed on top of or close to commercial and domestic buildings (Parag and Sovacool, 2016). Distributed generation renewable systems thus entrench relations of geographical, organisational and institutional proximity between sites of electricity production and consumption that greatly differ from those of traditional power systems.

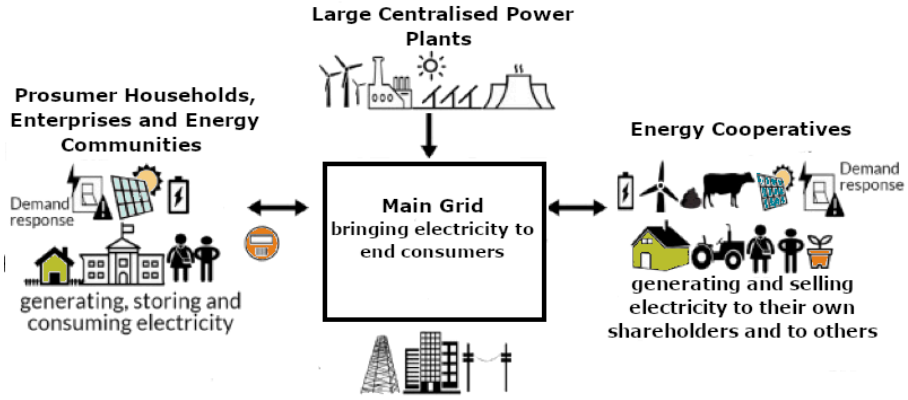

Figure 6: Power System in which Distributed generation renewable systems operate alongside Individual Prosumers and Groups of Prosumer (source: author)

Following the conceptualisation of proximity that gained prominence with the French school of proximity in the 1990s and was then expanded to include less eulogistic approaches and a more international lens (Torre and Wallet, 2014), what I mean here is that distributed generation renewable systems imply not only greater vicinity for end users to places of production (geographical proximity). They also mobilise publics belonging to similar interest groups and subscribing to similar worldviews (organised proximity) and open spaces for intervention in both regulation and incentivisation to localised institutional actors (institutional proximity). These relations are intensely political and their centrality

in historical and present urban energy transformations has been increasingly studied, in francophone literature especially (Florentin, 2017; Tabourdeau and Debizet, 2017; Wernert, 2017).

Tabourdeau and Debizet, in particular, take an approach akin to that mobilised in this chapter by conceptualising urban energy systems with increased levels of self-consumption (here discussed as prosumption) as 'socio-energy nodes' whose transformed relations of proximity shed a light on the ways in which the sociotechnical regimes of energy and real estate development shape energy futures (Tabourdeau and Debizet, 2017). Even if not speaking of proximity per se, De Laurentis gets to some of the changes to institutional proximity implied by the proliferation of distributed generation renewable systems by showing how regional actors in Italy can wield *territorial responsiveness* to mediate material and constitutional obstacles to power system reconfigurations and use the new spatialisations of distributed generation renewable systems to justify interventions that make their territory appealing to external investors (De Laurentis, 2022). The new institutional relations of proximity brought about by distributed generation renewable systems are central to this chapter, as they contribute to making the sociotechnical transition from a centralised power system to one permeated by decentralised infrastructures so politically powerful.

In anglophone research, the focus on proximity is less present. However, an increasing number of energy transition scholars writing in English recognize the potential of DG infrastructures for socio-political transformation, especially when they are associated with prosumption, collective ownership, and participatory democracy practices (Burke and Stephens, 2018; Chilvers and Pallett, 2018; van Veelen and van der Horst, 2018). Often mobilising the term "energy democracy", an increasing number of social scientists studying distributed energy politics have considered how the design, low capital cost, and relatively easy upkeep of distributed forms of renewable electricity generation can make space for more democratic political systems. Or to put it concisely, this work explores how "distributed energy sources and technologies enable and organise distributed political power and vice versa" (Burke & Stephens, 2018; p. 78).

A few scholars are specifically taking a relational approach to trace the politics of energy democracy. Foregrounding a relational approach to both power and the state, James Angel for example follows the Berliner Energietisch campaign to conceptualise energy democracy as a tool for emancipatory energy transitions that can extend control over the commons of renewable energies "in-against-and-beyond the State" (2017). He thus begins to put in conversation the tradition of prosaic stateness (Aiken, 2016; Painter, 2006) and neo-Gramscian theories of the state with the phenomenon of energy democracy, excavating the state's porosity and susceptibility to non-institutional actors in decentralised energy transitions. More interested in the process of *infrastructuring* that technologies of distributed energy generation undergo, Blok (2016) instead follows the unruliness of the material politics of the Copenhagen wind turbines to show how the political principles being inscribed in the development of low-carbon infrastructures are just "as unsettled as the technologies" that constitute them (Blok, 2016, p.104). In doing so, he convincingly describes the multiplicity and dynamism of the politics and ethics encoded in energy transitions' processes and material infrastructure. Staying with similar tensions, Van Veelen and Eadson (2020) espouse a deliberately neomaterialist approach to depict the assembled nature of community energy projects and their consequential entanglements with multiple social and political relations. They thus open theoretical space to engage with the ways in which community energy schemes continuously enrol and are enrolled by publics with heterogenous interests and provide an entry point to the usefulness of assemblage thinking in studying distributed energy politics. In this chapter, I set out to contribute to this scholarship with a similar theoretical approach but by exposing a different manifestation of the sociopolitical potential of distributed generation renewable systems: the disruptive capacities of these systems on the socio-material structures of the state-as-assemblage thanks to their material-discursive labour and to the novel relations of institutional proximity they imply.

This conceptual move is informed by several scholarly contributions from disparate disciplines dealing with notions of prosaic stateness and infrastructure politics. In order to approach these disparate literatures cohesively, the subsection below draws its ontological

position from frameworks within the field of new materialisms (Coole and Frost, 2013), which although not theoretically homogenous, tend to coalesce around ideas of becoming, relationality, dispersed agency, and heterogeneity (Coole, 2013; Fenwick, Doyle, Michael, and Scoles, 2015; Fox and Alldred, 2019).

Infrastructure Politics: sociomaterial productions of state-society boundaries

To approach the material politics of state-society relations it is useful to reference an emerging body of work that puts in conversation two well-established scholarships that theorise infrastructures as intensively productive and conceptualise the construction of the state as not limited to the founding of nation-states. The first body of work understands infrastructures to produce symbolic meanings (Larkin, 2013), encode national imaginaries (Jasanoff and Kim, 2009; Swaan, 1988; Swyngedouw, 1999), negotiate the form of social relations (Anand et al., 2018) and be brought into being by the performance of specific sociotechnical practices (Barry, 2013). The second ensemble reconceptualises the state as emerging unevenly and continuously in everyday social interactions, state practices, and stories of statehood (Timothy Mitchell, 1991; Mountz, 2003; Painter, 2006).

Broadly discussed here under the umbrella term of "infrastructure politics", this emerging literature signals the unique role that infrastructures have in "providing the material foundations for social life and the imaginative resources through which political participation is structured" (Harvey et al., 2016; Knox, 2017, p.9). Examining current infrastructure development as a generative site of continuous state building and state legitimacy, this approach widens the study of infrastructure beyond a technopolitical lens, which recognises that technical systems are carriers of social and political values that often exceed or diverge from the original designers' intent (Winner, 1980; Hughes, 1983; Jasanoff, 2004; Huber, 2009). It moves instead toward an understanding of the contingent and volatile labour of infrastructures and infrastructured objects in the configuration of sociomaterial networks and socio-spatial formations, such as the state itself, which are themselves in continuous processes of becoming.

Leila Harris, for example, advances state theory by following the construction of a large dam in Turkey, presenting it as an enabling sociomaterial agent and the manifestation of the separation between state and society (Harris, 2012). Bringing together STS approaches and the new-materialist ontological turn in anthropology, Hannah Knox traces the affective capacities of a new road in Natua Perú to show that infrastructures produce political imaginations of the state and allow for particular politics to emerge "in the process of material engagement" (Knox, 2017, p. 380). And drawing from object-oriented-ontology, Katie Meehan mobilises the concept of *tool power* to follow water infrastructure in Tijuana, Mexico and excavate the powerful capacities of some of the materials that constitute it (in this case, the law, the grid and the barrel) to "create, destroy, or limit the contours of what we call the state" (Meehan, 2014, p.216). Drawing from diverse theoretical frameworks and situating themselves in separate disciplines, these scholars all point to the active role of infrastructures in co-producing the state, the laborious production of state/society demarcations, and the porosity of stateness itself. This chapter adopts a similar post-structuralist understanding of the state, which is further illustrated in the next section.

The state in post-structuralist theories: as effect, as prosaic, as assemblage

Rejecting essentialist understandings of the state as an ontological given, post-structuralist state theories set aside the idea of a state as a subject with coherent ideology, authority or deliberate statecraft, like for example that conceptualised in Scott's *Seeing Like a State* (Scott, 1998), in favour of an understanding of stateness as practiced, itself multiple and therefore never stable in pursuing a unitary rationale (Kuus and Agnew, 2008).

Mitchell (1991) speaks in particular of *state effect* to conceptualise the way in which the political reality of the state and its power is produced in a myriad of practices "that make [state] structures appear to exist" (Mitchell, 1991, p. 94). It is through these very practices that the demarcation between state and society is constantly negotiated and that the second becomes a realm onto which the state appears to operate as a unitary external agent (Baker and McGuirk, 2021). Precisely because of the practiced nature of state effect,

state production is in Mitchell's theorisation never complete, but rather a continuous provisional process.

In conceptualising *prosaic stateness*, Painter furthers theorisations of the state that refuse a clear separation between state and society by focusing on the "unsystematic, the indeterminate and the unintended" of mundane, everyday practices that undergo statisation and are particularly effective in producing state effects (Painter, 2006). For example, he argues that the use of "we" by national politicians to speak of the national body of citizens as a whole has specific stateness-producing semiotic effects. Such a focus is coherent with neomaterialist ontologies: if bodies in the latter are theorized as becoming agentic through the temporary stabilization of the relations between their constitutive elements, stateness is in Painter's work achieved provisionally in the impermanent coordination of materials, discursive practices, and actors with disparate interests both within and without "state" organisations (Painter, 2006; Baker & McGuirk, 2021).

Understanding the state as prosaic, as effect, and ultimately as assemblage allows me to think about power system configurations as some of the networked elements that have the agency to produce the state in new ways. In the discussion of this chapter, I map how the reconfigurations I follow both reproduce stateness as it were and bring forth new images of it. To trace this seemingly paradoxical process - the simultaneous strengthening and weakening of the form of the state - I draw from Assemblage Theory which is uniquely able to capture the multiplicity here at play.

Analytical Tools: De/Reterritorialisation and De/Coding in Assemblage Theory

Itself not unitary or rigidly prescriptive, Assemblage Theory emerges from the work of Deleuze and Guattari and focuses in particular on their concept of *assemblage*, a notion speaking to the relational, unfinished, and multiple nature of all things (Anderson and McFarlane 2011). In this framework, assemblages are understood to have limited properties but open and unpredictable capacities due to their contingency on exterior

relations (Briassoulis, 2019), an ontological position that demands an analytical focus on the effects of emerging new relations on phenomena in becoming.

Formulated in the writings of Deleuze and Guattari and abundantly mobilised since, the concepts of de- and re-territorialisation function to this end. As Grosz explains (2008), an assemblage provisionally takes on a territory (is territorialised) when it first emerges as a framed structure, that is when its multiple parts provisionally come together and stay together in an ordered manner. In other words, an assemblage is only able to affect others when it takes on a territory, when its external boundaries are temporarily sharpened and its interior relations coalesce for a time.

The ephemerality of this stability is fundamental to Deleuze and Guattari's (1987) formulation of assemblage, who propose de- and re-territorialisation as tools to understand how assemblages change. De-territorialisation describes the ways in which assemblages follow "lines of flight", gather new parts in forming new relations, lose stability in their form and thus change (Deleuze and Guattari, 1987 p. 7). Re-territorialisation describes instead processes of re-assembling that follow "lines of segmentarity" (ibid), movements towards increased stability in the relations between the parts that constitute the assemblage, which strengthen the boundaries of the claimed territory and make the assemblage more rigid. Importantly, assemblages are not unitary systems and therefore possess both lines of flight and of segmentarity. They undergo processes of de- and re-territorialisation when some of these lines become intensified and, as I will argue in the discussion, movements in one direction may at times reverberate to intensify change in the opposite one.

Building on the writings of Deleuze and Guattari, Manuel De Landa (2016) further explores the ways in which assemblages grow more or less stable and puts forward the analytical tool of de/coding. De/reterritorialisation is associated in De Landa's work with the material role of elements in an assemblage: their ability to coordinate internal relations and define more or less permeable external boundaries (DeLanda, 2016). De/coding, on the other hand, concerns their expressive role (Swenson, 2018), that is, their highly specialised affective capacities to linearly define the identity of a whole and to influence

perception of an assemblage (Woods, 2015). In other words, coding speaks to the linguistic and the discursive elements of assemblages, and in particular to their ability to carry information and associated meanings. Similar to how de/re-territorialisation works, coding describes the rigidification of meanings and discourses carried by assemblages, while decoding signifies their opening toward new meanings. Whereas an assemblage undergoing coding processes carries predominantly unitary definitions and meanings, therefore, one that is being de-coded flies down lines of flight that multiply characterisations of its identity.

In the case study that follows, I stay with the analytical tools of de/re-territorialization and de/coding to map how the becoming assemblage of the Italian state is reassembled through the proliferation and governance of distributed generation renewable systems.

3.3 Power systems reconfigurations and the State - Snapshots from the Italian State

The period in which I conducted my fieldwork coincided with a constitutional moment of particular vibrancy and dynamism for the distributed energy politics milieu in Italy[8] (Concetti, unpublished). Indeed, in February 2020 the national government partially implemented European Directive RED II by passing a decree incentivising experimentation with schemes of "collective renewable prosumption" and "renewable energy communities" (RECs), and subsequently proceeded to full implementation in November 2021. It thus further incentivised the proliferation of distributed generation renewable systems and allowed a number of powerful new elements to come into play in the assemblages of the Italian power system and state. For example, the national legislation on RECs especially encoded definitions of collective use of distributed generation renewable systems along technical lines that benefit grid stabilisation and focused less on the "social benefits" emphasised in RED II. It also created ambiguity as to the relevance of already published regional legislation on the matter and fostered a belief that even wider

[8] I conducted my fieldwork between October 2020 and March 2022 through participant observation and semi-structured interviews with people operating in distributed energy politics in Italy. I spoke with individual owners of small distributed generation renewable systems (DGRS), shareholders and clients of DGRS-heavy energy cooperatives, regional government representatives involved in DGRS governance, energy authority officers, and third-sector volunteers and activists involved in trying to shape energy development and policy.

incentivisation might be put into place in the future. This is the setting against which the following snapshots from my fieldwork take place.

From conversations with several of the state representatives involved in legislating, implementing or setting up RECs (mayors, regional authorities and national civil servants) I got to speak to, stories emerged concerning some of the everyday practices and processes that make up the Italian state. They reinforced my understanding of a state that not only is not all-encompassing or entirely coherent, but whose workings depend on relations between state officials, vertical hierarchies spanning different administrative levels, horizontal demarcations between state departments, the mobility of certain legislative documents, and the penning of set amounts of funds towards specific issues. For example, during the first week of March 2022, I interviewed state officials whose work is devoted to ensuring Italy's sustainable development, the promotion of energy efficiency and the deployment of renewable energy technologies. From these conversations, emerged stories of some of the everyday practices and processes that make up the heterogenous and peopled Italian state. One participant in particular offered a reflection especially expressive of the assembled nature of the state. When asked about constitutional ambiguity in the roles of the central government versus regional governments on energy policy, they shook their heads and told me the issue was much more complicated:

> Incentivizing particular forms of energy use is the prerogative of the state, what happens after, however, is the competence of the regions. What happens in practice? The ministry, which today is that of ecological transition, defines incentives for the energy transition of buildings, but the regions have their own competence in defining the investments to be made on school buildings or on those, for example, of public health. […] But the administrative chains are different, so those who plan schools and healthcare at the regional level are not the same as the counterparts to the ministry when defining the incentives on energy transitions, and therefore what happens is that this year we will redo all the windows in the schools, and next year we will take everything down, because there are seismic safety measure to be carried out and therefore, since perhaps the shape of the opening in the wall is no longer adequate from the seismic point of view, the energy efficient frame is thrown away because we have to do something else and maybe we won't even do it again with the previous energy standards, because the resources in this case are for seismic safety.

From them, I also grew cognizant of the fact that though precarious, the assemblage of the Italian state is not immediately malleable to individual decisions or

singular policies; rather, its peopled heterogeneity functions, in Deleuzian terms, to preserve rigidity. That is, precisely because the state is not a unitary actor but rather an effect emerging from the coordination of multiple actors and actants with their own disposition and varied interests, it is resistant to direct policy reform that assumes state rationality and congruency.

This durability of the Italian state assemblage however does not do away entirely with its susceptibility to changes in its sociomaterial elements. In Deleuzian fashion, rather, the state is simultaneously refractory to change and intrinsically assembled through relations of exteriority that open it to unpredictable transformation. For example, though many of the civil servants I interviewed seemed frustrated with the difficulty of new policies to effectively change the arrangement of the state, the proliferation of distributed generation renewable systems has in the past few years effectively contributed to shifting relations of power among state bodies. As a matter of fact, when the administrative chains of the state showed recalcitrance to implementing energy transition policy that would harness the innovation of distributed generation renewable systems, state representatives working as regional administrators began to answer directly to EU directives and passed specific legislation on "energy communities" years before the national government did. The first regional legislation on energy communities in Italy appeared in 2018 and since then 7 regions have published similar laws. The first to move in this direction, and to do so before national legislation was even discussed in parliament, were regions like Piemonte and Puglia, which had seen a great spread of distributed generation renewable systems and prosumption practices. The proliferation of distributed generation renewable systems and their novel relations of institutional proximity thus entangled with the assemblage of the Italian state to produce de-territorialising effects. In this instance, regional laws on energy communities heightened a process of destabilisation in the state assemblage: power relations within the state shifted and the boundaries of "the state" became more permeable to ambiguity as national and regional policy decoupled.

This process of destabilisation occurred within a time of larger tensions disrupting the semi-federal governance of the Italian state. Indeed, some regional administrators were

taking on the legislative powers constitutionally conferred to them in matters of energy governance and renewable energy deployment; others were pushing to obtain even more regional powers by asking for full-fledged regional autonomy. This aspiration was not new especially among northern regions, where in 1989 emerged a party, Lega Nord, who made regional federalism one of its top priorities, but it had been marginal for many years (Mangiameli, 2012). Around the time in which RED II was implemented at the European level and regional laws on energy communities began appearing, however, the question of "strong regions" or "regional federalism" overtook the national discourse again. Its increased relevance is best showcased in the electoral results on the Lega Nord in 2018, which went from 4% of the national votes in the prior election to 17.4%. The party even governed for a brief time in coalition with the Five Star Movement and tried to pass a law on federal regionalism that was never actuated due to the coalition falling in 2019 (Di Majo, 2020).

Such heightened disruptive discourse and the similarly disruptive proliferation of distributed generation renewable systems were working onto an already fragile milieu. Italy had in fact been operating for two decades under a Constitution that embeds uncertainty in its organisation of legislative and administrative powers (Mangiameli, 2017). Though never analysed as such beyond expert circles, the 2001 reform of Title V of the constitution crystallised the Italian Republic into a hybrid federal system with irreconcilable internal tensions. Passed during a time of political stability that has not been experienced since, the long-drawn-out and controversial reform residually distributed to the regions all legislative powers outside of 17 enlisted national competences and of a nebulous body of concurrent national/regional prerogatives (Bettoni, 2017). In so doing, it initiated a yet unfinished period of tentative and incoherent constitutional implementation, which, due to a lack of both textual clarity and practical indications (Rolla, 2019), the State, the Regions, and the Courts are all approaching contrastingly (Mangiameli, 2017). The uncertainty emerging from such heterogeneity in constitutional interpretation produces breaches in the stability of the Italian polity and its multi-level governance, breaches that can be aggravated by intruding actants that challenge centralised power systems, like distributed generation renewable systems.

Thanks to the 2001 reform of Title V of the Constitution, people investing in distributed generation renewable systems (at the time of my fieldwork) in any of the regions having published such laws operated under construction and environmental standards dictated by different bodies and pursuing different purposes. New legislation on energy communities thus furthers a process whereby state bodies are increasingly associated with work that is distinct from the central government. For example, during the inauguration of a new wind turbine, a technician working with a prominent energy cooperative in the north of Italy shared with me his frustrations about the multiple legislations regulating the materials of his work in installing distributed generation renewable systems technologies:

> "How is it possible that what I can do in Piemonte in a matter of a few days it takes me months to do in neighbouring Lombardia? The state should intervene to ensure that these things make sense nationally."

Though the regions are administrative organs of the Italian state, these words suggest that in legislating separately on the matter of renewable energy communities and distributed generation renewable systems they become associated with parochial politics. In adopting regional legislation on a matter that had no national guidelines, each region opens itself to being discussed and perceived as internally homogenous and effectively separate from the state, especially in a larger discourse where full regional autonomy is portrayed as a real possibility and "the central state" is often coded as antagonistic or impinging on the rights of the regions rather than as part of the same political structure. The coding of the regions as administrative bodies of the Italian state thus begins to lose grip in favour of contrasting definitions that underscore their difference and heterogeneity. Part of this semiotic move is evidenced in the fact that the media began at the time to describe regional presidents as "governors", a term that has no bearing on the Italian administrative system and evokes images of federal countries.

Once again, rather than distributed generation renewable systems solely initiating moments of de-territorialisation, the words of the technician cited above show how decoding re-territorialises as well. I want to point out here the relationship between changing definitions of bounded territories and the reterritorialisation of the scale of the nation. In this snapshot, the ambiguity produced in the decoding of the regions as state bodies incites cries for central government intervention and national legislation. Frustration among citizens during these moments of decoding procures new stability to the state assemblage and, consequently, further intensity to its image of a separate entity from society. Rather than making the state appear fragmented or permeated by issues that may equate it to non-state organisations or lay society, the ambiguity-producing work of regional legislation on renewable energy communities ultimately reproduces state authority and the effect of the state by creating a paradoxical juxtaposition between the regions, themselves state bodies, and the national state. In contraposing itself against the apparent incoherence of the regions, which are coded as external to it and as inefficient because of their heterogeneity and multiplicity, the state appears all the more unitary, cohesive and rational.

As mentioned above, these regional laws did not emerge spontaneously from the ether. Rather, they resulted from the encounter between regional administrations in processes of homogenisation and the myriads of materials and discourses circulating as distributed generation renewable systems permeated the Italian electricity infrastructure. In October 2020, I went to visit an energy co-operative that is often cited as foundational for the establishment of distributed generation-based energy communities in Italy, the Comunità Cooperativa Melpignano (CCM) located in a small town in the region Puglia (Candelise & Ruggieri, 2017). Already in 2011, almost ten years before the creation of national legislation on renewable energy communities, the then mayor of the town rallied a group of citizens to found a cooperative that would collectively invest in rooftop solar panels. These would be installed on the houses of cooperative members, and the cooperative would redistribute the profits from the sale of excess electricity to the shareholders and to community benefit programs. When I got to Melpignano, however, it became clear that the work of CCM had moved significantly away from investment in

renewable energy technologies towards other services for the community. Use of the rooftop solar panels by members in the community seemed nonetheless to inspire great pride among cooperative staff. These technologies were storied as symbols of resistance to unscrupulous regional authorisations of large renewable generation plants owned by speculators foreign to the community that had taken away agricultural land without giving anything back to the local populations.

In this snapshot of reterritorialisation, it is thus not just the state that is re-assembled but the concept of energy community and the idea of desirable energy transitions as well. The very small community of CCM came together to encode specific values in infrastructures such as distributed generation renewable systems, values that centred democratic processes and equitable distribution of economic benefits against dominant discourses. One of the original members told me:

> It's because of those obscene solar parks that we decided to come together all those years ago. And when we saw it worked, that we could do it, we did all we could to make experiences like ours a real alternative where communities could be independent from these big interests. That's why we worked so hard to get the regional law published.

Over the following months I got to speak and listen to several other members of the community energy sector in Italy or to owners of distributed generation renewable systems and the mention of independence from bigger interests became a familiar tune. Many of those I interviewed told me they felt proud they could think of themselves as liberated from the logics that govern energy production in the country, and activists in the third sector in particular often stressed the potential of these technologies for affording communities self-determination and autonomy. This focus on community independence, democratic practices and distribution of economic benefits aligns well with other experiences of renewable energy communities in the EU, which nonetheless would be misrepresented if discussed as a harmonised group (Verde and Rossetto, 2020).

The experience of CCM speaks to a larger discourse circulating in Italy in spaces associated with collective prosumption practices through distributed generation renewable

systems. Distinctly, however, those involved in the early days of CCM were able to inscribe in the regional law their visions of what community energy ought to be. The law mentioned by the staffer above was passed in 2014. It regulates "community cooperatives" rather than renewable energy communities themselves, yet it heavily influenced the development of energy policy in the region. When in 2019 Puglia became the second Italian region to pass a law regulating and incentivising renewable energy *communities* specifically, it encoded a relationship between the establishment of energy communities and the intervention of municipal governments, something that the founder of CCM had ardently fought for in the writing up of the 2014 law on community cooperatives. In doing so, it tied the experience of energy communities to narratives of commoning of electricity generation, narratives underscoring the need for solidarity, democratic values and equality (Rayner, 2012), and to the active role of the local government in ensuring that such values be safeguarded.

In this snapshot, the assemblage of distributed generation renewable systems is caught in moments of decoding too. Indeed, when passing regional legislation on energy communities, Puglia responded to changes in local imaginaries of energy and participated in processes of meaning making that tied the term 'renewable energy communities' to particular realities and relationships involving specific actors. It did so in response to practices already existing in its territory, like CCM and the other community cooperatives that it had inspired in the meantime. But it also did so in response to European definitions and objectives. The assemblage of distributed energy was thus ascribed definitions that compete with those that are crystallised in national energy policy. Technical specifications are indeed almost entirely absent from the definitions appearing in the regional law, whereas they play a central role in subsequent national classifications of RECs. RECs were defined at the national level in terms of their connection to distribution-level transformers first and then to higher voltage ones. Puglia's regional definition of energy communities mentions nothing of the sort, underscoring instead, as mentioned above, the notion of "commons". This snapshot thus shows how distributed generation itself undergoes a process of decoding where its meanings lose stability and becomes open to ambiguity and contested definition.

3.4 Conclusion

In this chapter, I have argued that electricity infrastructures are intensely entangled in the assemblage of the state and in its production. The discussion of the development and implications of distributed generation renewable systems projects in Italy has shown how sociotechnical change in electricity supply systems implies great vibrancy and dynamism for the assemblage of the state. I was attentive, in particular, to the agency of these disruptive technologies that take on new and, at times, contrasting meanings among organisations outside and inside of the nominal state. Mobilising the analytical tools of de/re-territorialisation and de/coding, I have mapped changes in the configuration of both the power system and the assemblage of the state itself. These snapshots reveal the image of a state assemblage that is undergoing processes of re-territorialisation paradoxically emerging in part from provisional moments of intensification in its line of flight. Hence the technologies I have followed have been ascribed values of independence, self-determination and even individual sovereignty, yet at the same time ambiguities in their coding also inspire imaginations of an all-encompassing, efficient state that is expected/asked to intervene and make sense of a cluttered legislative milieu. In other words, distributed generation renewable systems have contributed to the reproduction of the state as separate from society and uniquely able to manage complex sociotechnical matters. Just as ironically, I observed how moments of de-territorialisation emerge from the recognition of stubbornly territorialised practices. This approach has allowed me to conceptualise a state that is at once porous, prosaic, random and rhizomatic, a state that simultaneously destabilises and re-stabilises itself in encounters with powerful materials such as those of a changing power system infrastructure.

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CHAPTER 4 - ASSEMBLING RENEWABLE ENERGY COMMUNITIES: Energy Governance and the Materialities of the Italian Power System[9]

4.1 Introduction

As increasingly concerned citizens in the EU call for climate change mitigation and transitions to low carbon energy systems, policymakers, power systems engineers and electricity regulators are struggling to balance aspirations for renewable generation with the demands of electricity grids whose delicate tuning is vulnerable to the permeation of new machines. Their struggle is multifold as it encompasses issues of market, frequency, and political stability, both present and future. Transitioning mature power systems to low carbon configurations implies immediate contention with the need to keep the lights on while disturbing sociotechnical apparatuses that have adjusted on different conditions. But it also requires careful attention to what visions are prioritised in investing and incentivising certain schemes over others as imagined futures of national energy security emerge alongside modelled systems of increased international interconnection, ambitions for local green re-collectivisation, and even visions of off-grid hyper independence.

Though large-scale centralised renewable electricity generation propels some of these visions and has found remarkable success in some national power systems in the EU, like in Denmark for example, it has also engendered issues at the transmission level in other systems. This is the case for Italy, whose power system was especially challenged when developers in the first decade of the new millennium found incentives to locate large renewable generation capacity far from loci of consumption. The spatialisation of renewable energy deployment in Italy is indeed uneven across the peninsula (De Laurentis and Pearson, 2018) and concentrates largely in spaces that offer great environmental conditions for solar and wind generation but little actual demand for that generated electricity. This was influenced both by a national solar photovoltaic (PV) Feed-In-Tariff scheme called *Conto Energia,* which ran through five different iterations between 2005

[9] Written as an article to submit to *Environment and Planning C*

and 2013 (Colasante et al., 2022) and by regional schemes geared more towards attracting on-shore wind investment in southern regions hoping it would bring local economic development (Cowell and De Laurentis, 2023). The issues that arose from the proliferation of renewable generation farms in those years are increasingly highlighted in the white papers and strategy reports published by the country's Transmission Operator, Terna. In these documents, it becomes apparent that the potential for grid instability brought about by large renewable generation farms has taken on great significance in Italy and created an appetite amongst operators for renewable energy deployment that facilitates grid flexibility rather than hinders it.

Though some scholars are increasingly working to tease out the material dimensions that contribute to transition pathways (De Laurentis and Pearson, 2018), little attention has so far been devoted to how the material configuration of transmission systems, some of the most obdurate, iconic, and temperamental elements of power grids, are shaping energy politics and assembling energy transition governance. This is a missed opportunity to both further theory on the sociomaterial production of energy politics and the assembling of its governance, and to disseminate useful depictions of the reality of changing electricity systems, a reality that is fundamental to grasp for any public interested in participating in and directing energy transitions. For this reason, this chapter takes seriously the materialities involved in assembling energy governance in Italy as the country rolls out policies that incentivise public participation in the electricity system via schemes of renewable energy communities and groups of prosumers.

I argue that the sociomaterial configurations of the electricity grid in Italy are actively assembling energy governance in the country and that this is especially discernible through the materialisation of policies meant to encourage citizens to become collective prosumers, that is consumers of electricity that also produce it and share it with nearby consumers. Though prosumption is not often discussed as a spatial process in social sciences literature, I argue that the energy governance that emerges in the sociomaterial entanglement of technical grid configurations, European policy agendas, and the national energy landscape in Italy is one that incentivises prosumption as electricity production in

spaces of consumption, whereby the productive element of prosumption is specifically located in its unique spatialisation. Moreover, I argue that an energy governance that emerges from such tight entanglement with technical elements of the grid is excluding many from fully being able to exploit the incentivisation schemes that are produced in the process. Indeed, conducting fieldwork and policy analysis between 2020 and 2022, I was able to follow carefully how the country moved to transpose European Directives UE2018/2001-RED II, (REDII) and UE 2019/944-IEM, (IEM). I was thus able to map the elements that are shaping "the process of steering collective action" (Briassoulis, 2019) towards collectivised local energy generation and observe how these are allowing specific publics to hack the incentivisation schemes in ways that are entirely inaccessible to those who do not have professional expertise in the grid, its functioning, and its technical regulation.

To preface the chapter's core arguments, the next section will introduce the schemes under study, that is renewable energy communities and prosumer groups, and contextualise them within wider trends of "community energy" proliferation in the European Union. This discussion will also serve to review relevant literature showcasing dominant approaches to the politics of community energy, amongst which appear heterogeneous efforts to point to the "material politics" of community energy schemes. Though these efforts inspire this chapter, I will show them to often take for granted the constitutive elements of community energy and thus obscure the entangled transcalar configuration of the material politics they conceptualise. I will instead propose a diffractive approach to the material politics of renewable energy communities and prosumer groups in Italy. This is an analytical method rooted in Baradian "agential realism" and capable of foregrounding the work of the material in assembling energy governance and affording this governance exclusionary boundaries.

4.2 Harnessing the bottom-up potential: community energy in European energy governance

Large, centralised, fossil-fuel based electricity generation is becoming increasingly vulnerable to both climate change-induced extreme weather events and targeted military

attacks while simultaneously getting more and more difficult to justify to citizens concerned about climate change. In the European Union, policymakers are thus beginning to recognize forms of decentralised renewable and collective electricity production as valuable tools in energy transitions management. Even if initially discussed as potential threats to system innovation, indeed, civil society, grassroots organisations, and social movements are increasingly recognised as potential facilitators of sustainable transitions (Middlemiss and Parrish, 2010; Smith et al., 2016; Törnberg, 2018). This has meant that the European Commission and Council have been increasingly attaching part of the resources and steering strategies of a larger governance effort to increase the proliferation of Renewable Energy Sources via the mechanism of Energy Communities.

These schemes are meant to involve citizens in clean energy transitions and to increase public acceptance of renewable energy technologies (European Commission, 2022). As of now, they are promoted via three different projects started in 2022 and regulated and incentivized via two Directives within the EU's Clean Energy Package: REDII, the Renewable Energy Directive concerning the promotion of the use of energy from renewable sources; and IEM, the Directive on common rules for the internal electricity market. Though both directives introduce "energy communities", they differ in the entities they identify: REDII delineates specific aggregation levels in energy production and consumption, namely Renewable Energy Communities (REC) and Joint-Acting Renewable Self Consumers (JARSC); and the IEM regulates the entry of electricity consumers into the electricity market via the definition of Active Consumers (AC) and Citizens Energy Communities (CEC). While RECs and JARSC are defined by their use of renewable energy sources and are not limited to electricity (they can manage the use of heat and gas too for example), CECs and ACs are not bound to use renewables exclusively but can only deal with electricity. Each entity then differs in terms of the spatial, organizational and governance specificities they require to qualify for state and EU incentives. This multiformity in the legal definition of energy communities matches the reality of "community energy" in Europe, which even before specific EU legislation encompassed several configurations differing widely in activities, objectives, legal form, financing, and more (Verde and Rossetto, 2020).

The term “community energy” came into use in the early 2000s and has since been widely and ambiguously used to identify projects where citizens actively contribute to the production or use of energy. These comprise of a large spectrum of arrangements with no single typology where members of differently defined communities participate in collective and collaborative energy endeavours (Chilvers and Pallett, 2018; Hicks and Ison, 2018). In the EU, community energy members are often co-owners of ventures including (but not limited to) collective investments in renewable energy technologies for the sale of electricity to the grid, energy cooperatives acting as conscious electricity retailers, and city-wide energy efficiency projects (Verde and Rossetto, 2020). Though most coalesce around the use of renewable energy sources, taking advantage of both government incentives and the lower initial capital investment that they require, this is not the case for all such schemes. They have historically involved both private and public actors and have remained either very local in scale or grown to include several thousands of participants from across entire countries depending on whether they function as communities of place or communities of interest (Solomon et al., 2018). Communities of place identify the “community” that they are open to and/or serve around pre-existing socio-spatial delineations such as the neighbourhood, the parish, the village, the town, or the municipality(Parkhill et al., 2015; Süsser et al., 2017). Communities of interest, instead, delineate the boundaries of their publics around shared interests regardless of geographical location or distance from the energy source in which the community invests, and thus tend to grow larger than their counterparts (Hicks and Ison, 2018).

The heterogeneity in the forms that community energy schemes take in Europe and the public they involve is mirrored in the uneven spatialisation of community energy schemes across the continent, with Southern Europe lagging behind its northern counterpart in terms of both spread of community energy projects and public enrolment in such schemes(Candelise and Ruggieri, 2020). Indeed, if by 2012 in Germany 9% of total installed renewable energy generation capacity was owned by cooperatives, in Southern Europe such share would revolve around 1-2% at the time (Verde and Rossetto, 2020). Italy has historically been no exception, hosting only a few community projects revolving

mostly around the use of photovoltaic solar and mostly depending on a feed-in-tariff scheme running from 2005 to 2013.

Although communally owned energy cooperatives have existed in Italy since the early 20th century, until the mid-2000s their spread remained mostly limited to place-based projects in alpine regions, a manifestation of the unique nexus of highly territorialized community practices and readily available hydropower and biomass found in these places (Magnani and Patrucco, 2018). With the advent in 2005 of *Conto Energia,* a feed-in-tariff program making photovoltaic panels cheaper and more profitable, however, newer forms of collectivized energy projects began appearing in the country (Candelise and Ruggieri, 2017). Magnani and Patrucco (2018) divide these among three key categories, nominally collective electricity production among groups of "solidarity-based purchasing"[10]; solar cooperatives founded by "ecopreneurs" who recognized in the incentive scheme an opportunity to make investment in medium-large renewable generation projects profitable and low risk thanks to collective shares; and small scale, place-based renewable energy cooperatives founded by local businesspeople or often by local administrations to use the solar incentives as a means of fighting the depopulation of rural communities.

As the *Conto Energia* was discontinued in 2013 and the national energy strategy did not favour the proliferation of collectivized energy projects at the time, community energy schemes did not multiply as fast as elsewhere, even if renewable energy generation in the country kept increasing. The torpor around community energy in the country was shaken, however, with passage at the European level of the Clean Energy Package, which gave the phenomenon new vigour and boosted the spread of new projects and the scaling up of existing ones. Indeed, since 2017-2018, when the RED II was being discussed and then passed, several associations have been calling for legislative provision of energy communities in Italy, around fifty municipalities and private groups began the processes of setting up collective schemes of electricity generation, and six of the 21 Italian regions

[10] These are groups of conscious consumers whose motivations and aims are those of reforming consumption processes via a highly moralized code of conduct. They are identified by the acronym GAS in Italy and coalesce around different issues, from sustainable clothing consumption to "zero kilometer" food products.

passed ad-hoc legislation on renewable energy communities before 2020, effectively transposing the RED II before the national government did.

The first provisions to transpose the Clean Energy Package at the national level were made in the 2020 Decree Milleproroghe, an annual instrument used by the Italian government to postpone the ending of state programs whose abrupt termination would impact the life of its citizens and to introduce new measures without undergoing the lengthy process of writing up separate decrees. Through this instrument, the government allowed a period of experimentation of 12 months for the incentivization of renewable energy communities and groups of prosumers, during which all participants of a given scheme needed to be connected to the same Cabina Secondaria, a low voltage transformer located in the distribution network of the grid, and could only produce a maximum output of 200kw. The experimentation ended in February 2021, when the RED II was fully transposed through the Decree 199/2021. In this period, several new community energy projects came online, though many more began the associative process but refrained from constituting the legal entity in the hope that the full transposition would imply less strict limitations and a higher incentive. These hopes were partially met in the latest form of the decree, which extended the output limitation of the schemes to 1MW and tied their spatial limitation to the Cabina Primaria, a transformer that is connected to the larger medium voltage network. Between February 2020 and May 2022, Legambiente mapped 100 renewable energy communities and groups of prosumers, 35 of which are already operating, 41 planned, and 24 under discussion (Legambiente, 2022)

This heightened level of engagement with community energy and especially the passing of the national decree on renewable energy communities and groups of prosumers in 2021 have been hailed by certain political parties and third-sector organisations in the country as the success of activism on their part. However, a closer investigation shows that more participated to this development. In fact, the national law transposing the Clean Energy package in Italy remarkably underscores as qualifying requirements for eligibility to state incentives technical markers that do not appear in the EU directive. As will be further elaborated below, these follow the sociomateriality of the electricity grid and of the new technologies proliferating on it, hinting to the possibility that this policy and the energy

governance effort that it is a part of emerge from elements that supersede party agendas or socio-political interests.

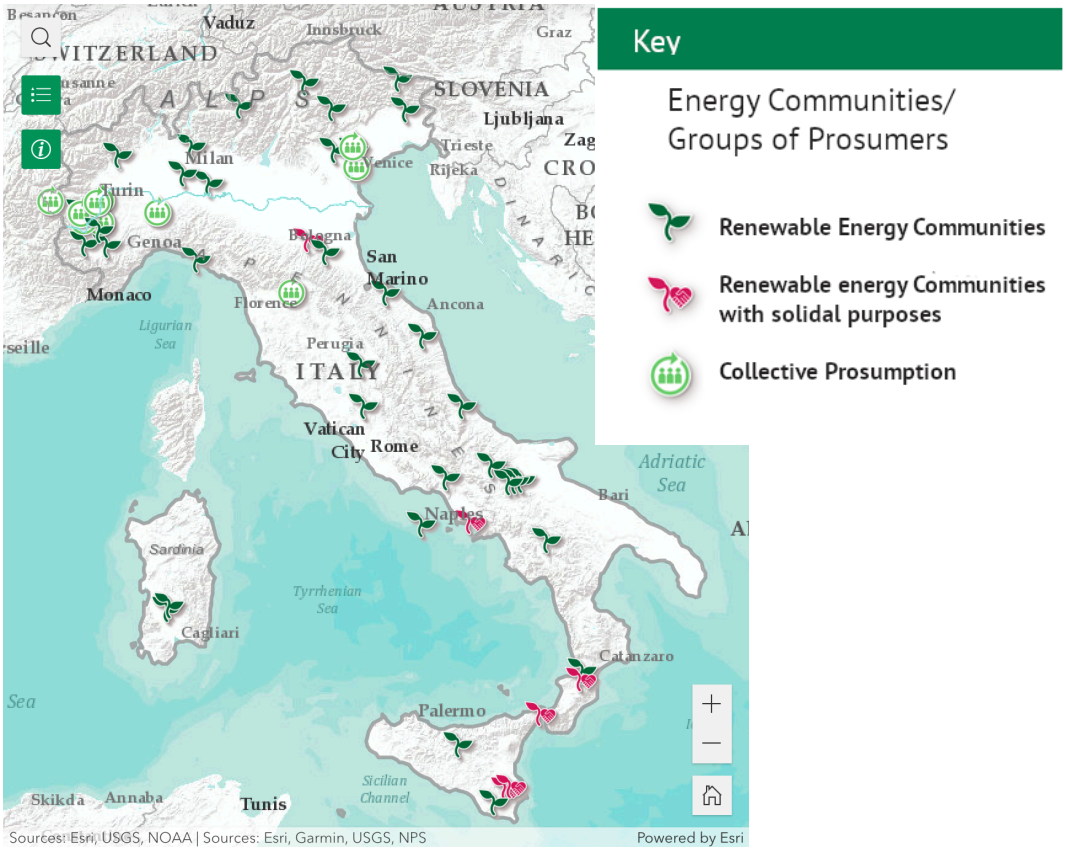

Figure 7: Map of renewable energy communities in Italy in 2023. Source: Legambiente, https://www.comunirinnovabili.it/mappa/ Modified and Translated into English by author. "Solidal purposes" identifies schemes that have a stated commitment to local solidarity and community betterment

4.3 Community energy in the literature

Though advocates of distributed small-scale renewable energy sources have long speculated about the potential of communally owned energy schemes to profoundly impact politics (Lovins, 1977), such musings only began to receive serious scholarly attention when community energy became associated to a low-carbon energy transition (Aiken, 2012; Seyfang et al., 2013). By now, community energy schemes have caught the attention of a diverse, interdisciplinary, and international group of scholars (for a recent review of the field in the context of the EU see: van Bommel & Höffken, 2021). In Italian literature,

studies of community energy are often located in the discipline of sociology and are interested either in taking a snapshot of the status of community energy in the country (Candelise and Ruggieri, 2017; Magnani and Patrucco, 2018) or in technical and policy evaluation of the current regulations (Coletta and Pellegrino, 2021; De Vidovich et al., 2021). In anglophone literature, too, a growing number of scholars are studying community energy schemes as enablers of energy transitions (Bauwens, 2017; Saintier, 2017; Wierling et al., 2018), especially foregrounding their potential to increase the social acceptance of renewable energy technologies (Bauwens and Devine-Wright, 2018; Dusyk, 2018; Ruggiero et al., 2021). Dusyk (2018), for example, associates community energy with a "neighbourhood effect", a process by which the presence of community-owned and managed renewable energy technologies not only produces positive attitudes toward renewables in their place of deployment but also entices neighbouring communities to similarly deploy such technologies.

Community energy is also increasingly featured in emerging literatures on the concept of energy justice (Allen et al., 2019; Lai, 2021; van Bommel and Höffken, 2021). These works frame community energy as facilitating distributed, procedural and recognition justice among those participating in these projects (Mundaca et al., 2018; Forman, 2017), though critics have pointed out that such accounts may be skewed towards only tracing the benefits and leaving out the potential drawbacks (Radtke & Ohlhorst, 2021). A related body of work similarly ties community energy endeavours to energy democracy(Becker and Kunze, 2014; Burke and Stephens, 2018; Martiskainen et al., 2018) , effectively positing the possibility that community energy may bring about opportunities for associative, participative, and material democracy, as van Veelen and van der Horst (2018) neatly summarise in their review paper. What these contributions share is a recognition that community energy projects may be conducive towards a particular type of desirable politics, be it because of their associative nature, their governance style, their economic structure, or specific elements of the technologies they mobilise.

The latter of these considerations points to recognition of a material politics embedded in the projects under study, whereby something in the materiality of these

projects influences power relations and institutional transformation (van Veelen & van der Horst, 2018). The use of the analytical lens of material politics follows a "materialist return" (Whatmore, 2006) that has engrossed scholars in the social sciences since the early 2000s (Bakker & Bridge, 2006; Robbins & Marks, 2010) and has foregrounded "materiality" in endeavours to gesture to the significance of the non-human in socio-political processes. These endeavours do not homogenously belong to the same theoretical traditions, nor do they pursue synchronised agendas (Bakker & Bridge, 2021). Rather, materiality and material politics, including those explicitly or implicitly traced in papers on energy democracy and justice in the context of community energy, are invoked within discordant pursuits.

For example, Ryghaug et al. (2018) follow Chilvers and Longhurst (2016) in conceptualising participation in energy transitions as "emergent and co-produced" and proceed to show how three different devices, photovoltaic panels, electric cars and smart meters, enrol issue-oriented publics (2018). In so doing, they conceptualise a material politics of community energy that is "material" because it is co-produced by technologies and their users. The socio-political impacts of community energy are thus mediated by what each technology allows certain publics to do and are most evident in what kind of publics each technology contributes to coming together. Martiskainen et al. espouse an approach to "material politics" inspired by Noortje Marres' work and that of Andrew Barry, and move to trace the specific "forms of everyday politics" (2018, 21) that community energy projects perform because of their "material practices and configurations" (ibid, 26). They discuss how Energy Cafes in the United Kingdom make the energy bill into a political object through which larger energy practices can be negotiated and contested. The material politics of community energy are thus here "material" in so far as they allow objects to take on political value and, similarly to the paper above, enrol publics in political discussions.

However, scholars discussing the material politics of community energy often fall into an uncritical understanding of the scalar nature of this phenomenon, whereby community energy schemes are presented as bounded to their local setting and their

materiality appears only productive in so far as it impacts everyday individual relations with energy and energy practices. This mirrors similar pitfalls of discussion of community energy more in general, as Creamer et al. have discussed in a 2018 paper that challenges assumptions of singularity in community energy and shows community energy projects to be "enabled and constituted by trans-scalar assemblages of overlapping actors" (2018:1). This chapter takes inspiration from Creamer et. al to move beyond a localism of the material politics of community energy and ask *how* – i.e., through entanglement with which sociomaterialities? - community energy comes to take form in national policy documents. The answer to this question in the Italian context opens a further line of questioning on the material politics of community energy. That is, if energy governance in the country is in fact emerging in entanglement with the requirements of a system as black-boxed as that of the transmission grid, how can the resulting governance mechanisms be fully accessible to the general public? And if only expert publics are able to optimally exploit the mechanisms of renewable energy communities, can their material politics really be democratic and just?

This chapter's approach to material politics is also inspired by Briassoulis' proposition to understand governance as assembled multiplicity (2019). In an admirable tour de force of a paper, Briassoulis skilfully shows how though governance studies have privileged epistemological questions over ontological ones, a recent shift in the discipline to studying the practices that create governing reflects conceptual affinity with Assemblage Thinking and its quest for a relational ontology. She therefore proposes to reconceptualise governance as assembled to denote "the provisional, situated, unique compositions continuously emerging from the process of heterogeneous components coming together for the purpose (desire) of steering to achieve particular, issue-related common goals" (2019, 440). In this chapter, I accept her definition of governance and move to investigate how governance of community energy is assembled in Italy by entangled sociomaterial elements. Rather than attempting to map the entire milieu involved, however, I follow Barad in taking a diffractive approach. This means that I choose to operate an agential cut into the entangled sociomaterial and artificially foreground some of the elements involved in assembling governance. To be precise, I read the national policy on renewable energy communities and groups of prosumers diffractively through the configurations and

criticalities of the transmission grid highlighted in the documents of transmission operators in Italy. As I further elaborate below, this temporary foregrounding allows one to see how the energy landscape in its current configuration works as a structuring effect that enables the specific energy governance synthesised in Decree 199/2021 to materialise.

4.4 Reading Diffractively to identify how Governance is Assembled

Decree 199/2021 regulates and incentivises renewable energy communities and groups of prosumers in Italy. Following the European Directive REDII, the decree defines both schemes as organisations that can operate within the energy system at large, and may thus deal with heat and gas too. However, it uses language that is only relevant to electricity and it incentivises and regulates both schemes through key limitations that follow elements of the electricity transmission grid. In fact, the state incentive is entirely calculated in megawatt hours (MWh), a unit that immediately signifies that the measure is targeted to prosumers of electricity specifically. To be exact, article 8 of Decree 199/2021 stipulates that electricity consumers who invest in new renewable energy capacity of maximum 1MW will receive a small unitary compensation for avoided system costs[11] and:

1) 100€/MWh (if organised as group of prosumers)
2) or 110€/MWh (if having established a legal entity of renewable energy community)

for the electricity that their plant produces *as long as* that electricity is consumed in the same *time band* by consumers *located under the same "Cabina Primaria"*, a medium voltage transformer station. In so doing, the decree enforces an incredibly specific spatio-temporalisation of what is desirable, and in fact possible, collectivised prosumption in Italy.

[11] sum of the transmission tariff for low voltage users, equal to 7.78 €/MWh for the year 2022, and the highest value of the variable distribution component for low voltage users for other uses, equal to 0.59 €/MWh for the year 2022

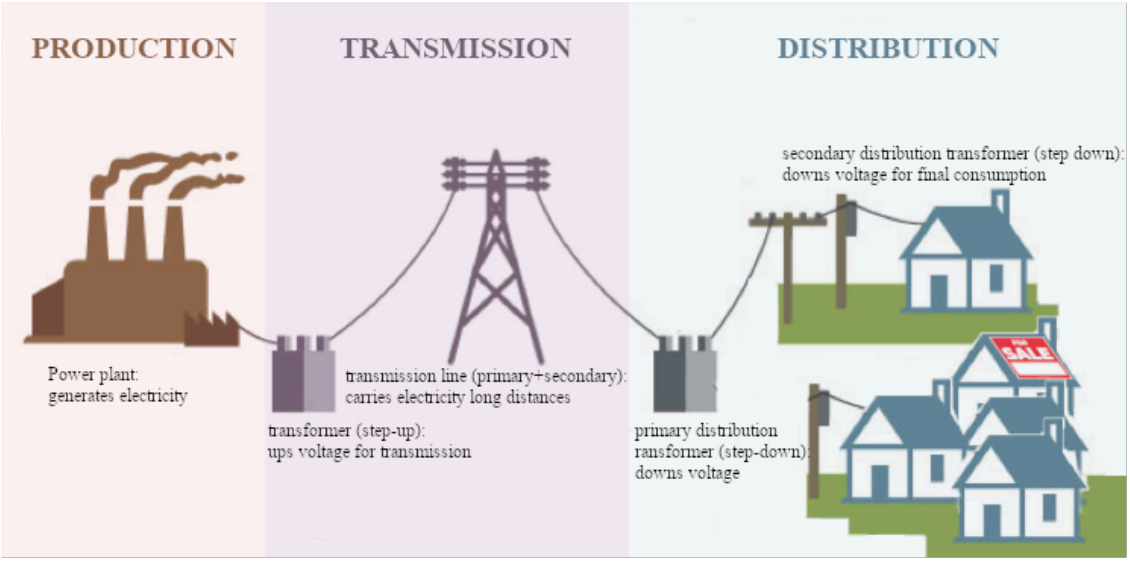

Figure 8: Diagram of Conventional Power System Configurations, whereby electricity flows from left to right. Source: Author

The specificity of this limitation does not mirror EU instructions about energy communities which, as discussed above, have been introduced in European legislation primarily as mechanisms to increase acceptability of renewable deployment. And it also does not follow the experience of other European countries in regulating renewable energy communities and collectivised prosumption more generally (Verde and Rossetto 2020). In fact, when read as a mechanism meant to increase development of local economies, reduction of energy bills, social cohesion, and CO_2 reduction through renewable deployment, which is how renewable energy communities and groups of prosumers have been framed in official documents and webinars by institutional actors, local authorities, and interested private parties (Enelx, Regione Emilia, GSE), the specific spatio-temporal limits of the incentive scheme are difficult to understand. And as I entered policy spaces and webinars where these schemes are discussed, I discovered that these limitations appeared ridiculous to many of those looking to become involved in the new incentivised practices.

When the state moved to incentivise renewable energy communities and groups of prosumers – initially through the experimentation phase in 2020, and then through a national decree in 2021 - I began attending several webinars on the matter. Between December 2020 and November 2022, I attended or listened post-hoc to 52 webinars open

to the general public that provided occasions for key figures in the governance of community energy in Italy to frame the new incentivisation schemes and answer questions about their specifics. In these spaces, I noticed clear excitement about the possibility of instituting renewable energy communities both among interested private companies and lay citizens who felt like this would give them back some agency in the process of procuring electricity, which at the time many associated with fearsome geopolitical vulnerabilities (Concetti, 2023c). However, the chats of these online webinars were filled with people asking about why the incentive was organised around transformer stations, objects that many could not even visualise.

This was especially the case during the experimentation phase of the incentive, when these limits were even more stringent. When in October 2021 I interviewed the mayor of a small town who was seeking to set up a renewable energy community, he transparently voiced his frustration over the incentive's spatial limits. These at the time required all prosumers and consumers of a renewable energy community to be connected to the same low voltage transformer station, or "Cabina Secondaria" (60kV). He told me:

> "Imposing such a physical limit on a community that is already so small seems so weird to me. […] We're a town of 500 people. It's difficult to explain why a neighbourhood would be involved and another wouldn't be. […]We had to try and understand to which transformer station each consumer was connected, an operation that was extremely difficult: we had to request the information via certified post for each consumer after we received an authorization to do so for them, it would have been so much easier if these codes were directly shown within electricity bills!"

Another small-municipality mayor occupied in a similar venture shared instead the following thoughts in an interview in September 2022:

> "We are very closely following the reception of the RED-II, as we hope that the new decree will overcome the limitations of the transformer station, it's very important for us. We hope to be able to widen the renewable energy community, we have 3,000 citizens and right now we would only be able to connect circa 100 domestic consumers and 20 non-domestic ones. We want to be able to involve all of the citizens in our municipality in the renewable energy community and to become a municipality that is powered through self-consumption, the law right now does not allow us to do that".

Their frustration matched that of many participants to an institutional request for feedback on the initial experimentation period for collectivised prosumption, which highlighted a real recalcitrance to the low-voltage network limitation (GSE 2020). When I asked representatives of private energy companies, consumer associations, and volunteer groups what they responded to this consultation call, many said they pointed out issues with the difficulty of identifying which consumers would actually be attached to which transformer station, and the seeming happenstance nature of such a limitation. This was partly due to the grid's spatialisation in the country, which does not follow the spatialisation of the electricity-consuming built environment. Two residential dwellers on the same street or even two commercial entities in the same mall conglomerate may indeed be attached to different low-voltage transformers as these connections are determined at times of construction and follow grid logics rather than urban sprawl. Though strategic nodes in the grid network, therefore, these transformer stations and their connections do not operate coherently with delineations of communities of place such as neighbourhoods, streets, estates, or industrial areas, let alone with lines developing around social practices such as school districts, parishes etc.

Interestingly, the Decree 199-2021 did widen the spatial limitation of renewable energy communities and groups of prosumers to the medium-voltage transformer station, or Cabina Primaria (132 kV) but the document released by the energy authority explaining this decision did not mention issues akin to neighbours forming renewable energy communities. Rather, it framed the need to widen the allowed perimeter to the fact that larger electricity consumers such as energy intensive factories may connect directly to the medium voltage network and would therefore be excluded from participating in collective prosumption schemes if the limit did not extend (GSE 2021). Though prioritising the entrance of large industrial actors may appear strange when understanding energy communities as opportunities for communal ownership of energy systems or increased participation of everyday citizens in decision processes about energy transitions, it becomes most logical if thinking about renewable energy communities as governance schemes assembled by the material needs of the electric grid too. When reading this explanation diffractively through the configuration and criticalities of the Italian

transmission grid, bringing such large consumers into schemes that determine the spatialisation of new renewable capacity becomes an opportunity for load balancing, decongestion of high voltage networks, and contrasting issues of reverse power flows.

In fact, all of the spatio-temporal provisions of the state incentive that appear arbitrary when read through a framework of renewable energy communities and groups of prosumers as mechanisms for "social and environmental benefits", which is how they are framed in the decree text, become absolutely logical if understood as mechanisms of grid management. For example, the temporal limit of the incentive, that is that only the electricity consumed during the same time band when it was generated may be remunerated, speaks of the Italian grid's need for load balancing by co-locating production and consumption. To elaborate on this, I first need to summarise some key power system processes.

Electricity grids are systems that provide electricity to heterogenous consumers, from houses to large industrial complexes, all of which pattern electricity consumption around socioeconomic habits. Because of cooking, heating, refrigeration and electro-domestic use for houses, and hours of operation for industrial plants, for example, electricity demand in Italy peaks around 11 am and then again at 8 pm in winter. Different peak and troughs then occur seasonally throughout the year depending on heating needs and natural light availability. When conventional power systems operate on the basis of large fossil-fuelled power plants, Transmission System Operators (TSOs) accommodate these peaks by ramping up generation around times of increased demand and reducing it during troughs. The term *load balancing* is used to indicate measures this attempt to match the curves in demand with the curves in generation. Moreover, fuels such as coal, natural gas and nuclear, whose costs to turn on and turn off are high but running costs are relatively low, are privileged to acquire base load for the grid, that is the minimum amount of electricity required to meet demand outside of peak times. Whereas other fuels, such as combined cycle or biomass, are used as reserve load, that is potential capacity that can be switched on and off when seasonal or temporary increased demand requires it.

Though renewable deployment is often imagined to displace fossil-fuelled generation capacity, this is not the case unless peak demand times coincide with periods of peak renewable generation. Unfortunately, these peaks in generation cannot be decided a-priori or manipulated by the operators, as many renewable generation technologies are intermittent and non-programmable because they depend that is on external factors such as solar radiation and wind speed that are not continuously available and cannot be controlled. If renewable generation peaks occur outside of peaks in electricity demand, no matter how much wind or solar capacity is installed in a system, fossil-fuel-based reserve load needs to be operationalised. By incentivising only renewably generated electricity that is consumed in the same time band in which it was produced, the Decree 199/2021 therefore performs a load-balancing intervention focused on demand management rather than on manipulation of generation. Indeed, by incentivising consumption occurring in the same time band as generation, it attempts to manage demand to make it follow generation patterns rather than patterns dictated by habits or convenience.

Similarly, fixing the incentive spatio-temporally to encourage consumption in the same time band as generation and to direct installation of generation capacity to places with large consumption needs, helps with two of the criticalities that the Italian TSO, Terna, has been highlighting since 2014: reverse power flow in medium voltage transformers and power congestion in high and superhigh voltage networks (Piano di Sviluppo 2014). To understand what these criticalities mean and how the incentivisation of collectivised prosumption schemes in national policy clearly seeks to intervene against them, it is necessary to get to know some of the configurations of the Italian grid. In Italy, the national transmission grid is owned and managed by Terna group, an independent TSO. The grid consists of more than 66.000 km of electricity lines that converge around ca. 900 electricity stations, infrastructural nodes where electricity is either sorted, converted or transformed. Sorting (or switching) stations allow electricity to flow between different electricity lines at the same voltage level, effectively connecting them. Converter stations and transformer stations, instead, intervene in the nature of the electricity current moving through the lines that they connect. The latter, transformer stations, change the voltage of the electricity circulating in the lines, bringing it in Italy to one of five possible voltage levels: 380kV,

220kV, 150kV, 132kV and 60kV. Traditionally, this power flow would go in one direction: after a first step-up from the generation units, it would flow from the highest voltage in the lines coming from converter stations or generation units to the lowest voltage of the cables connecting final users. With increased renewable energy deployment spiking the percentage of distributed generation (where electricity generation is connected directly to the distribution network) Terna has however begun registering issues of reverse power flow, that is the movement of electricity from low-medium voltage networks towards higher ones. Their 2021 Development Plan states:

> "Over the last few years, the phenomenon of power flow reversal has increased, which consists in the flow upstream of power from the distribution network to the transmission network, in the event that the production of Distributed Generation exceeds the local load underlying the substation itself" (2021:128)

If not properly curtailed, this phenomenon causes damages to the traditional life cycle of the transformers, originally designed to transform and transmit power in one direction only, triggers the islanding of the transformers themselves, and lessens the effectiveness of grid protection and control settings. The issue it causes to grid control is particularly significant *because* the generation capacity connected to the distribution network is renewable. Indeed, because grid monitoring was designed considering a unidirectional flow of electricity, the operator is only able to observe transmission networks and is dealing with inadequacies in monitoring systems and automations designed for unidirectional operation (Terna, 2021: 128). When distributed generation accounted for a minimal part of total generation capacity and renewable generation technologies had not permeated the power system widely, being able to see and control the distribution network was not necessary for the TSO as this layer in the grid was assumed to simply passively distribute electricity to final consumers. Now, not only up to 28GW[12] of installed capacity is connected directly to the distribution network (≤150kV) in Italy, but this capacity is renewable and thus susceptible to sudden changes in meteorological conditions such as cloud cover or wind gusts *and* it is flowing upstream into the transmission networks without the TSO being able to monitor it (Terna

[12] This is 33% of total installed capacity in Italy

2021:128). This means that the grid is no longer "observable" and "controllable" like the operator needs it to be in order to intervene against unexpected contingencies in the system.

The issue of reverse power flow has also led in Italy to increased congestion in the high tension transmission networks due to overgeneration (Terna 2014, 2021). This means that there is too much electricity flowing in the grid for the consumption needs of the country even when considering export to nearby markets. When this happens, the operator needs to intervene through the "extreme measure" (Ibid 2021:129) of curtailing renewable electricity from entering the grid entirely, thus creating a phenomenon that Terna terms "Missed Eolic Production", whereby they ask wind farms to turn off their plants altogether. Such a move evidently voids the decarbonizing effects of installing renewable capacity, as the electricity generated by these technologies is not only unable to displace the need for high-carbon reserve load to be operationalized, but it is wasted entirely. Issues of overgeneration and network congestion have been happening especially in the southern regions of the Italian peninsula, where investors were able to buy land inexpensively and install large renewable generation capacity even if the electricity they produced was not needed in the area. The spatialisation of industrial processes in Italy is indeed highly uneven too, and most of the large electricity consumers are not located in the southern regions but rather in the northern ones around the valley Pianura Padana.

This is where a mechanism that incentivizes spatio-temporal vicinity between generation and consumption loads comes into play. Indeed, by benefitting investment in renewable generation capacity that is located *near* consumers, whether residential or industrial (as above), and incentivizing consumption in the same time bands as generation, national energy governance is steering a spatialisation of renewable electricity generation that makes material sense. As both generators and consumers accrue financial benefits only when the electricity generated in the collective prosumption scheme is actually consumed, the prosumption that is incentivized is one that deliberately brings consumers to try and model their demand to generation patterns or invest in storage facilities and that makes it more profitable for investors to install generation capacity where it is needed rather than wherever land is cheapest and permission processes easiest. Indeed, limiting renewable energy communities and groups of prosumers to constituents connected to the same

medium voltage transformer ensures that the electricity these schemes generate does not need to travel far before finding a potential consumer, and the time band provision makes it so this consumer would be incentivized to consume that electricity there and then even if needing to shift their energy consuming practices to do so. Similarly, the incentive would benefit the prosumer community if they decided to invest in storage capacity and only released the electricity produced during times of high demand.

By continuing to read diffractively the national policy incentivizing renewable energy communities and groups of prosumers with documents from the Transition System Operator, the governance of community energy in the country appears assembled not only by present material contingencies of the grid, but also by concerns about future operations. In its 2021 development plan, Terna introduces itself as "director and enabler of an ecological transition meant to produce a development model based on renewable sources and respectful of the environment" (Terna, 2021). However, as elaborated in the same document, Terna's first responsibility is to ensure the security, adequacy, reliability, resilience and efficiency of the transmission grid. This means that Terna's team of managers and power systems engineers is, first and foremost, liable for making sure that the grid is able to resist sudden disturbances (security), able to meet the national demand via adequate generation, storage and transport capacity (adequacy), continuous in its operation without periods of blackouts and maintaining the right tension requirements (reliability), able to respond to peaks in the system (resilience), and functioning at minimum cost for the citizen/consumer (efficiency). Twenty years ago, an ambition to increase the deployment of renewable energy resources mostly challenged Terna in its commitment to efficiency, a challenge slowly overcome as renewable generation became cheaper, state incentives lowered the installation and final operating costs of renewable energy technologies, and the TSO received clear directives to prioritise system decarbonisation over cost minimisation. As renewable energy generation technologies successfully proliferated and permeated the Italian power system, however, Terna found itself facing real challenges in delivering on its security, reliability and resilience commitments.

In a 2012 document published by the TSO, and approved by the Italian Regulatory Authority for Energy, Networks and Environment (ARERA)[13], we find one of the clearest explanations of how increased renewable deployment challenges the power system:

> "Consistent non-programmable renewable generation creates temporary situations that cause challenges in the functioning of the primary electrical system as it reduces the regulating capacity and operational inertia of the national electrical system, which thus becomes increasingly exposed to vulnerability. The recent deployment of generation from non-programmable renewable sources has exacerbated the aforementioned physical problem and introduced new control problems as it is dispersed in thousands of generators connected to distribution networks. (Terna, 2012)

This quote speaks of three powerful issues. One of them is the issue of lack of observability mentioned above, whereby issues in the distribution network are not immediately visible to transmission system operators. The other two, regulation capability and inertia, show how the operator will be increasingly challenged as fossil-fuel-based power plants are decommissioned in favour of further permeation of renewable generation capacity. Both of these issues come from the non-programmability of renewable generation technologies, which means that their output depends on the weather conditions, rather on controllable sources that move a traditional turbine, such as steam or water.

Indeed, conventional power systems have historically relied on the possibility provided by synchronous machines, such as the rotating rotors in coal-fired plants, gas combined cycles or hydro power plants, to naturally speed up or slow down their power output in order to control the system frequency whenever the operator needed to regulate power. However, converter-based renewable energy generation technologies such as solar panels and wind turbines do not have this tendency to follow the frequency of the rest of the system and offer less support for frequency control. To function efficiently, they are dispatched at the maximum workable operational value of wind speed and solar radiation, which means that their frequency cannot be increased if needed. Efficiency is a key term here, as this is a decision that is made both to maximise the decarbonisation potential of

[13] At the time called Italian Regulatory Authority for Electricity Gas and Water, denomination changed 1st of January 2018

renewable electricity plants but also the economic viability of their functioning. Similarly, increasing converter-based renewable generation capacity implies a loss of system inertia. The inertia from the rotating turbines of conventional power plants, that is the tendency of a rotating object to remain rotating, is conventionally used to keep the system going temporarily when a large power plant in the system fails. Though this may seem inconsequential to an untrained eye, the few seconds that inertia provides in slowing down the effects of a power plant failure allow the coming online of systems designed to respond to a failure before blackouts ensue (Denholm et al., 2020). Converter-based renewable technologies do not inherently provide inertia precisely because of their connection to a converter and thus challenge the transmission operators to find new ways to intervene in the grid to safeguard security, reliability, and resilience of the system. These inherent constraints of converter-based renewable generation technologies suggest that as energy transitions logics demand power systems to accommodate increasing shares of renewable generation capacity and decommission more polluting plants that offered regulating capacity and operational inertia, the operator will be left with less and less control over the frequency control of the system.

Once again, the Decree 199/2021 includes incentives that respond to this need. Rather than by encouraging the spatialisation of the landscape of electricity generation and consumption, this response is particularly institutionalised in incentives to electricity storage. The decree sanctions that the state incentive for both renewable energy communities and groups of prosumers is cumulable with other incentives benefitting investment in residential and commercial storage facilities (batteries) and electricity vehicles. The text even clearly states that this further incentivisation exists to make renewable generation “more programmable”, in this way transparently showing a grid management agenda (Decree 199/2021). Interestingly, these provisions effectively steer collective action towards the integration of resources that may side-track the role of transmission operators rather than aide them as seen until now. Indeed, incentivising investment in localised storage facilities to accumulate excess generation from plants connected to the distribution grid does not help centralised flexibility measures for transmission operators. This is the case because, as discussed above, transmission operators

are not able to observe or intervene in variations of power in low voltage networks, which under conventional grid designs were meant to simply passively distribute electricity to final consumers rather than host generation capacity.

Instead, favouring "programmability" of renewable energy resources is a project that speaks to future ambitions of decentralised grid flexibility (Kubli et al., 2018). When reading diffractively Decree 199/2021 with the above discussed constraints, what this points to is that community energy governance in Italy is partly assembled by an imagined alternative configuration of grid operation whereby distribution system operators (DSOs) would take on some of the dispatching responsibilities of transmission operators to balance and optimise generation within the low-voltage network they control. The words of a key actor working in the regulation of renewable energy communities and groups of prosumers, whom I interviewed in March 2022, confirmed to me this governance interest in the possible future participations of DSOs in grid flexibility. The response to my question about whether they interacted with Terna in establishing the storage incentives was: "No, no, not with Terna. Our direct interlocutors are the distributers". This was a sentiment shared by another public servant who was in charge of overseeing incentivisation schemes to sustainable mobility when I spoke to him in the same period. He told me:

> "Terna will definitely be called upon to have a key role in this context in the long term, because we need an infratsrucuration of the distribution network if we need to accommodate electric cars in every neighbourhood. However, as we think about vehicle-to-grid, our main points of contact are the distribution network operators".

Incentivising storage is the key piece of this ambition because in order to have dispatching abilities, DSOs would need to have access and manipulate decentralised electricity storage such as batteries connected to local solar panels, the batteries from electric vehicles. In other words, DSOs would need to program, for example, when private batteries able to store electricity coming from solar panels can take in electricity and when they can feed it into the distribution grid, when EV vehicles can be charged and how much reserve capacity needs to be left within each battery to offer buffering capacity to overgeneration, or how much of the charge stored in the EV can be used to meet times of high electricity demand in the grid. This potential inclusion of DSOs in electricity dispatch

relies on both the willingness of individual prosumers to give access of their storage systems to external operators and on the technical possibility of acquiring this access.

4.5 A Concluding Provocation

The diffractive reading above worked to delineate how the governance of community energy in Italy synthesised in Decree 199/2021 incentivising renewable energy communities and groups of prosumers acts in response to sociomaterial configurations of the electricity grid and in entanglement with specific visions of grid development. In so doing, it highlights a material politics of community energy that is not limited to everyday interactions with energy objects but rather creates a structuring effect on national policy. The politics of such a structuring effect however are not limited to the institutionalisation of a specific incentivisation scheme but rather reverberate into the potential for justice and democracy that renewable community-energy schemes in Italy can mobilise. Indeed, if understanding the current national governance of community energy in Italy as so profoundly tied to technical needs of the grid, it is imperative to ask whether it may replicate some of the technocratic black-boxing tendencies that centralised electricity planning and generation have been said to present (Rydin *et al.*, 2018). After all, there is a reason why webinar chats and in-person events on both schemes have been filled with complaints against limitations based on technical objects that for many non-technicians are as real as unicorns and fairies and why an internet search of the term "renewable energy communities" in Italian now results in several advertisements for consulting companies offering specific services for the founding, running, and compliance of these schemes at a fee.

In my interviews with people involved in setting up renewable energy communities, ambitions of grid management never appeared amongst the reasons motivating their work. This should not be surprising, as such technical agendas are not mentioned in the policy, which demands instead "provision of environmental and social benefits" as a requirement for the founding of renewable energy communities (Decree 199/2021). People most shared with me that they were approaching these schemes to foster social capital in increasingly disenfranchised communities, taking back control of corrupt energy systems, and sharing

benefits with friends and family. I found this understanding of community energy as an opportunity for political revolution most distilled in the documentary "We the Power" (2021), which I saw screened in front of a group of shareholders of a large energy cooperative celebrating the opening of a collectively-owned wind turbine in October 2021. As I watched the room fill with excitement as the documentary was played to introduce a discussion on renewable energy communities in Italy, I could not avoid thinking about a recent conversation I had had with a private actor in the electricity market. He had told me that he was lobbying local administrations across three different regions to enter a super-sized renewable energy community, a not-for-profit scheme that would have nonetheless afforded him a large salary and paid large sums into his private consultation firm. To my questions about the technical limitations of the national incentive around medium-voltage transformers, limitations that are splitting apart villages of 1000-2000 inhabitants let alone three different regions, he responded with a grin. He shared with me that he himself had worked in the regulation of electricity for years and his business partner still had close ties with the regulating agency: they knew exactly how to circumvent the limitations that concerned everyone else. The stark contrast between the decentralising revolution the documentary promised and the unique possibility for speculation that this electricity expert had access to concerned me then and concerns me now.

It is perhaps too early to measure the effects of the material politics of community energy governance in Italy, as the policy is still being fully operationalised through the coordinating interventions of the Italian Regulatory Authority for Energy, Networks and Environment, the GSE, and the DSOs at the time of writing of this text. It is nonetheless important to map how such governance emerges and to raise the question of its ultimate effects, especially as renewable energy communities and groups of prosumers continue to be presented to the wide public as opportunities for social cohesion, energy justice and democratic participation.

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CHAPTER 5: MAPPING CRITICAL JUNCTURES FOR SUSTAINABLE CHANGE[14]

When I first explained to my father that I was embarking on a PhD to study the material politics of community energy governance in Italy and the ways in which the proliferation of distributed energy technologies may affect the reproduction and transformation of the Italian state, he looked at me with vacant eyes. At first, I thought it may have been a poor choice of lexicon on my part that confused him, but the conversation that immediately ensued showed me his was not confusion but scepticism. How would research institutes fund me to explore such a topic when community energy was not in fact the norm in the Italy and when, according to his perception, distributed energy technologies only represented a *small* part of the fleet that powered the country? At the time, I remember answering his questions with attempts at representing the potential of the germinal transformations I was already noticing, effectively trying to convince him that although he could not see it yet, I knew *something big* was coming. In other words, I answered his concerns without challenging the temporal framework to energy transitions and sociotechnical change that his questions implied. In fact, my answer re-enforced both the idea that progress is linear and unidirectional and that in order for change to occur a disruptive force needs to become big enough to trigger it.

However, as I discuss in the introduction to this thesis when I talk of studying energy transitions in-the-making and swiftly mention in Chapter 2, my entanglement with the research assemblage I encountered when conducting my fieldwork challenged the way I conceptualise sociotechnical change and opened my eyes to the fallacy of the centrality of scalability in this process. In this chapter, I delineate an alternative to overestimation of scalability in sociotechnical change by discussing what I call a "critical juncture in time", a term I borrow from Political Science. Through this concept, I am able to highlight how sociotechnical change in energy transitions can occur in the contingent coming-together of several small processes that, in their intra-action, interrupt the recurrence of the status quo

[14] I submitted an abridged version of this chapter to the STS journal *Tecnoscienza.* It is currently under review.

and materialise the emergent territorialisation of an alternative. Similarly, focusing on sociotechnical imaginaries helps me draw attention to how the virtual and imagined is intensely material and therefore able to affect energy politics even when physical systems remain apparently unchanged. Thanks to the agential cut performed by the use of the analytical lenses of critical juncture and sociotechnical imaginaries, then, the energy transition-in-the-making I followed for years and the ensuing changes to the country's energy politics appear more so as re-assembling and becoming than as the inescapable result of small systems scaling-up.

Before delving into the empirical work that helps me draw this picture, the following theoretical review introduces existing scholarly conversations about temporalities in sociotechnical transitions to sustainability.

5.1 Problematizing Transitions to Sustainability: non-linearity of sociotechnical transitions to decarbonised and decentralised electricity generation

Though institutional and academic narratives of transitions to sustainability often present them as processes dominated by linear and continuous progress away from carbon-intensive systems towards low-carbon ones, the sociotechnical changes that characterize these transformations operate on temporalities that are neither linear nor continuous (Geels *et al.*, 2017). Rather, sociotechnical change, be it future, present or past, materializes through dynamics that simultaneously include progress and regress and that are vulnerable to surprising and unpredictable disruptions (Beck *et al.*, 2021). Work on polychronic temporalities, on time as occurring and being experienced at different speeds and orders across compounding timelines, helps to understand this dimension of sociotechnical change. Given that the logics of progress and modernity underline widely held understandings of the functioning of the world (Hartog, 2015), however, being attuned to such varying temporalities is indubitably challenging. It is even more so when the subjects of such transformations are systems populated by incumbent infrastructures that are seemingly impervious to change like electric power systems.

Imagining and enacting a transition from traditional power systems to less-polluting versions of electricity provision has nonetheless produced novel and disruptive stories of possible alternatives too, each implying specific and contrasting prescriptive visions of the future. From focusing on degrowth or energy justice to saturating systems with optimized smart grids or hyper resilient isolated microgrids, from prioritising decentralised energy democracy to calling for nationalised energy sovereignty, from fighting for the re-commoning of electricity systems to defending the benefits of collective self-consumption, these 'alternative electric futures' and many more have been populating both policy and public counterdiscourses. The heterogeneity of these narratives speaks to the multiplicity of groups competing to establish a dominant vision of what a desirable energy future actually looks like. Competing, that is, to participate in the production of *sociotechnical imaginaries*, which Jasanoff defines as "institutionally stabilized and publicly performed visions of desirable futures, animated by shared understandings of forms of social life and social order attainable through, and supportive of, advances in science and technology" (Jasanoff and Kim 2015; Beck et al. 2021:143). Though the narratives and visions surrounding desirable sociotechnical futures are multiple, incumbent sociotechnical imaginaries shape the directions towards which societies set out to move by framing certain options as plausible, probable, realistic, desirable, or attainable, and others as utopic, irresponsible, or unfeasible (Delina, 2018). This however does not mean that sociotechnical imaginaries are immutable, as they themselves depend on changing balances of power among social groups, on the material entanglements of the technologies they revolve around, and on the continuous production of the division between state and society, which implies constant revisions of the relationship that ties these categories in becoming.

This chapter contributes to problematizing the temporalities of sociotechnical change by investigating the emergence of new sociotechnical imaginaries of distributed generation, a contested political field in Italy. The focus on Italy and on sociomaterial publics enrolled in renewable distributed generation derives from a recognition of a 'constitutional moment' (Jasanoff, 2011) happening in the country as it comes to terms with a sociotechnical transition towards an electric power system increasingly permeated by decentralised technologies like PV solar panels, small wind turbines and micro hydroelectric screws.

Following Jasanoff, 'constitutional moment' here indicates a time when relations between citizens and the state are being reconfigured (2011). Indeed, the arguments presented in this chapter are founded on the understanding that "electricity infrastructures are intensely entangled in the assemblage of the state" and that this moment of transition is transforming the spatialisation of electricity in Italy and re-assembling the state (Concetti 2023a). It expands on this premise to show that as arrangements between competing publics shift, they contribute to the institutionalization of specific sociotechnical imaginaries by occasioning the contingent encounter of groups with distinct interests with materialities that afford specific politics. They produce, that is, critical junctures in time. Following Capoccia and Kelemen, the concept of "critical junctures" captures the non-linearity of change, underlining instead how change happens in punctuated spurs (2007). This paper will map how agentic sociomaterial publics with shifting provisional relevance materialise in entanglement and lead to the reframing of desired futures by producing these interspersed "critical junctures" (Ibid, 2007) in time where certain pasts are put aside in favour of new futures.

As is throughout in this thesis, a neomaterialist sensibility is a fundamental piece of the analysis presented below. For this reason, the next section will put scholarship on sustainable transitions in conversation with interdisciplinary reflections on the more-than-human construction of the future. This review of theoretical context bolsters the discussion on temporalities mentioned above, and justifies the paper's use of sociotechnical imaginaries and critical junctures as analytical tools.

5.2 Producing the Future: Sociomaterial Participation and Changing Energy Infrastructures

As scholars devote increasing attention to the project of sustainable transitions in large socio-technical systems (Sovacool *et al.*, 2020), some are problematising the conventional temporal frameworks used to conceptualise such transitions. They argue that these framings oversimplify complex, unpredictable and contingent processes into linear representations of technological development and social progress (Krüger, Eichenauer and Gailing, 2022). Patterson et al., for example, take issue with the idea of sustainable

pathways, which they fault with often overstating the coherency of transition processes, and argue that sustainable transitions are stochastic, susceptible to overlapping and multidirectional forces, and always occurring under frameworks of uncertainty (2021). Tozer et al. build on this work to sustain that the notion of pathways is often mobilised in deterministic ways that reinforce linear ideas of progress, and that it needs further granularity to be useful (2022). They argue that sustainable pathways emerge when multiple efforts to enact change come together and coalesce rather than when particular projects for sustainability finally acquire a large enough scale (Ibid, 2022). The issue these authors take with the overemphasis in sustainability transitions literature on the ability of decarbonisation projects to "scale up" shines a light on how dominant framings of space-time obscure processes of change by representing sociotechnical transformation as a linear trajectory consisting simply of getting bigger and moving forward.

Bensaude-Vincent conveys similar doubts about the use of scale and scalability, convincingly arguing that it functions as the necessary premise for the conceptualisation of one unitary time that can unfold everywhere in one direction (2021). This is, however, where conversations in Human Geography on the concept of scale become particularly useful for a conceptualisation of time in processes of change that can account for discordancy, heterogeneity and situatedness. Indeed, though some geographers have problematised the use of scale as a "conceptual given" that mystifies research objects (Marston, Jones and Woodward, 2005:422) many others continue to defend scale as long as it is used as a performative and relational tool. The latter, that is, argue that the usefulness of scale depends on a scholar's commitment to avoiding pitfalls of abstraction that present scale as if it may exist in a vacuum outside of prior and posterior social practices (MacKinnon, 2011; Bouzarovski and Haarstad, 2019). This attention to the performativity of scale separates it from universalising theorisations of a "one-world-world" (Escobar, 2018) and allows researchers to think carefully instead about how the mobilisation of this concept produces or inhibits the creation of desired worlds (Cameron and Hicks, 2014). A performative approach to scale therefore obviates the tendency of the concept to hide the multiplicity and contingency of time and its trajectories.

Though these conversations may have remained insular to the discipline of Human Geography, I argue that they are helpful in approaching the daunting task of troubling dominant frameworks and working through temporalities that admit polychronicity and the participation of the more-than-human to the construction of timescapes. After all, those who problematize the spatiotemporalities of transitions to sustainability already build on multidisciplinary literatures on the social construction of time and space. Indeed, if remarking the powerful implications of spatiotemporal frameworks in the production of knowledge reminds us of the seminal work by Massey on time and space (Massey 1992), objecting the linearity of time and of the future takes us back to the work of scholars who have criticised the logics of modernity (Escobar, 1995; Kothari *et al.*, 2019). This literature rejects the idea that technological advances and economic growth are the end-all solution to societal issues as well as the idea that the only timescale available is that of anthropocentric progress (Bensaude-Vincent, 2021).

Though STS has as a discipline grappled extensively with the ways in which actors make use of stories, images and metaphors to reinforce visions of the future that eventually become inscribed into institutional imaginaries, incidentally a key component of Jasanoff and Kim's work on sociotechnical imaginaries (2009), Groves argues that little work has been dedicated to the role of the more-than-human in this production of the future (Groves, 2017a). In his work, he shows capacities to anticipate and influence the future as distributed unequally among different publics thanks to material factors. The "material" he speaks of include the scripts inscribed in technological devices and infrastructures, the artifacts onto which social practices depend, and the affective nature of "socio-technical-natural environments". What emerges from his contribution is therefore a characterisation of futures-in-the-making as co-constitutive of sociomaterialities, where both humans and non-humans shape visions of the futures and are recursively shaped by them.

The attention to the role of the non-human that Groves calls for owes to neomaterialist approaches that recognize the interdependence, and at times intra-connection, of the human and more-than-human (Barad, 2007). Though the field of neomaterialism cannot be discussed as unitary, it is undeniable that its disposition to distribute agency to the non-human and ascribe affective capacities to the material (Coole

and Frost, 2010) has been gaining popularity across the social sciences (Whatmore 2006), and particularly so in studies of energy transitions (Bulkeley, Castán Broto and Maassen, 2014; Broto, 2017; Stripple and Bulkeley, 2019). Energy infrastructures, devices, and practices have in fact been extensively investigated as powerful elements able to both contribute to societal change and to crystallize status-quo dynamics (Bennett, 2010).

In *Vibrant Matter,* Bennet famously shows how the functioning of everyday life for thousands of people was disrupted at a moment in time due in part to the networked agency of electricity, power plants, and transmission lines (2010). She indeed uses the example of a 2003 blackout to show how agency "extrudes from multiple sites", one of which being the flows of electrons that constitute electricity and whose sudden and unpredicted change of direction shaped the blackout to be the cascading event that it was (2010:53). More recently, in reviewing what energy studies can bring to the social sciences, Van Veelen et al. have argued that energy materialities are particularly interesting objects of study because differently from other resources they necessitate infrastructures to become visible (2019). The ambiguous "in/visibility and in/materiality" of energy, they argue, opens avenues for ontological disquisitions about what matter is, how it performs, and how it enrols publics (Ibid: 3). Cross et al. instead discuss the special role awarded to electricity in neomaterialist studies as warranted by the uniqueness of energy as an object, a relationship, and an indispensable fuel for human and non-human activities (2017). In this chapter, electricity and its assemblages are conceptualised as intensely agential too, so much so that the empirical discussion below is centred specifically on observations and analysis of processes surrounding recent reconfigurations of the Italian electricity grid and its regulation.

5.3 Sociotechnical imaginaries as tools of transitions research

Though Jasanoff and Kim first introduced the concept of Sociotechnical Imaginary in 2009 to speak of the specific capacity of the nation state to "deploy imaginative resources" that relate policy and policy objectives to the common good through technological innovation (2009:141), the concept has in more recent years evolved to move beyond the domain of the state. *In Dreamscapes of Modernity*, a monograph entirely dedicated to the definition

of sociotechnical imaginaries, the same two authors widened the concept to include global, regional, and local actors (2015) and the increasingly popular (Rudek, 2022) nascent literature mobilising the concept to study sociotechnical transitions has tended to stay with this widened approach. Several scholars use the concept of sociotechnical imaginaries and, as Jasanoff and Kim had argued it would, this has allowed many to speak of the collectively held visions of desirable futures, of how these are institutionalised in policy documents, and to problematize the social order that is presented as attainable through the technological advancement around which these visions coalesce (Burke, 2018; Levenda *et al.*, 2019). Scholars who underscore the need to operationalise Sociotechnical Imaginaries under a framework of co-production, by which ideas, institutions, practices, materials, discourses and publics simultaneously shape each other's development, tend to focus more on the practices that maintain Sociotechnical Imaginaries relevant or allow them to emerge (Longhurst and Chilvers, 2019). Rather, those who seek in Sociotechnical Imaginaries policy tools tend to focus more on discourses and visions extricable from their institutionalised manifestations (Sovacool and Hess, 2017). In both cases, Sociotechnical Imaginaries is a useful analytical tool that allows investigation of the material in all its forms, whether tangible versions like technological artefacts, infrastructures, policy documents and jurisprudence, or less tangible ones like visions, discourses and stories, perform in social systems and produce political impacts.

What recent reviews of the use of the sociotechnical imaginary concept in academic literature have evidenced to be missing are serious contentions with the ways in which imaginaries emerge, how some become dominant and how alternative visions may become institutionalised (Rudek, 2022). This is the angle this paper takes: the aim is not to unearth the sociotechnical imaginaries embedded in regional or national policy but rather to trace the emergence of new imaginaries and their institutionalisation.

5.4 From recurrence to change: mapping the critical junctures for STI institutionalisation

Figure 9: Zooming in on the Critical Juncture for Distributed Energy Politics in Italy: some of the actors at work in the catalysis of change. Source: Author

As the energy landscape in Italy, like elsewhere, is produced and reproduced iteratively in entanglement with multiple publics and multiple actants (Concetti, 2023b), so are the country's sociotechnical imaginaries of energy. This is a reproduction usually characterised by a temporal scale of recurrence, where the temporary relevance of different sociomaterialities shifts depending on human and more-than-human factors without necessarily creating change. Through the discussion below, I will show that in Italy the assemblage of distributed generation in both its materialised and imagined state in fact only changed thanks to punctuated moments in time of intense institutional flux. These critical junctures create a constitutional moment (Capoccia and Kelemen, 2007; Jasanoff 2011) when the status quo can be disrupted by bringing together particular materialities, publics, and logics and thus intensifying their affective capacities in such specific contingency and entanglement.

I conducted my fieldwork in Italy during such a constitutional moment, during a time, that is, when some of the most obdurate relations tying human and non-human actants in the make-up of the energy landscape were undergoing great transformation. When I started my interviewing with institutional actors and participant observation in October 2020, the electricity grid had already been physically undergoing for ten years a slow shift

from a system almost entirely based on large, centralised conventional power plants burning fossil fuels, to one permeated by myriads of decentralised renewable technologies like solar panels and wind turbines. And, notably, the policy that regulates the grid's development was at the time experiencing an institutional push coming from European directives to increment this permeation and decentralise some of the processes of electricity production and distribution. In particular, the government had just few months prior, in February 2020, started the experimentation phase for the implementation of "renewable energy communities", renewable energy schemes enrolling lay citizens as well as industries in the generation and distribution of electricity through distributed generation technologies (producing electricity at the distribution network level).

For the Italian energy landscape, this meant that in 2020 for the first time, owners of electricity generation technologies could – within certain boundaries – produce electricity not just for their consumption but for that of others too. Such an apparently small amendment to the conventional process of electricity provision in the country actually amounted to meaningful sociotechnical change. Indeed, the complex and multifaceted relationship tying electricity consumers to the electricity they consume, a human-non-human relation that had not changed beyond market dynamics since the establishment of the nation, had for a few years been changing as practices of prosumption (electricity production in places of consumption) became more commonplace with the proliferation of renewable distributed generation technologies; it was now further transforming to link in new ways electricity-consuming appliances, their users, the infrastructure connecting them, the technologies powering them, those who owned such technologies and the state who moved to regulate and incentivise the flows of electricity from one to the other.

Only a critical juncture in time could allow a transition from a system characterized solely by centralised electricity supply to one permeated by state-incentivised shared production to happen. As I discussed elsewhere (Concetti 2023b), this juncture was facilitated by the mobilisation of diverse publics following the increased accessibility of decentralised electricity generation technologies. However, it was also made possible by the effects of the proliferation of these technologies on other key *things* operating in the assemblage of electricity provision in Italy. For example, speaking with one of my research

participants I discovered something that I would later be able to confirm in reading annual development documents published by the country's transmission operator (Terna, 2021). The increased and increasing use of decentralised electricity production by domestic and industrial consumers in Italy had caused a reversal of electricity flow, especially in certain regions. As electricity started to flow from what were conventionally consumer spaces back up distribution network cables towards the transmission network, electricity substations in the country were (and are) no longer doing what they were designed to do, that is only helping electricity voltage jump down to consumption levels, but were rather asked to ramp up voltages as well. And as these infrastructures were never designed to receive in-feed from multiple directions, they suffered unpredicted wear and started to pose stability risks to the entire grid (Terna, 2021). The proliferation of distributed generation technologies, that is, did not just mobilise publics across the country looking to influence change in a way or another, but also, like in Bennett's account of the 2003 blackout, enrolled agentic electricity flows, which affected substations, cables and several other elements of the grid in such a way as to create real friction in the system of grid management (Bennett, 2010). And such friction contributed to making the temporal juncture I entered in 2020 a critical one because, as an institutional stakeholder in a directorial position shared with me in an interview, it created the need to confront distributed generation practices as problematic processes that needed revision and as prioritised technical problems that did not have an immediate technical solution. In other words, such friction contributed to affording that specific temporality a disposition towards change rather than recurrence, to creating a critical juncture.

This critical juncture in time cannot be understood as isolated from other moments of change at scales others than that of the Italian nation. Indeed, from interviews with state officials tasked with the implementation of European Directive RED II (EU 2018/2001) in Italy, emerged that shifting priorities in the governance of the electricity market at the European level particularly shaped the energy landscape I entered in 2020. In particular, the national energy strategy in Italy at the time was greatly influenced by the 2018 publishing of the EU Regulation on the Governance of the Energy Union and Climate Action (EU 2018/199), which among other things pushes member states to favour

renewable energy community schemes. Another institutional stakeholder whose mandate now includes self-consumption and energy communities shared with me in an interview in March 2022 that until the publication of such EU regulation, the dominant logic behind grid governance in Italy was to ensure that systems that may be disruptive to the national grid be curtailed as much as possible. For this reason, different decrees and energy authorities' deliberations in the early 2000s and 2010s (e.g.. ARERA, 2015) had limited the scope and functioning of private grids and closed distribution systems, i.e. infrastructures owned by actors other than the national transmission system operator and distributing electricity among industrial clients situated in close proximity to each other. However, he explained, as new priorities emerged at the European level, the Italian legislative landscape began to change, which eventually led to changes in the way in which grid governance was conceptualised. This much I was able to verify in the relevant policy documents. Indeed, not only does the new national legislation on shared prosumption (Decreto 199/2021) reference the EU2018/199, but so does the new national legislation on regulating the electricity market (Decreto 210/2021). More interestingly, these changes in national legislation show up in amendments to the typology of electric grid allowed in the country, which as the participant was alluding, changed to allow new private and closed distribution systems in 2022 (ARERA, 2022). Evidently, their potential disruption to the management of the grid no longer took precedence. In other words, as the interviewee was saying, it was not just policy that changed but also the logic underpinning grid governance in the country.

To claim that changing policy priorities at the European level had the direct impact on Italian national energy strategies that this research participant wanted to attribute to them would erase the labour of the other publics and materialities that were reassembling the energy landscape at the time. However, this anecdote does shine a light on the interconnectedness of critical junctures in time. As European energy transitions as futures-in-the-making centred community organisations as key publics in desired visions of the future and prosumption technologies as mechanisms for these actors to engage meaningfully in the electricity system, prosumption started to epitomise social aspirations towards sustainability and was given the status of sociotechnical solution to political

problems. So when policymakers in Italy were faced with the technical problem of reversed flow as they received lobbying calls from disparate commercial and third sector groups to expand community energy in the country, they encountered schemes akin to collective prosumption encoded in EU2018/199 as a solution rather than as a problem. At the European level, a Sociotechnical Imaginary of energy became institutionalised whereby civil collective action through community energy is fundamental for the spread of renewable energy which is fundamental for a sustainable transition. In turn, this facilitated the process of institutionalisation of a Sociotechnical Imaginary of distributed generation specific to Italy, one that was already forming but not yet stabilised in policy. This was, to be exact, a Sociotechnical Imaginary of distributed generation as holding great potential for communalism and of shared production as a solution to both grid instability and to insufficient representation of civil interests in the energy market.

Like it is important to remain cognizant of the fact that this critical juncture is produced through processes that are multiscalar, it is similarly important to remember that such processes operate on multiple temporal rhythms too. A particularly illuminating example of this is the tension that exists between the longevity of infrastructures such as those of a power system and the relevant ephemerality of the political bodies that govern it. Precisely because in Italy processes that operate on different temporal logics entangle to make up the assemblage of the system of electricity provision, recurrence usually dominates the system's temporality rather than change. Indeed, though technologies like solar panels and wind turbines have taken more than two decades to permeate the grid sufficiently enough to disturb it, those in charge of their governance and regulation come in and out of power every few years, even more frequently than elected mandates would have it, thus making the long-term changes brought about by the proliferation of distributed generation relatively irrelevant to electoral power dynamics. However, this tendency towards recurrence partly lost strength in the country when, as mentioned above, permeation of renewable distributed energy technologies became a priority at the European level and, significantly to the analysis at hand, it was made even weaker as renewable energy legislation in Italy became recognized in judicial discourse as a key space for power contestation between the regions and the national government.

As a matter of fact, Italy operates murky constitutional delegations of power between national and regional governments when it comes to key areas such as Industry, Energy, and Public Works Contracts among others (Di Gesù, 2020). Indeed, the separation of powers between the central government and the regions (and the two autonomous provinces) is encoded in two lists of competencies, one entirely ascribed to "the state" i.e. the central government, and one of shared responsibility between "the state" and the regions, outside of which "residual competency" is recognized to the regions. This means that regional governments technically have say over an indefinite number of issues if they are not mentioned in the above lists, prospect that has caused the Italian Constitutional Court to begin a yet unfinished process of judicial interventions to limit the powers of the regions (Morelli 2011). Concomitantly, the increased proliferation of renewable energy technologies in the 2010s pushed different regional governments to publish specific regional laws meant to either incentivize or limit the deployment of such technologies. These decisions caught the attention of the Court which has since deliberated several times against the regions' power to do so and compelled the devoluted governments to follow national energy strategies instead (Cozzolino, 2014). So when the RED II was passed at the European level, some of these regional governments found in the directive and in its mention of renewable energy communities a new space of legislative action through which to either incentivise or curtail renewable energy deployment.

Six regions legislated about renewable energy communities before the national government had and justified their move as implementation of European directives (Concetti, 2023a). In this way, the proliferation of specific renewable energy schemes took on electoral relevance at the regional level and specific importance in ongoing contestation about regional power. For this reason, distributed generation schemes suddenly became more *effective* in bringing urgency to the institutionalisation of a new sociotechnical imaginary of energy in the country. Indeed, when the national government finally legislated about them in 2020, it had to make sure to crystallise in national policy as much as possible what shared prosumption means for the country. Even so, actors involved in its politics like regional politicians, prosumers, and members of energy communities in several regions who had already operated under regional rules had already developed ideas about the kind

of relationship that ties such schemes to devoluted politics (Concetti, 2023a). As increased urgency characterised this assemblage, that is, a new STI of distributed energy had to be institutionalized and even so nascent counterdiscourses circulated and festered.

Even messier processes were hard at work in the institutionalisation of this STI. When talking about the present and the immediate future, for example, most of the prosumers I interviewed spoke to me of a time of chaos and uncertainty. They talked about uncertainty specific to the landscape they participated in, like doubts about when exactly the state incentives for renewable energy communities and shared prosumption schemes would become fully available, but also spoke of wider uncertainty that they felt characterised the present and the future. When in follow-up interviews I asked the many participants who mentioned "uncertainty" where this feeling came from, the answers I received mentioned different and compounding crises: climate change, the Covid-19 pandemic, lack of job prospects that would procure them the capital necessary to further invest in renewable energy, and, in the last months of my fieldwork, the invasion of Ukraine by Russia. Though a timescape associated with crisis may be assumed to be characterised by either paralysing anxiety or frenzied urgency, the entanglement of the present and future of the power system in Italy with moments of crisis appeared to me to be particularly conducive to centring some of its publics as empowered agents of future-making and to open the realm of what is seen as possible in the short and long term.

In fact, the aftermath of the havoc wreaked in Italy by the first outbreak of the Covid-19 pandemic led to the use of the policy tool of state incentives in ways that were unprecedented in the country's 21st century politics. After years of proposed cuts to national spending and traumatic bouts of austerity measures, the country experienced a time of unexpected largesse in public spending thanks to funds associated to the European Union's post-covid stimulus package, the largest ever in the history of the EU[2]. In this context, not only were specific incentives created to bolster the proliferation of energy schemes involving collective electricity generation through renewable energy technologies, but these were also compounded with other energy efficiency incentives. For this reason, the people I spoke to told me they found it easier than before to believe that energy transitions measures in the short term would actually be funded. Though the circulation of the various

incentives associated with the recovery plan did not necessarily favour the physical set-up of collectivised energy prosumption schemes – technicians shared with me that they had momentarily stopped taking on work for the installation of solar panels and similar in favour of getting through the bulk of orders funded through one of the first of post-covid state incentives to be passed, 110% state financing on home renovations – they became synonymous with a feeling of possibility. Similarly, the terrifying prospect of a prolonged war between NATO allies and Russia, only merely whispered by the time my fieldwork wrapped up in the first weeks of March 2022, inspired a few of the last research participants I interviewed to share surprisingly positive thoughts about the near future of energy transitions in Italy. Though they unanimously expected drastic issues with gas supplies to the country, their testimonies also coalesced around the idea that such issues would certainly prompt politicians to finally move the country's energy supply away from gas and towards renewable energy technologies in meaningful ways. Non-human elements separate from technological progress in renewable energy deployment were thus allowing the people I interviewed to think of new realms of possible futures as plausible.

Short term visions of the future in this sense were however rosier than those shared with me about the long term. For example, the fact that state incentives were bounded to crisis recovery programs preoccupied many, who felt like the opening of such positive futures was "too good to be true" and that all these measures would end once the government coalition in power at the time would fall. This is also what emerged in conversation with several of the individual members of one of Italy's energy cooperatives, ènostra, whom I interviewed. When I asked them about their visions of the future of the Italian energy system, many shared with me that they did not have much hope for a transition to actually occur, and that they had invested in the renewable energy technologies they had installed in their home precisely to be able to face such prospect. Thanking mostly their rooftop solar panels, they explained to me that they no longer felt enslaved by the logics of the grid. Through their smart meters, many could see exactly how much of their daily consumption was offset by their generation technologies and thus felt more at ease at the thought of a present and future entirely dominated by "greedy oil and gas interests".

This sentiment existed regardless of the individual participants' homes' capacity to function off grid thanks to their installed technologies, which was not the case for many of them. The mere presence of the renewable generation technologies on their houses reassured them that the future would be less uncertain for them even if one day they would effectively have to go off grid. In this way, the grid was, among the publics I interviewed, imagined as becoming less obdurate, and in fact even obsolete, despite its continued and undeniable present relevance in the functioning of the power system. What I could trace shifting was not the technical or political relevance of the grid as powerful infrastructure for electricity provision in Italy but rather the hold that such an object had on the minds of its users and on their ability to envision a future without it. Participating in prosumption practices opened a realm of imagined possibilities for these research participants that was previously unthinkable to them.

Many of the owners of distributed generation technologies I interviewed referred back to the particular legislative change allowing shared production when I asked them about their visions for the future of energy in the country. More than one told me that in encountering activists and cooperative representatives working to share the new opportunities brought about by the decree on shared prosumption, they began to think about the possibility of communities and cities acting as mini-grids, with users sharing electricity amongst each other rather than relying on centralised generation. Yet, only a few of those who shared this idea mentioned they had plans or were actually actively involved in the creation of a "renewable energy community" as incentivized by the state. New pathways for change seemed to open up in the imagination of those interacting with distributed generation technologies even when such pathways only existed as desired futures rather than as buildable presents.

For this reason, I asked some of my research participants to share with me whether there were specific elements of prosumption practices that had tickled their imagination. This seemed to be one of the questions that people stumbled the most on, as many could not exactly pinpoint what was so exciting about prosumption or even participation about collective energy practices more at large. However, several people used words of wonderment and emotional engagement when trying to answer the question. Some

recounted how amazing their first interaction with a technology of renewable energy generation was, how they were left bewitched by an encounter with a small hydro turbine when they were little or felt ecstatic in front of a solar panel that they felt would give them independence, while others became visibly excited as they talked about the unprecedented nature of being able to send electricity, something so volatile, to someone else. Some people I personally saw reacting with "oohs and aahs" at an event for the inauguration of a "community wind turbine" when they first saw the turbine in question. I saw a woman breaking in tears, and when I asked her about it she told me: "Seeing the turbine moved me. It's like a totem of our tribe".

The mention of a totem initially surprised me, but when many more at that same event told me they felt that the turbine was magical, many testifying to the fact that it was making them feel hopeful as if they were children again, something became apparent to me. Some of the materialities whose provisional relevance has become key to the formation of sociotechnical imaginaries of energy in Italy are able to afford new ways of thinking about the future not necessarily through their design, but rather through their affective capacities. They cause feeling of amazement, ecstasy, wonder, and through this wonder the possibility of imagining alternative futures opens up. As the technology is emotionally experienced as magical, it is recognized the ability to change things that would otherwise seem immutable. And though these affective capacities seem to be prerogative of renewable generation technologies rather than shared prosumption in itself, the element of sharing electricity inherent to shared prosumption magnifies this feeling of wonder, both associating it to emotional aspects of community belonging and to childish disbelief in front of a possibility before unthinkable.

5.4 Conclusion

Sociotechnical imaginaries of energy become institutionalized thanks to the shifts in relevance and agentic capacities of different publics and materialities making up energy landscapes. This means that change, even in the virtual, cannot be conceptualised as linear or as dependent on one technology. Rather, not only do we need to look at the whole picture to understand change, but this change is so dependent on factors external to technological

progress that the logic of modernity or linearity cannot be the moving rationality that fuels it.

Through the discussion above, I have shown how Sociotechnical Imaginaries of energy transitions emerge in entanglement with particular temporal contingencies, or critical junctures, that are brought together by human and more-than-human elements. When putting all these elements in conversation with one another, it becomes easier to see how the critical juncture in time I entered during my fieldwork, one characterised by grid reconfigurations, global health crises, shifting geopolitical dynamics, and rising tensions between state bodies, allowed for new publics to become temporarily more impactful and mobilised things that enacted new effects onto the energy landscape in Italy. Moreover, the discussion above points to how as these publics and materialities took on provisional relevance, they were able to participate in the institutionalisation of a new Sociotechnical Imaginary of energy in the country, one where distributed energy has become part and parcel of common visions of the future, finds prioritisation in national policy and carries with it revised expectations of the society-state relations inscribed in practices of electricity use. And as this new Sociotechnical Imaginary has become institutionalised, the materialities that have made its emergence possible now influence visions of the future that circulate among the publics they enrolled, affording them the ability to think about the future in novel ways.

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CHAPTER 6: CONCLUSION

Even though I do not claim for the findings presented in this thesis to amount to an exhaustive and coherent representation of the state of distributed energy politics in Italy or even a complete answer to the question of how the proliferation of Distributed Generation has been affecting socio-political political relations in the country, the stories they tell are all intimately intertwined. The discussions I introduce through each chapter do the work of answering the research questions presented at the end of this thesis' Introduction. They describe and analyse how the spatialisation of distributed energy schemes in Italy has been shaping (and is being shaped) by energy policy and governance; how it re-assembles the state and visions of energy transitions through lines of de- and re-territorialisation; and how they contribute to a critical juncture that has allowed a new sociotechnical imaginary of energy to emerge in the country. All the while maintaining the role of the more-than-human front and centre.

I have mobilised new materialist analytical methods and insights to show that energy transitions are sociotechnical processes with sociopolitical effects. In doing so, I have demonstrated the usefulness of espousing an ethico-onto-epistemology and methodology gleaned from the diverse field of the New Materialisms. Specifically, following Deleuze and Guattari, I have argued that the Italian state is re-assembled in the energy transition in-the-making towards a power system permeated by renewable distributed generation schemes, and that this is best captured via the concepts of de-/re-territorialisation and de-/coding. I discussed this in Chapter 3 to explicate that the Italian state is paradoxically being re-coded as a unitary entity with clear boundaries and legitimacy through the de-territorialisation of some of its administrative functions.

Specifically, I have shown that when the assemblage of the state came into contact with the proliferation of renewable distributed generation schemes and with their codification across different scales, its relations of exteriority changed, thus materially bringing the Italian state-effect to lose and change some of the boundaries of its Groszian "territory". Indeed, entanglement with this energy transition in-the-making led to the

diversification of regional laws to regulate and incentivise renewable energy communities prior to a national transposition of RED-II. In turn, I have argued that this participated to de-coding the regions as entities separate from the state rather than as its own branches. The perceived inefficiency of this devolution in regulation has allowed the emergence of a discourse that characterizes the state as the necessary alternative, once again paradoxically an alternative to itself, and as an all-efficient administrative machine. Arguably, it would have been much more difficult for the state to attain this characterisation were it not for its perceived contraposition to the regions, and thus the Italian state effect obtained increased homogeneity in its relations of interiority thanks to a partial change in its relations of exteriority.

This argument is completed by the discussion in Chapter 5, which, staying with contingency and with Tsing's insight on the limitations of focusing on scalability, shows that this re-assembling of the Italian state-effect was only possible thanks to the formation of a constitutional moment in time brought about by the critical juncture of several sociomaterialities. Indeed, if a naïve reading of the objectives of my thesis may point to the simplistic argument that a decentralisation of the power system linearly leads to a decentralisation of the Italian state, a more in-depth engagement with the arguments presented here tells a different story. In fact, I have discussed how the prosaic and processual nature of stateness and its necessity to constantly re-produce itself as state-effect makes the state all the more refractory to change.

I have indeed explained that the heterogeneity of the state and its reliance on prosaic practices protects the assemblage of the state from fundamentally changing when encountering processes that affect it in some of its relations of exteriority. In other words, precisely because the state is not one and stable, it is better able to absorb new elements within its assemblage without de-territorialising altogether. The discussion in Chapter 5, rather shows that the transition in-the-making that I have traced was particularly successful in re-assembling the state because it participated in a confluence of sociomaterial elements that altogether de-stabilised an institutionalised sociotechnical imaginary. This insight

highlights that mobilising concepts through a neo-materialist sensibility allows one to recognise the entanglement of sociomaterial processes and to advance existing theory.

Indeed, in this discussion it becomes apparent that sociotechnical imaginaries are not only the ultimate effect of the crystallisation of cultural ideas about technological development that determine what visions of the future become possible in a determinate nation state. Instead, what emerges is that they are themselves vulnerable to changes brought about by the unfolding of the future and of technological development. Effectively, I expand on the original notion of sociotechnical imaginary proposed by Jasanoff and Kim to show that in processes of state-reproduction what *matters* is not just the discursive and that the formation of sociotechnical imaginaries is not unidirectional. Rather, changes to infrastructures and other sociomaterialities are able to affect and change the very socio-cultural milieu from which sociotechnical imaginaries emerge. In other words, I use a neo-materialist approach to recognise the usefulness of the notion of sociotechnical imaginary and simultaneously demolish the previously established boundary between point A (norms, discourses and cultural meanings of national technological advancement) and point B (the technologies whose deployment is institutionalised as possible and desirable). In my expanded version, the relationship does not go only from point A to point B but rather becomes circular and continues iteratively between the two.

Differently, in Chapter 4 I have put to use the methodological promise of diffraction and shown how its sensibility to the minute materialisations of change allow a researcher to uniquely unearth the politics of sociotechnical change. Indeed, in digging through the technicalities of the material discursive objects that are the new decree regulating and incentivising renewable energy communities in Italy and the TSO's annual development documents, I performed a research cut that opened up some of the justice components of this energy transition in-the-making. I was able to argue from within and thus pay particular attention to the differences made by the entanglement of technical transmission requirements and ongoing national governance-setting. In this way, I showed that the governance strategy that emerged is characterised by sociomaterial configurations that make it particularly exploitable by publics who have access to information about the black-

boxed intricacies of transmission regulation and operation. I have discussed that this is particularly concerning when acknowledging that this governance strategy is discussed in public fora as a tool to increase the general population's access to energy processes.

Through this thesis, I have set out to answer the question "*How is distributed generation and collectivised prosumption shaping and being shaped by entrenched sociotechnical imaginaries of sovereignty and energy in Italy and how does this participate to the reproduction of the Italian state and to the development of energy governance in Italy?"*. The following table summarises how I have answered each of the sub questions I have set out for myself at the beginning of this process.

Research Question	**Answer**
How does the spatialisation of distributed energy schemes influence energy policy and governance in Italy?	The opportunity presented by the spatialisation of distributed energy schemes to produce electricity in *places* of consumption contributes to the emergence of an energy governance and policy that is highly respondent to the sociomaterial configurations of the electricity grid and its operation's necessities. For this reason, the policy incentivising renewable energy communities in the country creates uneven access to profiting from these schemes due to its reliance on heavily black-boxed technical information.
How do these new assemblages transform socio-political processes beyond energy politics? What effects do they have on the re-production of the state?	These assemblages entangle with the Italian Nation state and contribute to re-assemble it in novel ways. On one hand they participate in the de-territorialisation

	of some of its administrative functions, heightening internal conflicts to the configuration of the state that precede their proliferation. This is particularly discernible in the publication of regional laws on renewable energy communities. On the other hand, they contribute to re-stabilising the codification of the state as unitary and efficient by contraposing it to the regions, which paradoxically get de-coded as elements outside of the Italian's state-effect.
How do the process and possibility of infrastructural decentralisation impact sociotechnical imaginaries of centralised sovereignty and of state-wide energy transitions?	The entanglement of decentralised infrastructure proliferation with a multitude of other sociomaterialities allows for the formation of a constitutional moment in time where established socio-technical imaginaries become vulnerable to change.
What is the role of the more-than-human in all of the above?	The more-than-human functions as sociomateriality. Throughout the thesis, the more-than-human is shown to play an active role in re-assembling the state, producing governance strategies, and de-stabilising sociotechnical imaginaries. In the thesis, the more-than-human is accessed through the study of the material discursive. In fact, the more-than-human emerges as one of the protagonists of the energy transition in-the-making that this thesis diffracts.

6.1 Summary

In Chapter 1, I provided an introduction into how energy transitions are sociotechnical processes with socio-political effects. I introduced how Distributed Energy Generation is changing established electricity power systems and provided a conceptual vocabulary to understand the revolution it implies. This consisted first of a discussion of prosumption and its implications for the spatialisation of energy systems; and secondly of a long review of the literature in the social sciences tying changes to power system infrastructures to "the social". I delved into the ramifications of a part of the literature that posits a "material politics" tying the sociomaterial to political change. Of note here are works that investigate how infrastructural change relates to the reproduction of the state, scholarship that connects the decentralisation of energy systems with political transformations and with the expansion of what is considered possible when imagining the future, and finally conceptualisations of "materiality" in studies of community energy.

I developed my research aims and research questions from lines of inquiry and missed research opportunities identified in the literature. After presenting these (Section 1.3), I provided a brief rationale and context researching this topic and site. I have also in this chapter illustrated some background information about the policy and jurisprudence history that precedes the innovative regulations I analyse in the empirical chapters when it comes to collectivised prosumption in Italy. And finally exposed my methodological choices for data collection and the research strategy that governs them. Further information about the analytical methods I have chosen to cut into the research assemblage I have instead provided in Chapter 2.

In Chapter 2, I reflected on my participation in the research assemblage. I have here discussed how the encounter with the practicalities of my own research after having read the work of neo-materialist writers like Deleuze and Guattari, Tsing, Barad, Delanda, Thiele, Connolly and Bennett, pushed me to develop a new-materialist sensibility. I recount how the respect for polyphony, comfort with contamination, and attunement to noticing the more-than-human that derived from this sensibility helped me navigate my fieldwork

and make sense of how I would perform research cuts into the complexity I was entangled in. In this chapter is also where I have delineated what "new-materialism" means in the context of this thesis and carefully described what a new-materialist ethico-onto-epistemology gleaned from the thinkers that inspire me entails. This discussion is fundamental to set the stage for the following chapters and in fact provides the necessary context to fully qualify some of this thesis' research aims.

With Chapter 3 begin what I often call the "empirical chapters" of this thesis. These are chapters that I have written as stand-alone journal articles or contributions to disciplinary handbooks and that present arguments I have fashioned from the data emerging from my fieldwork. In Chapter 3, I have reviewed relevant literature and discussed my own research findings to expose how rather than unitary actors or fixed realities, states are porous, heterogenous and unstable phenomena in becoming, whose authority and cohesive appearance rely on the laborious coordination of material elements in both their structuring and discursive capacities. To set up my own discussion, I have brought together post-structuralist state theories that have shown how mundane everyday practices contribute to the production of stateness with the works of scholars who have detailed the ways in which infrastructure contributes to the formation of state-society boundaries across scales. I have drawn on scholarships on decentralised energy transitions and their potential for "energy democracy" and emergent engagements with the concept of "proximity" to postulate that the spatialisation of electricity processes implied by distributed generation renewable systems should be taken seriously. Focusing on reconfigurations of the Italian power system, I have then mapped how these simultaneously stabilise and de-stabilise the assemblage of the state through lines of de/re-territorialisation and de/coding.

In Chapter 4, I have zoomed into energy policies written to incentivise collective prosumption to show how the sociomaterial configurations of specifically the electricity grid are assembling energy governance in Italy. I have explained that though there is no dearth of research interest on the role of large-scale energy infrastructures on shaping the social, not many energy social scientists have focused on the ways in which the

transmission system itself and visions of how it should be managed constrain the realm of possibility for energy governance. Following Briassoulis' definition of assembled governance (2019), I have embarked on a diffractive reading of the decree regulating and incentivising renewable energy communities and groups of prosumers in Italy together with documents published by the transmission system operator in the country. Through this reading, I have shown how criticalities in the transmission grid and technical anxieties about the deployment of decentralised community energy schemes feature in Decree 2021 subtly but powerfully. In other words, I worked to map how these sociomaterial elements assemble a specific energy governance in the country. This is an energy governance that, despite the hopes for the socio-political role of community energy showcased in the literature I reviewed in the lead-up of that chapter, I have discussed to disproportionally benefit technocrats precisely because of its emergence in encounter with technical requirements.

Finally, in Chapter 5 I have turned to the temporal element of the energy-transition-in-the-making I have followed through this thesis. Here, I have indeed worked to answer what made the juncture in time in which I conducted my PhD so ripe for sociotechnical change in Italy and how did it do so. In other words, I have here investigated how the "constitutional moment" (Jasanoff, 2011) allowing the changes in entrenched citizen-state relations and energy governance that I had traced in the previous two empirical chapters came to be. I have set the stage for this discussion by reviewing literature on the production of the future that takes issue with dominant temporo-spatial understandings of changes to sustainability as linear trajectories of getting bigger and better and putting it into conversation with scholars who have begun theorising on the role of the non-human in producing the future. Through this review, I have contextualised the use of the concept of Sociotechnical Imaginary in the chapter, explaining how I would focus on tracing how new sociotechnical imaginaries emerge rather than identifying what these are. I have then mapped how the specific critical juncture in time in which I operated in emerged, focusing on delineating its dependence on the catalysing effect of multiple sociomaterialities coming together.

6.2 Parallel Stories, Shared Aims

The connective thread running through the chapters of this thesis is a desire to understand the implications of reconfiguring socio-technical systems for socio-political processes. This commitment is spelled out in Chapter 2, which delineates an ethico-onto-epistemology devoted to flattening a hierarchy that figures humans as the only powerful actors within a world filled with life-full and life-less sub characters, none of which *matter* as much humans. And though most evident in Chapter 2, it stays front and centre of the theoretical and empirical choices that guide the rest of the chapters. In Chapter 3 I paid close attention not only to the effects of changes in jurisprudence responding to the need of regulating distributed renewable generation technologies, but also to the effects on the reproduction of the state in Italy that the discourses that emerge from entanglement between publics and these new energy assemblages have. In Chapter 4 the more-than-human acts as the protagonist of a saga meant to show how energy governance in Italy is now heavily influenced by the sociomaterial reconfigurations of the electricity grid and specific visions of grid development. And Chapter 5 shows how the move from recurrence to change in sociotechnical transitions is catalysed by processes that intimately involve the more-than-human.

This of course does not happen by coincidence but is rather caused by the first aim of this thesis, that is: to "trace the agential work performed by the socio-materialities of grid-connected, collectively owned and managed schemes of decentralised renewable electricity generation in enacting socio-political change". The literature review (Chapter 1.2) showed how scholarship across the social sciences has recognised that several different forms of the "non-human" element of energy, from its infrastructures to its knowledge practices to the jurisprudence that governs it and the social practices that depend on it, are simultaneously shaped and shape "the social". Yet this work has often focussed on large-scale infrastructural projects and their ability to serve dominant stories of stateness. When scholars have investigated the socio-political implications of smaller energy technologies, such as rooftop solar panels or other forms of decentralised energy generation, they have either concentrated on these technologies' assumed *potential* for democracy and justice or

traced the consequences of their deployment on power relations that are confined either to the scale of the community or to the realm of energy policy. They have not, in other words, dedicated sufficient time to questioning the implications that decentralised energy schemes are having on wider socio-political processes and assemblages and to understand *how* these implications are coming to be.

I designed my thesis to address this lacuna. The three empirical chapters (Chapters 3-5) take up different lines of inquiry into an energy transition-in-the-making that features technologies of distributed generation and practices of shared prosumption. The empirical chapters do not paint a unified picture, but their conclusions share a coherent idea: that relational assemblages change when their relations of interiority and exteriority do. In other words, socio-technical changes – such as the permeation of distributed generation into electricity grids - powerfully reverberates into other, more obviously socio-political realms because of the way the latter are unfolding (rather than stable) phenomena whose trajectory depends on contingent encounter.

The second common theme that unites the chapters in this thesis is careful work to identify the several actors – human and otherwise – that make up the multiplicities that enrol publics into distributed energy politics and what characterises distributed energy politics in Italy. Indeed, none of the empirical chapters presented above draw unequivocal lines from one point to another. Rather, in every chapter I have laboured to stay with the heterogeneity of the assemblages in which I participated as a researcher. This attention to multiplicity is most evident in Chapter 5, where in order to delineate *how* sociotechnical change happens I mapped the myriad of human and more-than-human elements that had to come together to produce a critical juncture in time sufficient to catalyse sociotechnical change. But this commitment, made explicit in the thesis' aim to "Discern what are the elements that enrol publics in this process and what kind of politics are elicited through it" guided me throughout my research and is detectible through every empirical chapter.

It shows up in Chapter 3 through the simultaneous appearance of European Directives and Regional Laws, constitutional reforms and community cooperatives, all

equally shown to participate to the coding and de-coding of distributed energy politics and to the re- and de-territorialisation of the Italian state. Multiplicity is just as present in Chapter 4, where I argued that it was insufficient to understand current energy governance in Italy as the sole implementation of European ambitions for decarbonisation. Instead, I showed how a mixture of grid requirements and shifting visions of grid management heavily influenced the legislation that regulates and incentivises renewable energy communities and that collectivised prosumption in the country.

Similarly, each of the empirical chapters takes up the second part of that aim, that is to "discern what kind of politics are elicited" through the unfolding of distributed energy schemes enrolling publics in Italy. This line of inquiry is found in Chapter 4 where politics and governance function as the main event: not only does this chapter work to show how energy governance of distributed generation in Italy has emerged in encounter with specific requirements of the electricity grid, but it also raises questions about what this means for the politics that this governance elicits. In the "concluding provocation" that closes the chapter, I share my concerns with finding that distributed energy generation is currently regulated and incentivised through jurisprudence that is entangled with black-boxed technocratic interests. This discussion points to the need to question the premises that subtend governance structures for innovative energy solutions. Indeed, to return to Byrne and Toly's *centaurian technics* (2006), the autonomy and democracy-promising head of distributed energy resources may mean very little to those who choose to invest in them for these ideals if the body that propels them is one that allows the few to uniquely exploit them and requires system integration.

Identifying the politics at work in distributed energy politics in Italy is something that the other chapters work to do too, if less explicitly than Chapter 4. In Chapter 3, the tension between conflicting visions for renewable energy communities features in the last "snapshot from the Italian State". Here, I discuss the experience of an influential local community cooperative with the installation of collectively owned solar panels and how it allowed renewable energy communities to take on a much different political and juridical meaning in the region Puglia. I explain that by entrenching ideals of democracy and

community empowerment in their constitution, when the Cooperative di Comunità Melpignano invested in community solar panels it was able to code what an energy community was and to crystallise this coding into regional law. Similarly in Chapter 5, to show how the critical juncture that allowed a new sociotechnical imaginary of energy to emerge in Italy operated at multiple scales, I discussed how the politics elicited by the deployment and incentivisation of distributed energy generation can be contrasting and depend on the ways they intersect with dominant narratives and visions of energy transitions.

Ultimately, even though each empirical chapter pursues a specific cut into the research assemblage, the discussion in each is useful to enrich the understanding of the others. I follow Karen Barad's lead in Diffracting Diffraction, where she cites the same paper she is writing (2014), by citing other chapters in the thesis as forthcoming articles. This gestures to how the ideas that come from and go into each chapter participate in sedimenting arguments in the others, even when they do not act as successive points in a linear trajectory. In this way, Chapter 5 can adopt an understanding that the energy transition-in-the-making characterised by proliferating distributed energy schemes in Italy is intimately entangled with the reproduction of the state and participates to processes of de-and re-territorialisation of it. This insight comes from Chapter 3, where discussion is devoted to fulfilling the aim of the thesis to "interrogate the potential of the decentralised infrastructures under study to generate processes of spatial formation, de- and reterritorialization, and contestation/reinforcement of national sovereignty". And even though Chapter 5 does not approach the research assemblage with the same analytical tools as Chapter 3 (or even takes into close consideration the new spatialisation of the Italian power system after the proliferation of distributed energy schemes), the idea that such spatialisation matters (and that it matters beyond energy governance) subtends the claims that Chapter 5 makes.

Every chapter of this thesis, from the introduction to this conclusion, all tend towards fulfilling what is perhaps the most ambitious of the thesis' aims and the one I personally care about the most. This is to "demonstrate the significance of mobilising a new materialist ethico-onto-epistemology to approach both energy and the state when

interrogating how the decentralisation of the built environment of energy production is affecting state/society relations ". Since my first forays into academia, I have been advised to stay away from the verb "demonstrating" as, depending on whom one may ask, doing so requires unquestionably robust data or exceptional argumentative skills. However, after conducting the desk-based research for this thesis, I became firmly convinced about wanting to do so. This is because the germ of an idea that I came into my doctorate with - that is, to follow how the decentralisation of electricity provision was impacting the ways in which people related to a centralised state – could only grow into a coherent investigation when I encountered post-structuralist state theory and new materialist ontologies.

For this reason, every argument that this thesis puts forward fundamentally amounts to a wholehearted testament to the importance of maintaining relationality, becoming and dispersed agency as the premises for finding an answer to my guiding research question. In Chapter 2, I delve into how doing so allowed me to craft a research design that let me cut into the research assemblage in the specific ways I needed to in order to fulfil my research aims rather than getting stuck trying to oversimplify a complex process of change into a linear and homogenous story. I also here discuss how espousing this ethico-onto-epistemology helped develop a sensibility that afforded me the flexibility and awareness I needed during fieldwork. In Chapter 3, a relational and processual understanding of the state, whereby stateness is a constantly reproduced effect rather than a fixed entity, allows me to show how the state's assemblage reifies some of its boundaries while simultaneously becoming more porous to change as it encounters the infrastructure and discursive sociomaterialities of distributed energy schemes. And of course such a line of inquiry would not be possible without accepting the agency emerges in encounter rather than being a "capacity" that only humans hold. In Chapter 4, this dispersed, relational understanding of agency takes centre stage and allows me to read current energy regulation diffractively with infrastructural configuration to show how energy governance is shaped by more than political ideals or "transition pathways". And finally in Chapter 5 this ethico-onto-epistemology allows me to maintain all the elements that participate in catalysing sociotechnical change through a "critical juncture in time" on the same level as each other. Rather than falling into creating hierarchies of what actors are more influentially pushing

for the change to happen, or even be limited by the approach espoused by A-N-T to only follow what can be shown as having an *immediate* effect, I am thus able to allow it all to matter.

6.3 Desired Contribution to Geography

Through the theoretical reviews I have presented in this thesis, I have shown a relative lack of disciplinary reflection on the possible spatialisations and territorialisations of political power occurring through ongoing changes to energy infrastructures. A lacuna, in fact, that appears ever more significant when bearing in mind the seminal studies showing the ways in which sociotechnical systems and their vulnerabilities have been significant in producing political change in the past (Jasanoff and Kim, 2009; Mitchell, 2011).

Recognising that Geography has yet to grapple as a discipline with the relational materialisations of the socio-political brought about by sociomaterial changes in electricity systems, I have worked to contribute to the discipline a conceptualisation of how distributed energy resources and the sociotechnical imaginaries they coproduce materialise processes of de- and re-territorialisation of the state and assemble specific governance strategies with political effects. I also added to the disciplinary conversation of *how* such sociotechnical transformations reverberate into further change by investigating the temporal junctures that bring them together. Such a pursuit not only puts in conversation a number of inter- and intra-disciplinary literatures that have so far operated in isolation from each other but it is also in line with the recent interest shown by energy and resource geographers to re-visit useful heuristics like scale and space and investigate their relational production and spatiality to serve analyses of low-carbon transitions[15] (Hui and Walker, 2018; Bouzarovski and Haarstad, 2019). I have similarly worked to advance the discipline's prolonged effort to investigate energy transitions as multiscalar and political (Isoaho and

[15] as articulated in a recent special issue in *Energy Research & Social Science* edited by Castán Broto and Baker and entirely dedicated to highlight "the development of energy studies perspectives that consider 'relational space' as a critical concept organising the provision and use of energy" (Castán Broto and Baker, 2018: 1)

Karhunmaa, 2019; Yadav et al., 2019) and provided empirical insight into how an understudied and ongoing energy transition in-the-making in Italy is re-assembling the state, shaping governance, and contributing to changes in sociotechnical imaginaries of energy in the country.

The integration of a new-materialist sensibility in my investigation of the reproduction of the state in Italy and of the assembling of community energy governance has helped me begin to answer the numerous calls for an integration of analyses of power in methodological mobilisations of assemblage theory (Baker and McGuirk, 2017; McCann and Ward, 2012; Müller and Schurr, 2016). In the same vein, through this thesis as a whole I have worked to advance neo-materialist studies of energy transitions and to "move on to a reckoning of the material circuits, flow, and experiences that mark the 21st century" (Coole, 2013: 453) by staying with the disruptions of prosumption and distributed generation technologies. These had been only germinally conceptualised in geographical terms before (Ellsworth-Krebs and Reid, 2016).

Through this thesis, I have offered an impartial but detailed map of how the decentralisation of the electricity generation apparatus in Italy is agentially and affectively reproducing the country's socio-political milieu in novel ways. Empirically, I have documented the build-up of distributed generating capacity in Italy delineated the juridical and political context in which this is occurring I hope in so doing to have contributed to human geography by opening conceptual space to see local energy transitions as powerful more-than-human processes capable of deeply transforming the other relational assemblages they come in entanglement with. In espousing a research strategy rooted in new materialisms, I have also used this research project to show the merits of applying an ontologically relational approach to the geographies of energy, especially when conducting studies of politics. This is once again particularly significant because of a recognized need for sustainable transitions literature to deal with issues of power and politics while staying cognizant of their multi-actor, multi-scalar nature (Köhler et al., 2019).

6.4 Limitations and Opportunities for Further Research – Ending in the Middle

While I firmly believe in the research design I adopted in this thesis, the project has limitations. I set out to study energy transitions while holding onto the idea of becoming and therefore had from the start to make peace with researching unfolding processes – a transition in-the-making. However, national policy was drafted and put into operation *as* I conducted my research. I like to think this suggests the desk-based research I had conducted following the initial intuition for this PhD allowed me to accurately identify a critical juncture that had not fully manifested before. But it has also meant that my observations during fieldwork are based on the preliminary phase of the national regulation of collectivised prosumption. This implies that all the people I spoke to and the arrangements I immersed myself in were operating either in *waiting* for the policy to be executed or on the basis of partial information as to what the policy milieu will actually look like from here to the next 2-3 years. This is because different regulating agencies are still reviewing the legislation passed by the parliament and will have final say on the minute technical stipulations that may significantly impact how renewable energy communities and collective prosumption schemes impact distributed energy politics in Italy.

Moreover, conducting my fieldwork right after the first major lock-down following the spread of Covid-19 and through the consequent different variations of lock-downs in Italy, meant that I had to change my data collection strategy to involve a lot less participant observation and a lot more digital interviews. Though I greatly value the insight I have gathered through the latter, being unable to travel to in-person gatherings and relying solely on webinars and institutional point-of-contacts to start the snow-balling method of participant enrolment has meant speaking only to representative figures of several energy publics. Luckily, I was able to mitigate this issue by conducting semi-structured interviews with twenty different individual shareholders of a large energy cooperative, some of whom through video-calling and some in-person at the first in-person event the cooperative held after the lockdown. Through these interviews, I was able to explore how people who did not hold any position of power or vested interest in renewable community energy beyond

a small financial investment related to distributed energy politics. This however does not entirely remove the limitation that my composite data features insight from community energy-focused voluntary associations, trade associations and nascent municipal renewable energy communities with whom I have been able to enter in conversation only through "institutional representatives", either general directors or mayors.

Similarly, conducting my fieldwork during the first outbreaks of Covid-19 made it difficult to shadow everyday work that goes into the setting up and maintenance of renewable energy communities as well as that which goes into the writing of distributed energy policy. I would have liked to observe and speak more with the people who write the contracts that make renewable energy communities into juridical bodies, with the technicians that install and maintain the electricity generating and smart-metering equipment necessary for renewable energy communities to function, and even with the regional and national administrators drafting policy about them. Even though I did get to speak with several of the latter about their processes, I would have loved to sit in the rooms as these unfolded rather than only relying on the recounting of them. Doing so would have probably been difficult outside of Covid lockdowns too, but it would have certainly enriched this research. Trying to pursue this would be an interesting methodological opportunity for further research. Through this kind of immersion in the everyday work practices of distributed energy politics, more could be explored about how the ways in which the sociomaterial impacts the sociopolitical, including interesting lines of inquiry about the role of affect in materialising the assembled reality of distributed energy infrastructures, laws and organisations.

As to theoretical contributions, another opportunity for further research lies in a deepened contention with the ways in which the spatialisation of distributed energy systems may be relationally performing a multiplicity of scales. This would effectively amount to deepening the analysis presented in this thesis to engage with how the proliferation of distributed generation renewable systems come into assemblage with the sociomaterial, discursive, economic and otherwise processes that produce the porous and intersecting boundaries of geographical scales. In saying this I am inspired by

Bouzarovsky and Haarstsad's 2019 article, whereby the authors have highlighted the "inherently disruptive, dissensual and materially hybrid characteristics of trans-local low-carbon transformations" and the opportunities that bringing a relational understanding of scale presents to studies of sociotechnical transitions. Even though in Chapter 5 I have briefly touched on the concept of scale and on my commitment to move beyond nested understandings of it that allow the linear logic of "scaling up", further engagement with the ideas presented in Bouzarovsky and Haarstad's article would certainly be productive. Moving in the direction I sketched above would remain in line with the approach I have taken so far i.e., to switch useful analytical lenses on themselves and ask how scale is assembled in processes of sociotechnical change rather than how sociotechnical change encompasses re-scaling processes.

Through this thesis I do not present a comprehensive picture of a completed energy transition. Rather, I through this work refuse that to do research is to strive for representation and instead perform agential cuts into a complex energy transition in-the-making. By mobilising the analytical tools of assemblage analysis, diffractive reading and critical junctures, I stand on the shoulders of scholars across the social sciences to work through how sociotechnical transformations are intimately and powerfully sociopolitical. And as I started, I come me back to the middle. Through this thesis, my own lines of inquiry into the energy transition in-the-making I have participated in are not exhausted. They have become further deposited matter in a long process of sedimentation began before me and, I hope, continuing beyond me as further research takes on the task of investigating how ongoing decentralisations of electricity power systems reverberate beyond the grid.

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